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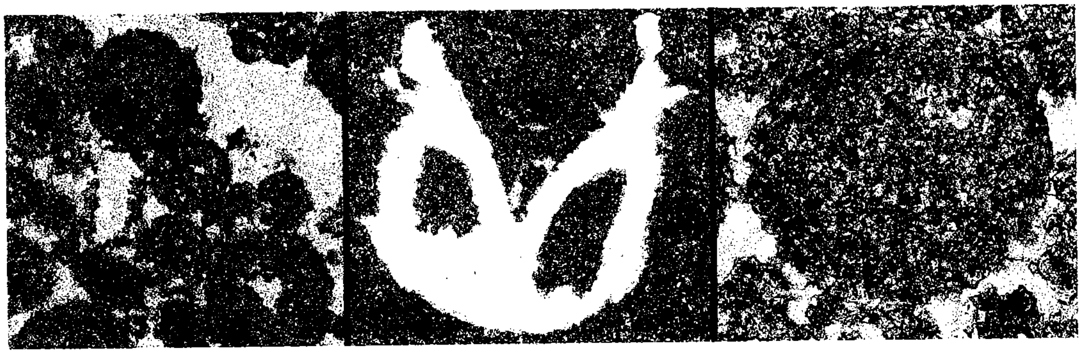
HUNTON GROUP (LATE ORDOVICIAN, SILURIAN, AND EARLY DEVONIAN) IN THE ANADARKO BASIN OF OKLAHOMA

THOMAS W. AMSDEN



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Title Page Illustration

Photomicrographs (with mezzotint screen) of *Kirkidium* biofacies (Upper Silurian). Left view, ×11, and right view, ×29, show dolomitized oolites; center view, ×12, shows cross section of ventral valve of *Kirkidium* sp. in crystalline dolomite. For full explanation, see descriptions of plate 3, figures *5* and *6*, and plate 4, figure *2a*.

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HUNTON GROUP (LATE ORDOVICIAN, SILURIAN, AND EARLY DEVONIAN) IN THE ANADARKO BASIN OF OKLAHOMA

THOMAS W. AMSDEN[1]

Abstract—This report covers the Anadarko basin, extending from R. 10 E. west to the Oklahoma border, and including some information on the Texas Panhandle. It is based on both surface and subsurface data. The latter is stressed particularly, as rocks exposed at the surface have been discussed in earlier publications. The principal emphasis is focused on a lithostratigraphic and biostratigraphic study of Hunton rocks, a group of Late Ordovician to Early Devonian carbonates that constitute an important oil and gas reservoir. In addition, structural and some lithologic data are provided from the underlying Sylvan Shale (Ordovician) and the overlying Misener Sandstone (Devonian) and Woodford Shale (Devonian-Mississippian).

One hundred and twenty-five Hunton cores have been studied megascopically, in thin section, by chemical analyses, and by porosity-permeability tests. These cores, which are confined to depths of less than −15,000 feet, are from wells that extend in a broad, arcuate belt from the outcrop area in the Arbuckle Mountains-Criner Hills north and west into the Texas Panhandle. In the deep part of the Anadarko basin, where cores are lacking, the lithostratigraphy has been investigated by stained thin sections prepared from well samples.

Hunton strata of Devonian age are present in the south-central part of Oklahoma, probably extending through the deep part of the basin and into the Texas Panhandle. These rocks comprise three Early Devonian formations, the Frisco, Haragan, and Bois d'Arc, with some very late Early Devonian (Emsian) strata locally present. These Lower Devonian rocks are represented almost exclusively in a limestone lithofacies. In the northern and western parts of the basin, Devonian strata have been largely removed by pre-Woodford erosion, and the Hunton rocks are mainly of Late Ordovician-Silurian age. Hunton strata of Silurian age in the outcrop area are divided into two major lithostratigraphic and biostratigraphic units: an upper Henryhouse Marlstone and a lower Chimneyhill Subgroup, both of which are low-magnesium limestones. This sequence appears to extend into the deep part of the basin with little change except for an increase in thickness from about 350 feet to perhaps 1,000 feet. In the northern and western parts of the Anadarko basin, Hunton strata of Late Ordovician-Silurian age are divided into an upper *Kirkidium* biofacies and a lower Chimneyhill Subgroup, believed to be essentially correlative with the Henryhouse-Chimneyhill sequence in the Arbuckle Mountains region. In northern and western Oklahoma, the *Kirkidium*-Chimneyhill beds are represented by a strongly dolomitic lithofacies, grading back into a limestone lithofacies in westernmost Oklahoma and the Texas Panhandle.

The stratigraphic and geographic distribution of the Silurian dolomites suggests that they originated as a penecontemporaneous replacement that took place at the depositional interface. In large part, possibly entirely, these dolomites are contemporaneous with, and a lateral facies of, the limestones of the Arbuckle Mountains and deep Anadarko basin and the limestones of western Oklahoma and the Texas Panhandle. The most strongly dolomitized beds have a crystalline texture, and analyses show 28 percent or more $MgCO_3$. Porous zones are irregularly developed in the dolomites, and these are the principal reservoir rocks for the Hunton gas deposits of western Oklahoma. The porosity is in considerable part a secondary porosity, altered somewhat by later introduction of calcspar and dolospar.

INTRODUCTION

The Anadarko basin is a large sedimentary and structural basin occupying much of the western half of Oklahoma and extending into the Texas Panhandle (text-fig. 1; panel 1, map A, in pocket). For many years the shallower parts of this basin have been intensively and successfully prospected for oil and gas, and drilling has been extended recently into the deepest part, to depths greater than 25,000 feet. The world's deepest well at the time the present report was prepared is the Lone Star 1 Rogers, Washita County, Oklahoma, with a total depth of 31,441 feet in the Lower Ordovician (Arbuckle Limestone). One of the main targets of the deep drilling is the Hunton Group, the principal subject of the present study. This investigation has, however, been expanded to provide additional information on strata of Late Ordovician to Early Mississippian age: the Sylvan

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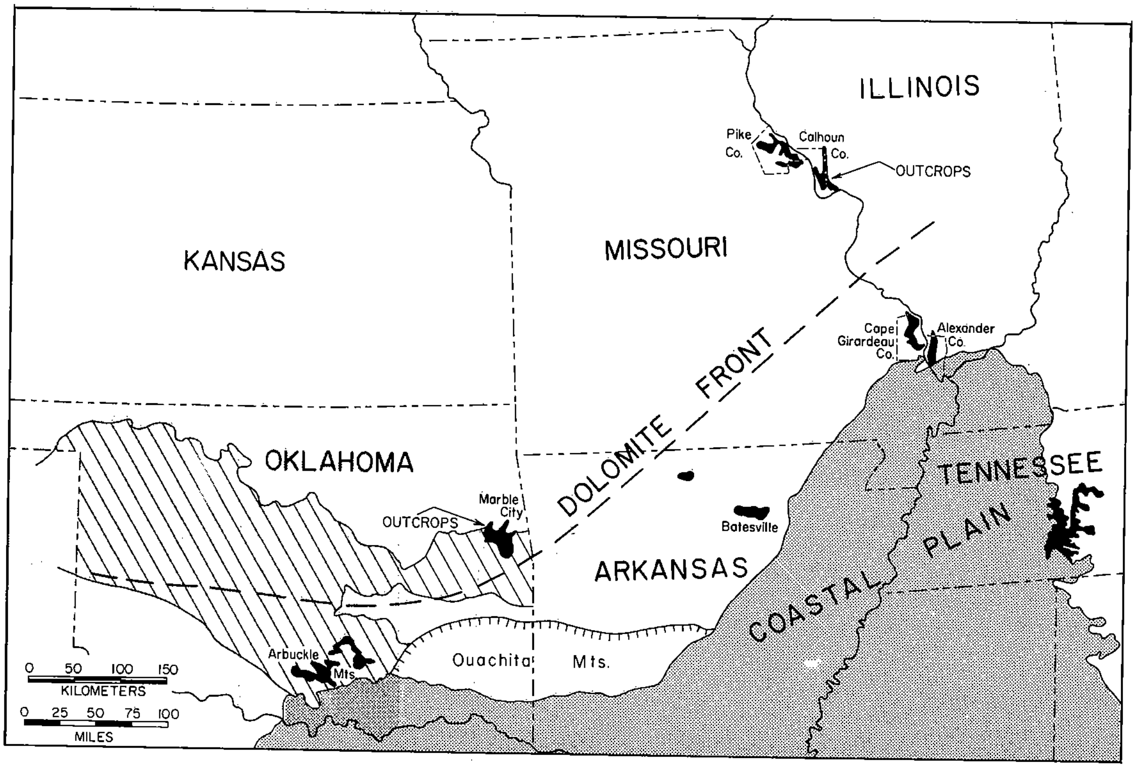


Text-figure 1. Map showing distribution of Late Ordovician-Silurian-Early Devonian outcrops (black) in central United States. Subsurface distribution of these strata in Oklahoma shown with diagonal lines. Area covered in present report shown by fine stippling.

Shale, the Misener Sandstone, and the Woodford (Chattanooga) Shale (text-fig. 2).

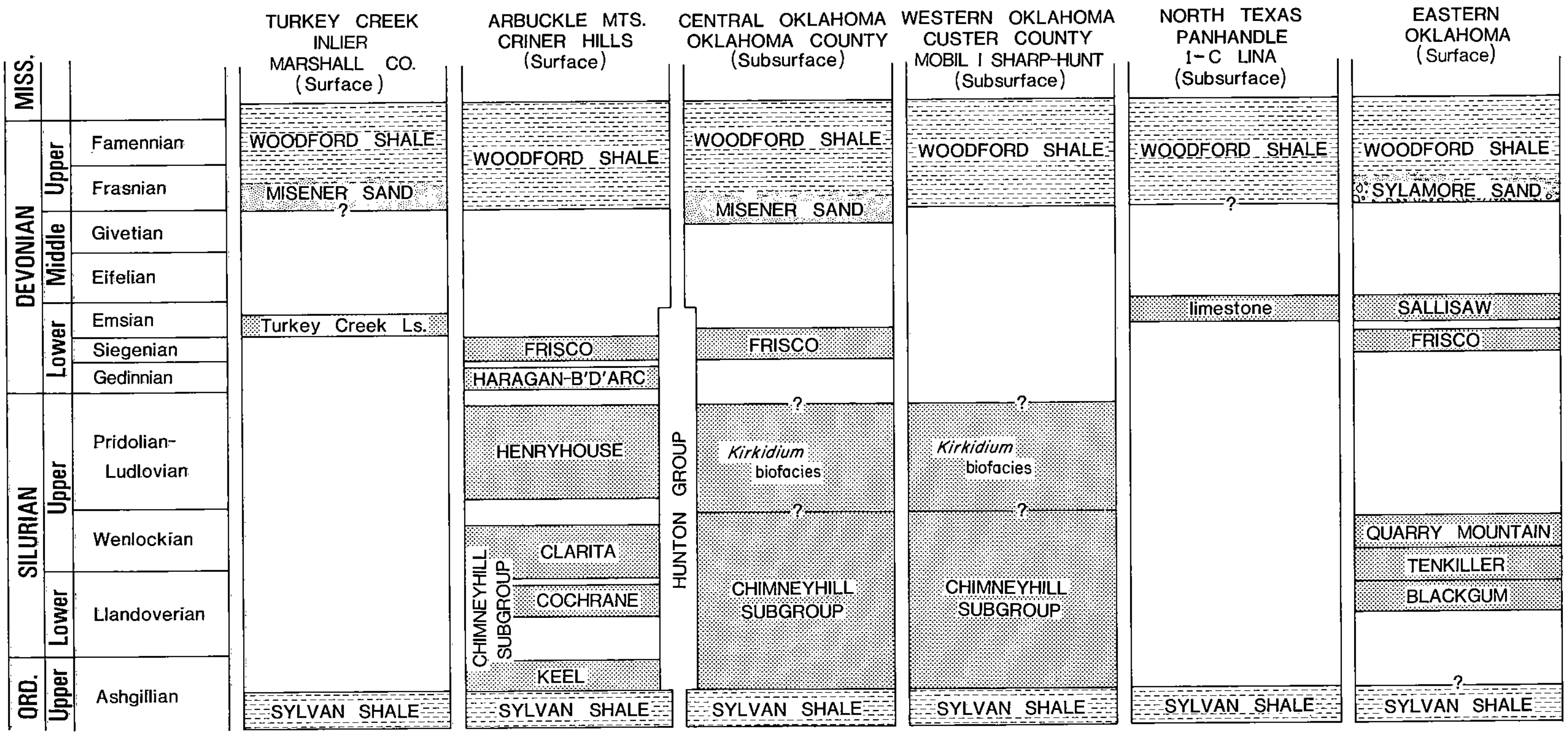
The area covered in this report is largely restricted to the western two-thirds of Oklahoma, from R. 10 E. to the western boundary, but the report does include some information on the Texas Panhandle. In this area, middle Paleozoic strata (Silurian-Devonian) crop out only in the Arbuckle Mountains-Criner Hills region, and the present study is concerned mainly with the subsurface distribution of these units. The most comprehensive information is derived from cores, of which over 125 cut some part of the Sylvan-Hunton-Woodford sequence (Appendix, part I). Unfortunately, the cores are concentrated around the shallow periphery of the basin, with relatively few penetrating the deeper parts. To supplement this, I have examined samples from 28 wells in the deep parts of the basin and in the shallow fault blocks bordering the Wichita uplift. In addition, I have utilized various mechanical logs, well-completion cards issued by Petroleum Information Corporation and Research Oil Reports, reports of the Oklahoma Corporation Commission, and the large collection of sample logs in the files of the Oklahoma Geological Survey. The data obtained from these sources have been utilized mainly in preparing the structure and isopach maps, whereas the cores (supplemented by well samples in the deeper parts of the basin) have provided the principal source for the lithostratigraphic and biostratigraphic control.

Texas Panhandle

This report is concerned primarily with Oklahoma, although a few Texas wells supplying important biostratigraphic data are included. Most of the maps stop at the State line, and only a few, such as the pre-Woodford geologic map (panel 9, in pocket), for which key data are available, extend into Texas. The combined Hunton structure and isopach map (panel 1, map B, in pocket) also includes the eastern part of the Texas Panhandle, this portion being based largely on previously published information (Quackenbush, 1969).

Cores

Cores provide the most reliable lithostratigraphic data and are the only source of the biostratigraphic information presented in this report. Coring has been concentrated in the



Text-figure 2. Chart showing inferred relationship of Late Ordovician to Early Mississippian strata in area studied in this report. Carbonate and sandstone units are stippled.

shallower parts of the basin, and the deepest core known to me is from Custer County, where the Mobil 1 Horton penetrated the Hunton to a depth of 14,754 feet (Appendix, part I). No Hunton cores are available below −15,000 feet (panel 1, map A, in pocket), and all information on the deep part of the Anadarko basin must be obtained from well samples and mechanical logs (see following section on well samples). Even in those areas where cores are relatively abundant, the information is generally incomplete, as most cores cut only a part of the Hunton. The locations of all cores studied in this report are shown on panel 1, map A (in pocket); the cores are described in part I of the Appendix (see also the stratigraphic sections on panel 10, in pocket).

The cores have been examined for fossil content, especially megafossils, although a number of cores have been processed for conodonts by means of formic residues; with few exceptions, the conodont faunas of the investigated cores are meager. The lithostratigraphic character of the cores has been investigated in hand specimens, in thin sections, and by chemical analyses. Several hundred thin sections were prepared, and almost all of the cores were completely analyzed for HCl-insoluble residue, $CaCO_3$ content, and $MgCO_3$ content. The chemical analyses were done mainly by wet analysis, although some data were obtained by X-ray analysis. In addition, complete rock analyses were prepared for a few selected cores. One of the goals of this study has been to determine the stratigraphic and geographic distribution of dolomite in Hunton rocks, and this has been effected by means of chemical analyses, thin sections, and staining with Alizarin Red-S.

Some cores have been tested for porosity and permeability; these are discussed in the main section on porosity and permeability in Late Ordovician and Silurian strata, and the data are recorded in the Appendix, part IV.

Well Samples

Well samples, supplemented by mechanical logs, have been used to study the Hunton rocks in the deep part of the Anadarko basin, owing to the absence of cores below −15,000 feet. In addition to the deep wells, a number of wells in the shallow fault blocks bordering the Wichita uplift have penetrated the Woodford-Hunton-Sylvan sequence. The lithofacies present in these shallow wells is similar to that of the deep basin, and these samples provide a most useful supplement. The locations of all wells whose samples were studied are shown on panel 1, map A (in pocket). Sample descriptions are given in part II of the Appendix.

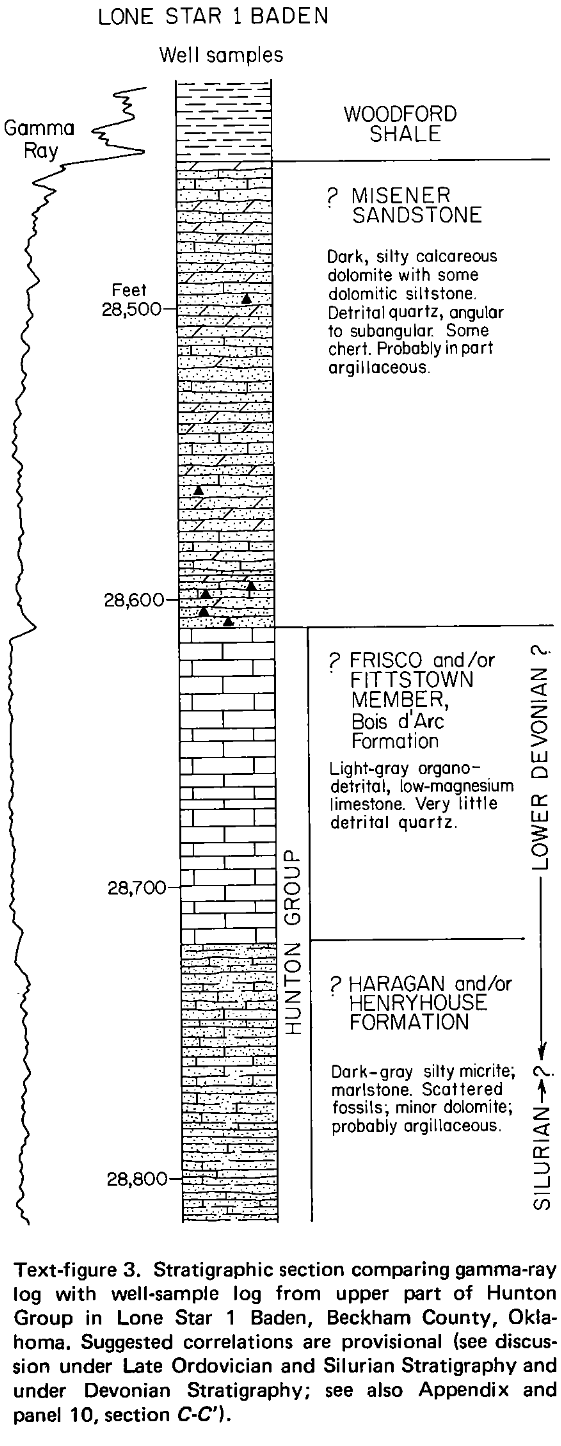
The well samples were examined with a binocular microscope, and this information was supplemented by a study of several hundred thin sections, most of which were stained with Alizarin Red-S to facilitate the distinction between calcite and dolomite. This method does not yield the quantitative results obtained from chemical analyses, and it is difficult to correlate precisely the data obtained from these two different methods of investigation. Nevertheless, it is possible by the use of stained thin sections to distinguish with reasonable objectivity certain major categories such as limestone, dolomitic limestone, and crystalline dolomite (see later subsection on Silurian dolomite), and these can be correlated with the data obtained by chemical analyses. Moreover, the thin sections provide excellent data on terrigenous detritus, fossils, character of the cement, and oolites. This makes it possible to distinguish organo-detrital limestones, marlstones, oolites, and other lithologies, and these lithostratigraphic divisions can be readily compared with those in the outcrop area and elsewhere. All in all, the well-sample study has proved to be most helpful, providing valuable lithostratigraphic information on the rocks in the deep Anadarko basin.

Chemical Analyses

A large number of surface and subsurface (core) samples have been analyzed for $MgCO_3$ and $CaCO_3$ content and for HCl-insoluble residues (a few complete rock analyses are also included). In the Hunton rocks under investigation, (1) the $MgCO_3$ occurs mainly as euhedral dolomite crystals replacing an earlier fabric; (2) the $CaCO_3$ is largely represented in the form of organic skeletal debris, or as micrite and spar cement; (3) the HCl-insoluble residues are believed to be represented mostly by clay- and silt-size terrigenous detritus. Thus all three components are of primary significance insofar as the present lithofacies study is concerned; accordingly, the $MgCO_3$, $CaCO_3$ and HCl-insoluble residues are expressed as a percentage of the total rock volume rather than as $CaCO_3/MgCO_3$ ratios or some other form. On a few graphs, the $MgCO_3$ and $CaCO_3$ are given as a percentage of the acid-soluble part, or as a ratio, but unless otherwise stated all analytical data are expressed as a percentage of the total rock. In the analytical tables given in part III of the Appendix, the $CaCO_3$ and $MgCO_3$ content is reported as ratios as well as percentages of the total.

Mechanical Logs

These have been used mainly to check the Woodford-Hunton and Hunton-Sylvan contacts, whereas the lithostratigraphic divisions within the Hunton Group are based on a study of core and well samples. However, in a number of wells I have compared the well-sample lithostratigraphy with the mechanical logs, and in many instances the divisions based on sample examinations are discernible on the gamma-ray and (or) spontaneous-potential logs. For example, in the deep part of the Anadarko basin and adjoining fault blocks, the typical pre-Woodford sequence consists of the following lithologies (in descending order): (1) silty and argillaceous carbonate, commonly with chert (?Misener Sandstone); (2) light-gray low-magnesium, organo-detrital limestone (?Frisco Formation and/or Fittstown Member, Bois d'Arc Formation); (3) dark-gray to reddish-gray marlstone (?Haragan and/or Henryhouse Formation); (4) light-gray low-magnesium, organo-detrital limestone with chert, commonly with a basal oolite (?Chimneyhill Subgroup); (5) the underlying Sylvan Shale. As shown in figures 3 and 4, these divisions can be recognized on the gamma-ray and spontaneous-potential logs.



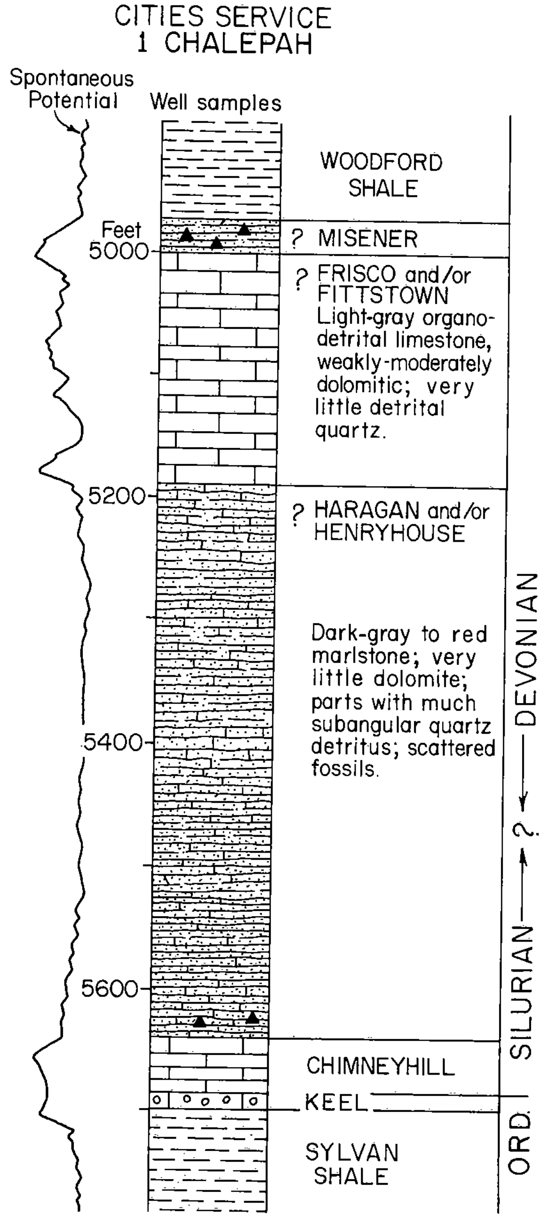
Text-figure 3. Stratigraphic section comparing gamma-ray log with well-sample log from upper part of Hunton Group in Lone Star 1 Baden, Beckham County, Oklahoma. Suggested correlations are provisional (see discussion under Late Ordovician and Silurian Stratigraphy and under Devonian Stratigraphy; see also Appendix and panel 10, section *C-C'*).

In western Oklahoma and the Texas Panhandle, the Hunton is represented by a different lithofacies. For example, in the Phillips 1-C Lee, Wheeler County, Texas (panel 1, map A, in pocket; Appendix), the upper part of the Hunton is a low-magnesium, organo-detrital limestone with very little insoluble material (*Kirkidium* biofacies), underlain by and sharply marked off from high-magnesium, crystalline dolomite with a basal strongly dolomitized oolite. As shown in text-figure 5, this lithologic sequence is reflected to some degree in the spontaneous-potential log but is not well defined on the gamma-ray log, except for the basal oolite.

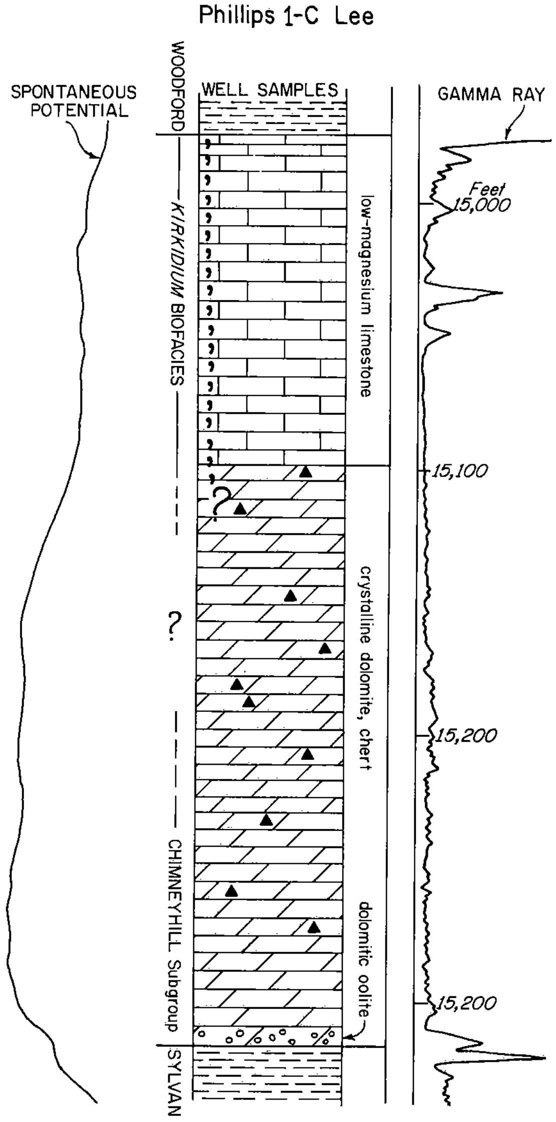
Mechanical logs can be useful in determining local lithostratigraphic correlations, but in my opinion they should be used with caution in establishing basic time-rock correlations within a carbonate sequence encompassing major lithofacies changes. For example, my investigation of the above-cited wells indicates that the *Kirkidium* biofacies of the 1-C Lee is correlative with part of the marlstone sequence in the deep basin, a relationship that appears to be entirely lost in the mechanical logs. This report attempts to document other stratigraphic complications involving both unconformities and facies changes.

Maps

This report includes isopach and structure maps of the Sylvan Shale, Hunton Group, and Woodford Shale at a scale of 1:500,000. The maps are based primarily on data obtained from well-completion cards issued by Petroleum Information Corporation and Research Oil Reports, as well as reports in the files of the Oklahoma Corporation Commission, supplemented where possible by information from cores and sample studies (over 4,000 control points were used on the structure and isopach maps). These data were plotted on a base map with a scale of 3 inches to the mile and then reduced to a printing scale of 1:500,000. Information from one well was selected to represent each square mile, if available; in areas with closely spaced drilling, one well was selected at random. I believe that the maps thus give a



Text-figure 4. Stratigraphic section comparing spontaneous-potential log with well-sample log in Cities Service 1 Chalepah, Caddo County, Oklahoma (panel 1, map A). Suggested correlations are provisional (see discussion under Late Ordovician and Silurian Stratigraphy and under Devonian Stratigraphy; see also Appendix and panel 10, section *C-C'*).



Text-figure 5. Stratigraphic section comparing well-sample log with gamma-ray and spontaneous-potential logs in Phillips 1-C Lee, Wheeler County, Texas. Upper part of Hunton was cored and yields numerous specimens of the brachiopod *Kirkidium* sp. (see Late Ordovician and Silurian Stratigraphy, Appendix, and panel 10, section *B-B'*).

reasonably accurate regional view of the structures and thicknesses for most of the basin. However, in the area bordering the Wichita fault system, which extends into the southeastern corner of the Anadarko basin and includes the Arbuckle Mountains-Criner Hills region, deformation becomes so intense that it is not possible to depict the structure on maps of this scale; consequently, considerable generalization has been necessary.

This report also provides lithofacies maps of the following Hunton stratigraphic units: Chimneyhill Subgroup, *Kirkidium*-Henryhouse biofacies, total Silurian sequence, Frisco Formation. In those areas with adequate core data, the maps are based on chemical analyses of the cores, but for the deeper part of the Anadarko basin where such information is lacking I have used well samples and thin sections prepared from samples to determine the lithologic character. Some difficulties are encountered in correlating the two sets of data, and, therefore, different patterns are employed to keep each category separate. I believe these maps provide a reliable regional guide to the distribution of limestone, dolomite, and insoluble residues.

Hunton Group

The Hunton was named by Taff in 1902 for Silurian to Early Devonian carbonate strata that crop out in the Arbuckle Mountains-Criner Hills of south-central Oklahoma. These strata overlie the Sylvan Shale (Late Ordovician) and underlie the Woodford Shale (Late Devonian-Early Mississippian), thus making a distinctive shale-carbonate-shale sequence that is easily recognized at the surface and in the subsurface. Hunton rocks have been intensively studied in the Arbuckle Mountains region, through major investigations by Reeds (1911), Maxwell (1931), and me (Amsden, 1960, 1961). Seven formations make up the Hunton Group in the Arbuckle Mountains and Criner Hills (ascending): the Keel, Cochrane, Clarita, Henryhouse, Haragan, Bois d'Arc, and Frisco Formations (Amsden, 1967, p. 944). In the present report, the Hunton Group is expanded to include late Early Devonian strata (Emsian) in eastern Oklahoma (Sallisaw Formation), southern Oklahoma (Turkey Creek limestone), and unnamed units in western Oklahoma and the Texas Panhandle (text-fig. 2). A detailed lithostratigraphic and biostratigraphic discussion of these rocks is given in the above-cited references.

Recent studies indicate that the Hunton comprises strata ranging in age from Late Ordovician to Early Devonian. The Chimneyhill Subgroup comprises three formations: the Keel Formation of Late Ordovician (late Ashgillian) age, the Cochrane Formation of late Early Silurian (late Llandoverian) age, and the Clarita Formation of late Early Silurian (late Llandoverian) and early Late Silurian (Wenlockian) age. The Henryhouse Formation of Late Silurian (Ludlovian) age completes the Silurian sequence. At most places the Henryhouse Formation is overlain by the Early Devonian (Helderbergian, Gedinnian) Haragan and (or) Bois d'Arc Formation. The youngest Hunton strata in the Arbuckle Mountains-Criner Hills region is the Frisco Formation of middle Early Devonian (Deerparkian, Siegenian) age. In Marshall County, the Turkey Creek limestone of late Siegenian or early Emsian age is the youngest pre-Woodford unit cropping out in south-central Oklahoma. The age and suggested correlation of these units are shown in text-figure 2.

Subsurface stratigraphers have applied the term Hunton to carbonate strata—variously given formation, group, and megagroup status—over a wide area in the central United States. These beds generally include strata of probable Silurian and (or) Devonian age, but other than this their connection with the Hunton beds of the type area is at best uncertain. There is, however, fairly solid evidence to show that the term Hunton, as employed in the subsurface studies of the present report, comprises strata of about the same age as those in the type region, the only change being the addition of very late Early Devonian (Emsian) strata (text-fig. 2).

Hunton Unconformities

A number of years ago a controversy arose concerning the stratigraphic relations within the Hunton Group (Amsden, 1962b). My own view on this subject, which has been presented in several earlier publications (Amsden, 1960, and subsequent publications) and is here repeated, is that the Hunton represents an incomplete depositional sequence with significant time-stratigraphic gaps developed over substantial areas in the Arbuckle Mountains-Criner Hills outcrop area. Most subsurface stratigraphers of that time preferred to interpret Hunton deposition as representing a single depositional episode, affected only by pre-Woodford erosion. Recently I have talked with several geologists who now believe that Hunton deposition in the Anadarko basin was interrupted by one or more unconformities of some magnitude, an interpretation generally based on logs, evidence of solution, sands, and other criteria. Within the Anadarko basin (and eastern Oklahoma), I find solid evidence for a pre-Frisco unconformity of some magnitude (see discussion of Frisco Formation under Devonian Stratigraphy), but, with the possible exception of the deep Anadarko basin, I can muster very little definitive evidence for unconformities within the Silurian sequence (see later subsections on Chimneyhill Subgroup and *Kirkidium* biofacies). In general, the lithologic distinction between the Chimneyhill Subgroup and the overlying *Kirkidium* biofacies is lost throughout much of the basin owing to lithofacies changes, and the only reliable means of identifying this unit is its fossils. The brachiopod *Kirkidium* is common and widespread in cores from western Oklahoma and the Texas Panhandle, and at no place is it found in close proximity to the Sylvan Shale. Diagnostic Chimneyhill megafossils are uncommon, although the known occurrences are rather widely distributed geographically; this fact, plus the presence of an oolite at the base of the Keel in many wells, suggests that Chimneyhill strata are well represented throughout much of western Oklahoma and the Texas Panhandle. Thus the general stratigraphic relations appear to militate against any regionally developed unconformities, although this certainly does not preclude the possibility of local unconformities.

Hunton Thickness

Hunton strata in the Arbuckle Mountains-Criner Hills region attain a maximum thickness of about 450 feet (Amsden, 1960, p. 22); however, the thickness varies widely within the outcrop area, owing in part to removal of strata by pre-Woodford erosion and in part to erosion during Hunton time. The maximum thickness (Amsden, 1960, p. 34, 51, 63, 82, 87, 127) of each of the stratigraphic units making up the Hunton Group is as follows:

Frisco Formation	60 feet
Haragan-Bois d'Arc Formations	325 feet
Henryhouse Formation	247 feet
Clarita Formation	45 feet
Cochrane Formation	57 feet
Keel Formation	15 feet

These thickness figures total nearly 750 feet, and the total original thickness may have reached 750 feet, at least locally.

Regional studies on Hunton thickness by Tarr (1955, p. 1851-1852), Huffman (1959, p. 2555), Maxwell (1959, p. 102-103), and Amsden and Rowland (1967a) have suggested a regional thickening into the deep part of the Anadarko basin, although until very recently there have been no data available below −17,000 feet. Thick sections (more than 1,000 feet) have been known for some time from the shallow fault blocks bordering the Wichita uplift, but these have been questioned because of the possibility that they could be in part the result of structural distortion (considerable folding and faulting are present in this region; see following main section on regional structure). Information from a number of deep wells is now available which indicates a basinward thickening, and for the deeper part of the basin there appears to be a fairly close relationship between structure and thickness (panel 1, map B, and panel 5, in pocket). Thicknesses greater than 1,600 feet are known, and lithostratigraphic studies based on well samples suggest that in large part these values represent true stratigraphic thickness and are not the result of structural deformation. The sample investigation, based on wells in the shallow fault blocks and in the deepest part of the basin, reveals a lithostratigraphic sequence remarkably similar to that present at the north end of the Arbuckle Mountains region (Amsden, 1960, stratigraphic sections P1, P3, P8, P11; Appendix). The upper part of the Anadarko basin section comprises organo-detrital limestones underlain by marlstones, which are in turn underlain by organo-detrital limestones commonly with a thin oolite at the base (panel 10, section *C-C'*). This resembles the Arbuckle Mountains section, which has Frisco-Fittstown organo-detrital limestones at the top, underlain by the Cravatt-Haragan-Henryhouse marlstones, with the Chimneyhill organo-detrital limestones at the base (commonly with Keel oolite at the base). Hunton rocks thicken from 500 feet or more in the Arbuckle Mountains section to a maximum of more than 1,600 feet in the basin, with each of these major lithostratigraphic units showing a corresponding increase (panel 10, section *C-C'*). Correlation of the stratigraphic units between the two regions is based entirely on lithologic similarity, there being no faunal data available from the well samples. Nonetheless, the similarity in lithology and lithostratigraphic sequence along this line of section suggests that these stratigraphic units are approximately equivalent, and the progressive thickening of each unit further indicates a sedimentary thickening as a result of increased subsidence. This further suggests that the deep-basin sequence may be more complete than that of the surface section, lacking some or all of the time-stratigraphic gaps of the latter. Hunton strata in the shallow fault blocks bordering the Wichita uplift do show substantial variation in thickness, ranging from less than 100 feet to over 1,600 feet. A part of this may be due to undetected structural anomalies, but a part is certainly the result of pre-Pennsylvanian erosion, with the Woodford Shale and the upper part of the Hunton missing in many of the very thin Hunton sections. Undoubtedly, movement along the faults occurred prior to (and possibly during) the period of pre-Pennsylvanian erosion, with the result that some blocks were eroded more deeply than others.

Toward the north, where the Anadarko basin becomes shallower, Hunton strata thin and finally disappear near the Kansas border (panel 6, in pocket). This is, in considerable part, clearly related to pre-Woodford erosion as the Hunton was thinned from the top; Devonian strata were eroded first, then the *Kirkidium* biofacies, leaving only a thin edge of Chimneyhill that finally feathers out beneath the Woodford. In addition to this regional thinning, Hunton rocks show linear, winding, thinned areas that are interpreted to be the result of stream erosion during the time of pre-Woodford emergence (see discussion under following subsection on Woodford Shale).

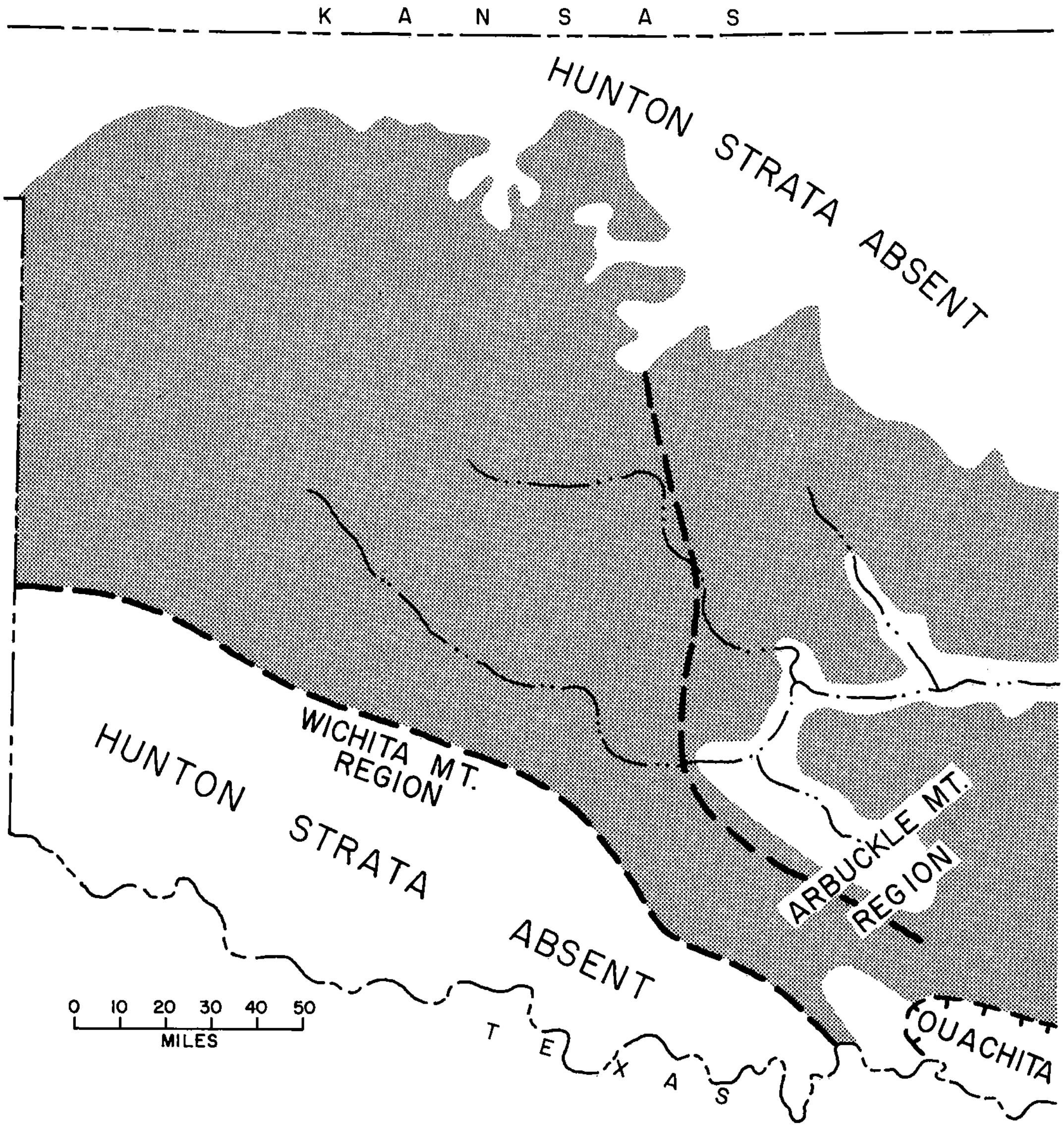
Hunton rocks in the central and northern Anadarko basin are believed to be represented by a different stratigraphic sequence than those in the deepest part and in the bordering shallow fault blocks. In the central part of the State, the Frisco Formation truncates the Haragan-Bois d'Arc Formations and rests unconformably on the Silurian (panel 9; panel 10, section *A-A'*). To the north and west, the organo-detrital limestones of the Frisco are absent, presumably owing to pre-Woodford erosion, and for the most part Hunton rocks in northwestern Oklahoma are composed of Silurian units only. Still farther west in parts of the Texas Panhandle, Lower Devonian strata are locally present (see under section on Devonian stratigraphy). Moreover, the Hunton lithofacies is different from that in the outcrop area and the deep basin; the marlstone facies is absent, and the rocks are generally low-insoluble dolomites and dolomitic limestones (see section on Late Ordovician and Silurian stratigraphy).

Woodford Shale

The Woodford is primarily a dark-gray to black shale that blankets much of the area under investigation (Amsden, 1960, p. 133-140; Amsden and others, 1967, fig. 3). Over most of the Anadarko basin the formation is less than 150 feet thick, but it thickens in the deep part of the basin, locally reaching a thickness of more than 700 feet (panel 4, in pocket). The Woodford thickens fairly uniformly into the deep basin, but in the eastern region the thickness varies substantially in short distances, probably at least in part owing to variations in the thickness of the underlying Hunton strata (compare Woodford isopach map, panel 4, with Hunton isopach map, panel 5, in pocket). Some chert is present, especially in the lower part, and in places a basal sandstone or conglomeratic sandstone is present. Throughout the outcrop area in the Arbuckle Mountains and Criner Hills, this basal clastic facies consists of at most a few inches of conglomeratic material. However, in some areas of the subsurface the Woodford is underlain by a widespread, well-developed dolomitic sandstone. This is the Misener Sandstone, described in the following section.

An unconformity separates the Woodford Shale (locally with the Misener Sandstone at its base) from the underlying strata so that it rests on strata ranging in age from late Early Devonian to Ordovician. Within the outcrop area of the Arbuckle Mountains region, pre-Woodford erosion locally truncates the Hunton completely, allowing the Woodford to rest on the Sylvan Shale of Late Ordovician age (Amsden, 1960, panel 3, pl. A). Regionally, there is a fairly uniform beveling of the Hunton toward the north, and along the northern margin of the State these rocks have been entirely stripped away (panel 9, in pocket). An interesting pattern was developed by pre-Woodford erosion just east of the Central Oklahoma fault zone, along the central and eastern margins of the rocks under study. Hunton rocks in this area appear to have been rather deeply dissected, producing relief of as much as 300 feet (panel 5, in pocket). Some rather long, well-defined channels are present in this area, and in places they cut through the Hunton into the underlying Ordovician. The shape and distribution of these depressions suggest that they are the remnants of ancient stream channels (text-fig. 6). According to this interpretation, Hunton strata in the central and southern Anadarko basin region formed a topographic high during pre-Woodford time, and these linear depressions, some of which cut through the Hunton into the underlying Ordovician, are the result of streams flowing eastward from this high area, an idea suggested by Amsden and Klapper (1972, p. 2331) on the basis of a Misener Sandstone study.

Woodford structure closely matches that of the underlying Hunton (compare panels 3 and 5, in pocket). The Woodford is absent from the Wichita uplift but is present in most of the fault blocks bordering the uplift. The Central Oklahoma fault zone is well defined on the Woodford structure map in the southern and central areas and by steep dips in the northern part of Oklahoma (panel 3).



Text-figure 6. Map showing inferred stream channels developed on Hunton surface during pre-Woodford erosion cycle.

In the southern area this fault zone is fairly well defined on the Woodford isopach map, suggesting movement during Woodford deposition (panel 4). To the north the fault trend is obscure, although some indication of it is represented in a zone of small isolated blocks from which the Woodford is absent (Jordan, 1962).

The Woodford Shale exhibits little change in lithology throughout the Anadarko basin, being largely a dark shale. Excluding the Misener Sandstone, the Woodford does not appear to develop any marked basinal facies; an examination of cuttings from wells in the deep part of the basin and adjoining fault blocks shows a shale similar to that of the outcrop area in the Arbuckle Mountains-Criner Hills and to the cores from the shallower parts of the basin.

Conodont studies by Hass and Huddle (1965, p. D128-D129) show the Woodford Shale in the Arbuckle Mountains region to range from early Late Devonian (Frasnian) to Early Mississippian (Kinderhookian). Recently, Klapper (Amsden and

Klapper, 1973, p. 2326-2331) recovered several conodont faunas from Misener Sandstone cores in the Federal 1 Wolleson, Amerada 1 Richey, Amerada 1 Breckenridge, and Gulf 1 Holtzschue (see panel 11, in pocket). These conodonts have an age range of late Middle Devonian (Givetian) to Late Devonian (Frasnian and Famennian), thus indicating that in part the Misener Sandstone was deposited contemporaneously with the lower part of the Woodford Shale in the Arbuckle Mountains region. This also suggests that the basal Woodford-Misener sequence is diachronous. The aforementioned late Middle Devonian conodonts in the Misener document the only presently recognized Middle Devonian strata in Oklahoma.

The following 26 cores cut some part of the Woodford Shale (described in part I of the Appendix and located on maps on panels 1, 3, and 4, in pocket): Cox 1-A Annis, Calvert 1 Bertie, Calvert Mid-America 2 Bloyd, Jones and Pellow 1 Boyd, Huber 1 Cherokee Methodist Church, Getty 1-B Coffman, Shell 1-15 Dill, Aspen 1-A Federal, Tenneco 1-11 Fisher Unit, Cleary 1-21 Gilbert, California 1 Goodell et al., Lone Star 1 Hannan Unit, Anadarko 1-A Hawkins, Glover Hefner Kennedy 1-1 Hoffman, Gulf 1 Holtzschue, Tenneco 1-A Jordan Unit, Gulf 1 Mainka Ring, California 1 Mullen et al., Pan American 1-B Roetzal Unit, Cleary 1-12 Rose, Gulf 1 Schroeder, Mobil 1 Sharp-Hunt Unit, Humble 1 State Hunton, Gulf 1 Streeter, Payne 1 Williams, Gulf 1 Wright Heirs.

Misener Sandstone

The Misener Sandstone covers a large area in north-central Oklahoma, although it rarely exceeds 20 feet in thickness (see panel 11, in pocket). It is composed of sand-size quartz grains (up to about 0.5 mm) set in a dolomitic matrix and ranges from a sandy dolomite to a dolomitic sandstone. The quartz grains are well rounded but commonly have crystal overgrowths. The sandstone overlies the pre-Woodford unconformity, grading upward into the Woodford Shale, and is believed to be a basal facies of that formation. The Misener in this region is interpreted as a second-generation sand, derived mainly from detritus weathered from the underlying Ordovician. Cores from the Misener yield a conodont fauna of late Middle to early Late Devonian age (Amsden and Klapper, 1972, p. 2323-2332; see also previous section on Woodford Shale).

There is also a well-developed sandstone underlying the Woodford Shale in Marshall County, although its presently known areal extent is limited (panel 11, in pocket). This sand differs from that of north-central Oklahoma in being composed of finer, much more angular quartz grains, including considerable mica. It is believed to be correlative with the Misener of north-central Oklahoma, but the angular grains suggest a primary sand, probably derived from the Ouachita region (Amsden, Klapper, and Ormiston, 1968, p. 163-164; Amsden and Klapper, 1972, p. 2332-2333).

My recent study of well samples (including a number of thin sections) from the deep part of the Anadarko basin and in the bordering shallow fault blocks reveals the presence of a silty carbonate lying between typical Woodford Shale and the organo-detrital limestones of the Hunton Group (text-figs. 3, 4; panel 10, section *C-C'*; panel 11). The detritus is mostly angular silt-size quartz grains (generally less than 0.1 mm) set in a carbonate matrix. The quantity of quartz is highly variable, ranging from a dolomitic siltstone to a weakly silty dolomite. Chert is commonly present. The more silty parts of this rock resemble the Misener Sandstone of Marshall County, with which it is tentatively correlated. The underlying Hunton limestones would appear to be a poor source for detritus, and this, plus the angularity of the quartz grains, suggests that the sand, like the Marshall County Misener, is a primary sand derived from a southern or southeastern source.

The following cores cut the Misener Sandstone: Amerada 1 Breckenridge (Amsden and Klapper, 1972, fig. 4, p. 2330), Shell 1-15 Dill, Tenneco 1-11 Fisher Unit, Cleary 1-21 Gilbert, Texaco 1 Gipson, Anadarko 1-A Hawkins, Gulf 1 Holtzschue, Amerada 1 Richey, Federal 1 Wolleson, Gulf 1 Wright Heirs (locations shown on maps on panels 1, 3, 4, and 11, in pocket).

The Misener Sandstone in north-central Oklahoma has a moderately coarse texture and is composed of a mixture of crystalline dolomite and quartz detritus. Parts have good porosity and produce oil and gas. The Misener in Marshall County also has beds of good porosity and produces oil and gas (Walters, 1958, p. 19-20, 30). For the most part, the Misener in the deep part of the Anadarko basin is relatively high in carbonate content, with only scattered quartz grains. The only information I have concerning its porosity comes from thin sections prepared from well cuttings, and these suggest fairly dense texture. More information is needed on the formation in this area concerning its lithologic character, porosity, and other properties.

Strata believed to be correlative with the Misener Sandstone were also noted in samples from the following wells: Signal 1 City of Ardmore, Lone Star 1 Baden, Mobil 1-A Cement, Cities Service 1 Chalepah, Goff-Leeper 1 Giles, Union of California 1 Goode, Inexco 1 Lovett, Texas 1 Rolls, Denver 1-A School Land, Sunray DX 1-A Wesner (panel 11, in pocket).

Sylvan Shale

The Sylvan Shale of Late Ordovician (Ashgillian) age is present over a large part of the area under investigation (panels 7, 8, in pocket). In its type region, in the Arbuckle Mountains and Criner Hills, the Sylvan is a brown fissile, graptolitic shale grading upward into a green claystone with varying amounts of carbonate (Ham, 1969, p. 11; Jenkins, 1970, p. 263; Amsden, 1960, pl. 1). The Sylvan in the outcrop area ranges from 100 to 350 feet in thickness and is underlain by the "Fernvale"-Viola Limestones of Middle and Late Ordovician age and overlain by the Hunton Group.

Throughout much of the Arbuckle Mountains-Criner Hills area and in parts of the subsurface, the Sylvan Shale is overlain by the Keel Formation of Late Ordovician (late Ashgillian) age. This contact is only rarely exposed, and the relationship of these formations is conjectural (Amsden, 1960, p. 32). In the outcrop area the Keel Formation is generally overlain by the Cochrane Formation of late Early Silurian (late Llandoverian) age, and there is evidence of at least local erosion during post-Keel, pre-Silurian time (Amsden, 1960, p. 43; Amsden, 1963b, p. 633-634; see discussion of Chimneyhill Subgroup, this report). This erosion is believed to have truncated the Keel in places, allowing the post-Keel strata to rest on the Sylvan Shale (Amsden, 1960, p. 34, panel 2, pl. C). According to this explanation, some Sylvan rocks must have been removed by erosion, although there is little direct evidence bearing on this. However, it is important to note that, with the possible exception of local areas in the Texas Panhandle (see below), there is no place known to me where Hunton rocks *of Silurian age* rest on pre-Sylvan strata. (The Frisco Formation of Early Devonian age in the Tidewater 1 Johnson, Jackson County, rests on Viola, but this is due to post-Silurian, pre-Frisco erosion.) Since the Sylvan Shale is thin, less than 100 feet thick over much of the area studied, it seems unlikely that it could have been subjected to much pre-Silurian erosion without being removed in some places.

In the deep part of the Anadarko basin, where both Sylvan and Chimneyhill strata have thickened, it is possible that a more complete Late Ordovician-Early Silurian section is present; in fact, Jenkins (1971, p. 490) suggests that deposition in the Texas Panhandle part of the basin was continuous from Late Ordovician into Early Silurian time. However, where I have examined it in well samples and cores, the contact between the Chimneyhill (commonly with the Keel oolite at its base) and Sylvan is sharply defined (panel 10, in pocket). The Sylvan surface on which Hunton strata were deposited was one of low relief, as shown on the Sylvan isopach map (panel 8; some Hunton isopachs are also shown on this map). The Sylvan thickness is irregular in the east-central region, centering around Pottawatomie, Seminole, and Hughes Counties, and this is the area where Hunton rocks have been deeply dissected, being completely removed in two elongate patches (panels 6, 8). In this area there is a rough correlation between the places where Hunton strata are thin and the places where Sylvan strata are thin; a somewhat similar relationship is present in Canadian County. Hunton thinning in these areas seems to be reasonably interpreted as the result of pre-Woodford erosion, which is thought not only to have breached the Hunton but also in places to have cut through the Sylvan Shale (see discussion of Woodford Shale; text-fig. 6). The apparent correlation between Hunton and Sylvan thinning is not clear. Possibly it is due to differential compaction; certainly there is little evidence for much pre-Hunton erosion.

The Sylvan Shale is a distinctive lithostratigraphic unit that is underlain and overlain by carbonate strata. Throughout most of the subsurface it is readily distinguishable from the overlying Silurian limestones and dolomites in cores, well samples, and mechanical logs. Identification problems do occur in the northwestern part of Oklahoma and adjacent regions of Texas, where this formation tends to lose its lithologic identity. An example of this is the Magnolia 1 Feldman, in the eastern part of Hemphill County, Texas; sample logs in the files of the Oklahoma Geological Survey show Hunton rocks resting on the Viola with no intervening shale. This could be due to pre-Hunton erosion (no Keel is reported), but it is more likely the result of Sylvan Shale grading laterally into limestone. Farther west, in Ochiltree County, Texas, the Phillips 1-C Lina cored Sylvan Shale, although the upper part of the Sylvan is calcareous.

Over much of the area under study the Sylvan Shale is about 100 feet or less thick. It thickens moderately into the deeper parts of the basin, reaching a thickness of 400 feet in a few places. In a few wells Sylvan thicknesses of 700 feet or so have been reported, but these are generally isolated wells and I suspect that many of these anomalous thickness figures are either the result of stratigraphic misidentification or the result of structural tilting of the beds.

Decker (1935b) assigned the Sylvan Shale to the Late Ordovician on the basis of graptolites from the lower part of the formation, and more recently Jenkins (1970, p. 284-285) recovered chitinozoans that indicate a Late Ordovician (Ashgillian) age for the entire Sylvan. Jenkins also notes (1971, p. 489) that throughout much of the Anadarko basin Silurian strata rest on beds no older than the *Dicellograptus complanatus* zone of Ashgillian (Richmond) age.

The following 10 cores cut the upper part of the Sylvan Shale (locations shown on maps on panels 1, 7, 8, in pocket; cores described in Appendix, part I): Kirkpatrick 1 Blevins Unit, Shell 1 Boley, Calvert Mid-America 2 Bloyd, Amerada 1 Breckenridge, Huber 1 Cherokee Methodist Church, Anadarko 1-A Hawkins, Tenneco 1 Huntzinger, Getty 1 Luetkemeyer Unit, Gulf 1 May, Gulf 1 Streeter, King 1 Tiger.

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REGIONAL STRUCTURE

This report is concerned mainly with strata in the Anadarko basin of western Oklahoma (panel 1, map A, in pocket). Ham and others (1964, p. 33-37, 149-154, fig. 3), in their study of the basement rocks of southern Oklahoma, assign this basin, including its southeastern extension into the Ardmore and Marietta basins, to the Southern Oklahoma geosyncline. According to these authors, this geosyncline developed in three stages: (1) an early basement-rock stage of Early and Middle Cambrian age during which time a thick sequence of volcanics and graywackes was deposited; (2) a second stage in which carbonate rocks of Late Cambrian to Devonian age were deposited; (3) a final stage with deposition of a thick sequence of Mississippian to Permian clastic rocks, a part of these sediments being derived from the uplift of an earlier part of the geosyncline (Wichita Mountains). Ham and others believe that the framework for this geosyncline developed during late Precambrian and Early Cambrian time, and that many of the major faults that cut the geosynclinal sediments had their origin in basement-rock structures.

The basic structural data used in the present report are derived from structure maps of the Woodford Shale, Hunton Group, and Sylvan Shale (panels 3, 5, 7, in pocket), aided by isopach maps of these same stratigraphic units (panels 4, 6, 8). Thus the basin is here viewed almost exclusively in terms of its middle Paleozoic stratigraphic and structural aspects. In one sense this presents a somewhat anomalous view, as these stratigraphic units are unlike the very thick sequence of later Paleozoic coarse clastics that total such a large part of the basin sequence; the Sylvan, Hunton, and Woodford comprise a relatively thin sequence of carbonates and shales that do not develop any geosynclinal facies of coarse clastics and graywackes. On the other hand, these three formations provide excellent structural control, as they make a distinctive lithostratigraphic sequence which in most places is easily recognized in mechanical logs, well cuttings, and cores; moreover, the Hunton has long been a target in oil and gas prospecting and thus provides a substantial number of control points.

The principal structural features of the Anadarko basin are mostly buried beneath Late Pennsylvanian and Permian strata. The major fault zones that border the basin on the south and east are covered by late Paleozoic strata, and there is little surface evidence of these extensive fault systems. The structures within the basin, which cause Hunton rocks to be downthrown several miles, for the most part are not reflected in the Paleozoic strata exposed at the surface, and the forces that produced this great synclinal sag must have been largely quiescent since the latter part of the Pennsylvanian. The most intensive folding and faulting is confined to the region bordering the Wichita Fault zone on the north and extends southeastward into the Ardmore and Marietta basins and includes the Arbuckle Mountains and Criner Hills. (A recent study by Mitchell and Landisman, 1970, p. 2654, suggests that the crustal movement in Oklahoma had a shallow origin.) In this region, the structural complexity is sufficiently intense (Harlton, 1972, p. 1546) to make effective structural contouring on a scale of 1:500,000 difficult; here, the maps are of necessity considerably simplified (see remarks on Maps in the Introduction). Toward the north the structural disturbance decreases in intensity, and the principal feature is a homoclinal dip into the basin, interrupted by folds and faults, which, although of minor significance in the overall pattern, are of importance in the locus of oil and gas.

The Anadarko basin is bounded on the east by the Central Oklahoma fault zone, which is well defined on the pre-Woodford geologic map of Tarr and others (1965), the pre-Pennsylvanian geologic map of Jordan (1962), and the structure maps of the Woodford Shale, Hunton Group, and Sylvan Shale of the present report (panels 3, 5, 7). It is also clearly marked on the basement map of North America (Kinney, 1967; see also Mitchell and Landisman, 1970, fig. 1) and on the tectonic map of the United States, where it is shown to join the Nemaha arch in central Kansas (U.S. Geological Survey and American Association of Petroleum Geologists, 1961). Denison (1966, p. 102, pl. 1) notes that the Central Oklahoma fault zone is underlain mainly by the Central Oklahoma Granite Group or the Chase County Granite Group. It is therefore a major tectonic feature affecting the basement-rock complex and most of the Paleozoic strata (outcropping Permian beds are unaffected).

The Anadarko basin is bounded on the south by the Wichita fault zone. The stratigraphic displacement along this fault is of such magnitude that Middle Ordovician rocks, which crop out at the surface in the Wichita Mountains, are downthrown to a depth of more than −28,000 feet. This is a broad fault zone, and in most places the Wichita uplift is separated from the deep part of the Anadarko basin by a series of shallow fault blocks, on which middle Paleozoic strata are only a few thousand feet deep (panel 1, map A; panel 5). The eastern margin of the Anadarko basin is here placed at the Central Oklahoma fault zone (panel 1, map A); east of this fault the dip is relatively gentle and the strike about north-south, whereas west of this zone the structure steepens and the strike changes to define the basin (panels 3, 5, 7). Toward the north, this fault system turns to the northeast and joins the Nemaha arch (see U.S. Geological Survey and American Association of Petroleum Geologists, 1961); toward the south, it bends to a northwest-southeast direction, joining the structural trend of the Arbuckle Mountains. The southeastern end of the Anadarko basin is formed by this northwest-southeast-trending structural complex and includes the Ardmore and Marietta basins, situated between the Wichita Mountains and the Arbuckle Mountains (Ham and others, 1964, fig. 3). This corner of the Anadarko basin gives the appearance of having been squeezed between the Arbuckle and Wichita Mountains complexes. Walper (1970, p. 36, fig. 4) has suggested that the major structures in southern Oklahoma are the result of left-lateral megashears, but the present study provides no information bearing on strike-slip movement, if any, along the Wichita fault zone.

Although the Central Oklahoma fault zone is sharply defined on the Sylvan, Hunton, and Woodford structure maps, it is not a simple fault because the downthrown side varies along the strike. Generally, the southern portion, in McClain and Cleveland Counties, is downthrown to the west, whereas the middle portion, in southern Oklahoma County, is downthrown to the east, with the two segments separated by an east-west cross fault (panels 3, 5, 7). The northern sector, in northern Oklahoma and Logan Counties, again has the downthrown side to the west. Farther north, beyond the truncated edge of the Hunton and Sylvan formations, the zone can be distinguished on the Woodford structure map (panel 3) by steep dips. This fault zone also appears to have been the locus for post-Woodford uplift, as the Woodford, Hunton, and Sylvan were removed over a fairly large area in Cleveland and Oklahoma Counties (panels 3, 5, 7) by pre-Pennsylvanian erosion.

At its south end, the Central Oklahoma fault zone merges into the more intensely deformed belt, swinging to the southeast and joining the Arbuckle Mountains structural trend. The control on this fault from McClain County northward is excellent; however, from here southward the increase in structural deformation makes precise identification of the faults difficult, and so the structure maps in this area are simplified and generalized. Excluding this intensively deformed segment, the vertical displacement is never great, probably at no place exceeding 1,000 feet or so and in most places considerably less. This fault maintains nearly the same position on the Woodford, Hunton, and Sylvan isopach maps (panels 3, 5, 7), suggesting a high-angle fault. (The combined Hunton-Woodford thickness in this area ranges from 400 to 600 feet.) The persistence, and moderate but variable displacement on this part of the Central Oklahoma fault, suggest that it is in large part a strike-slip fault.

The central and southern sectors of the Central Oklahoma fault zone are clearly marked on the Woodford and Hunton isopach maps (panels 4, 6) but are not well defined on the Sylvan isopach map (panel 8), although there is a zone of thinning along the fault trend. This relationship suggests that the fault was largely quiescent during Sylvan deposition but that considerable movement occurred during Hunton and Woodford deposition, probably becoming more intense toward the south. It also suggests that intermittent movement was taking place along this and other faults during the time the Anadarko basin was developing; moreover, it offers support for Ham and others' (1964, p. 154) conclusion that the structural forces that culminated in the late Paleozoic had their origin much earlier, probably starting in Precambrian time.

LATE ORDOVICIAN AND SILURIAN STRATIGRAPHY

Introduction

Strata of Late Ordovician to Silurian age are well exposed in the Arbuckle Mountains and Criner Hills of south-central Oklahoma (Amsden, 1960, p. 24-26). These strata are referable to two major biostratigraphic and lithostratigraphic divisions: an upper Henryhouse Formation (Late Silurian, Ludlovian), which is a fossiliferous marlstone, and a lower Chimneyhill Subgroup (Late Ordovician, Early and early Late Silurian), composed mainly of organo-detrital limestones, commonly with oolite of the Keel Formation at the base (Amsden, 1967, p. 942-944). These are distinctive lithostratigraphic units, the light-gray to pinkish-gray bioclastic limestones of the Chimneyhill being easily separated from the softer, yellowish-gray argillaceous limestones of the Henryhouse. They can also be distinguished in the subsurface on the basis of cores and well samples, and, in fact, the Chimneyhill-Henryhouse sequence is believed to be recognizable in the deep part of the Anadarko basin some 100 miles west of the outcrop area (see discussion of these units in following sections). However, toward the north and northwest, the Henryhouse marlstones grade into the *Kirkidium*-bearing limestones, and the entire Silurian section is dolomitized, so that the distinction between the Chimneyhill and the overlying *Kirkidium* biofacies is commonly obscure. I have little evidence bearing on the precise relationship of the Chimneyhill strata to the overlying Silurian beds in subsurface areas; however, in the deep part of the basin and in the adjoining shallow fault block, where the Chimneyhill-marlstone sequence is commonly well defined, the records of two wells, the Howell, Holloway, and Howell 1 Anadarko basin and the Texas 1 Rolls, show no recognizable Chimneyhill, with the Henryhouse Marlstone resting directly on the Sylvan (panel 10, section *C-C'*). This is also the relationship in the Arkla Exploration 1 Beauchamp, in southern Custer County, the Sylvan Shale being directly overlain by marlstone.

Late Ordovician and Silurian strata in the outcrop area attain a maximum thickness of approximately 300 feet, the Henryhouse having a maximum thickness of about 250 feet and the Chimneyhill about 70 feet (Amsden, 1960, p. 25, 29, 82). In the subsurface of Custer County, Silurian strata (possibly including a few feet of Late Ordovician beds) have a known thickness of at least 550 feet, and these strata may be as much as 800 feet or so thick in the deep part of the basin (panel 10, sections *C-C'* and *B-B'*; panel 9).

Chimneyhill Subgroup

Outcrop Area

The Chimneyhill was named for exposures on Chimneyhill Creek (South Fork of Jackfork Creek), in the northern part of the Arbuckle Mountains region. Reeds (1911, p. 258) designated it a formation and divided it into three informally named stratigraphic units (in descending order):

pink-crinoidal, glauconitic, and oolitic members. Maxwell, and later Amsden, formally named these divisions: Clarita Member (pink-crinoidal), Cochrane Member (glauconitic), and Keel Member (oolitic). In 1967 Amsden assigned these units formation status and made the Chimneyhill a subgroup; for a complete discussion of the nomenclatural history, see Amsden (1960, p. 27-30; 1967, p. 942-945).

The Clarita Formation is divided into a lower thin but persistent shale or marlstone, the Prices Falls Member (late Llandoverian), and an upper Fitzhugh Member (Wenlockian; Amsden, 1968). The latter is an organo-detrital, grain-supported limestone with either micrite or spar cement. Its terrigenous detrital content is low, although it increases in the central part of the Arbuckle Mountains (see under discussion of Henryhouse Formation). The Cochrane Formation (late Llandoverian; Amsden, 1971, p. 145) is also an organo-detrital limestone, mainly with spar cement and commonly with considerable glauconite (Amsden, 1960, p. 44-51). The Keel Formation (Late Ordovician; Amsden, 1970, p. 482; 1971, p. 19-21) is an oolite with varying amounts of fossil debris, grading locally into an organo-detrital limestone with only scattered oolites (Ideal Quarry facies). The relationship of the Keel Formation to the underlying Sylvan Shale is discussed in the section on the Sylvan Shale in the Introduction. In the outcrop area the Clarita attains a maximum thickness of about 45 feet, the Cochrane about 60 feet, and the Keel about 15 feet. Chimneyhill strata have a maximum thickness in the outcrop area of approximately 70 feet (Amsden, 1960, p. 29) but appear to thicken in the deep part of the Anadarko basin to about 200 feet (panel 10, section *C-C'*); in the Phillips 1-D Franklin (Texas Panhandle), the *Microcardinalia protriplesiana* zone of the Cochrane is 180 feet above the Sylvan Shale (text-fig. 9).

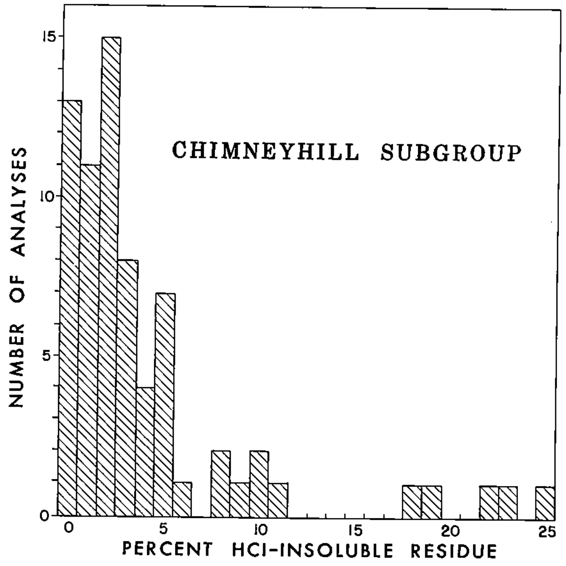
In the Arbuckle Mountains and Criner Hills, the Keel, Cochrane, and Clarita Formations make up an incomplete sequence of strata ranging in age from Late Ordovician to early Late Silurian, during which time there were local areas of uplift and erosion. It should be emphasized that these are discrete lithostratigraphic units with sharply defined upper and lower contacts; they are mappable formations that can be readily recognized throughout the Arbuckle Mountains and Criner Hills. Faunal data suggest that correlatives of these units are widely distributed in the Anadarko basin, although only the Keel oolite can be lithostratigraphically identified with certainty.

The Chimneyhill insoluble residues are low, averaging well under 10 percent, with only a few beds ranging into the 10- to 25-percent range (text-fig. 7). Most of the insolubles are silt-size terrigenous detritus. The $MgCO_3$ content is very low, averaging less than 1 percent, with only 3 specimens testing more than 1 percent (text-fig. 8). The distribution of HCl-insoluble residues and $MgCO_3$ content in the subsurface is shown on panel 1, map D; panel 2, map D; and panel 10. It is also discussed in following sections.

Cores and Well Samples

Cores have been relied on almost exclusively in tracing Chimneyhill strata into the subsurface areas of north-central and northwestern Oklahoma. Wells providing cores are rather widely spaced (panel 10, section *A-A'*) but do give the most complete lithostratigraphic, and the only biostratigraphic, information. This region presents special problems because of facies changes that make the lithologic distinction between the Chimneyhill and overlying Late Silurian strata obscure. (See the discussion under Subsurface, North-central and Northwestern Oklahoma and Texas Panhandle.)

Well samples have been relied on exclusively in tracing Chimneyhill beds into the deep part of the Anadarko basin and adjoining shallow fault blocks



Text-figure 7. Frequency diagram showing distribution of HCl-insoluble residue in surface samples from Chimneyhill Subgroup in Arbuckle Mountains-Criner Hills region, Oklahoma. Data largely from Amsden (1960, Appendix).

(panel 1, map D; panel 2, map D; panel 10, section *C-C'*). Correlation between this area and the surface is based on lithostratigraphy, as no faunal data are available. However, there appears to have been only minor facies changes between the two areas, and the lithostratigraphic sequence in the basin is much like that found in the outcrop. (See the discussion under Subsurface, Deep Anadarko Basin and Adjacent Shallow Fault Blocks.)

The following 28 wells are believed to have cored some part of the Chimneyhill Subgroup (for location, see panel 1, map A; see also panel 10, section *A-A'*; Appendix).

Cox 1-A Annis
American 4-A Bayne
Kahan et al. 6 Bean
Calvert 1 Bertie
Kirkpatrick 1 Blevins Unit
Calvert Mid-America 2 Bloyd
Huber 1 Cherokee Methodist Church
Sunray DX 1 Davis
Pan American 1 Droke unit
Gulf 1 Dyer
Phillips 1-D Franklin
Anadarko 1-A Hawkins
Carter 1 Hester
Anadarko 1 Hilpert
Mobil 1 Horton
Payne 1 Houck
Midwest 1 Hughes Unit
Tenneco 1 Huntzinger
Cleary 1-20 Kinney
Getty 1 Luetkemeyer Unit
Gulf 1 May
Jones and Pellow 1 Reherman
Sunray DX 10-A Rentie
Gulf 1 Shade
Gulf 1 Streeter
California 1 Ticer et al.
King 1 Tiger
Chevron 1 Zellers

Samples from the following 20 wells are believed to represent some part of the Chimneyhill Subgroup (for location, see panel 1, map A; described in Appendix).

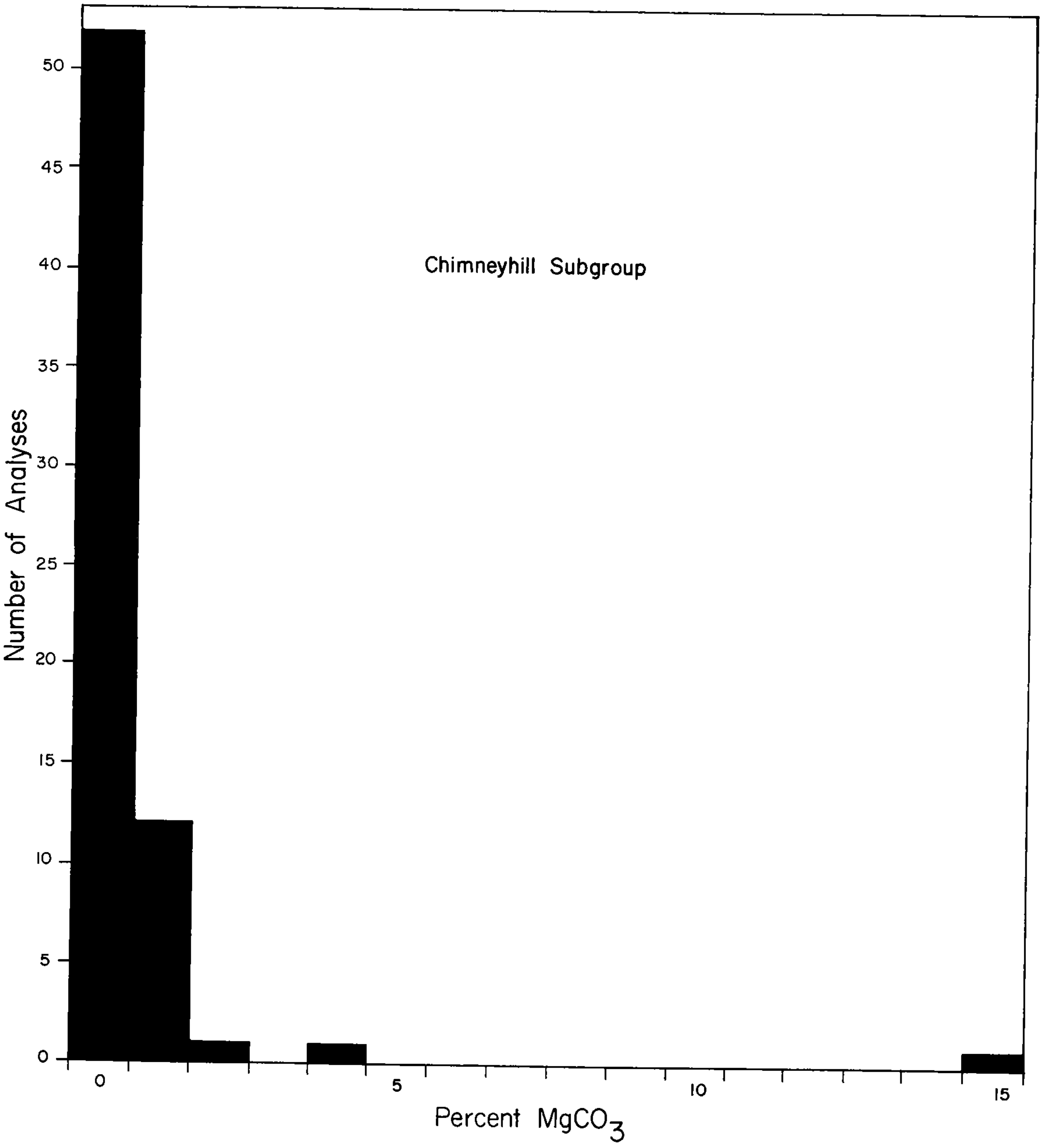
Lone Star 1 Baden
Phillips 1-A Bailey (Texas Panhandle)
Tenneco 1-27 Bradshaw
Mobil 1-A Cement (Ordovician test)
Cities Service 1 Chalepah
Signal 1 City of Ardmore
Pure 1 Fuqua
Goff-Leeper 1 Giles
Stanolind 1 Groves Unit
Arkla 1-17 Harrell
Glover Hefner Kennedy 1-27 Hayes
Inexco 1 Kendall
Phillips 1-C Lee
Texas Pacific 1-33 Libby
Inexco 1 Lovett
Inexco 1 Sanve
Denver 1-A School Land
Carter 1 State Taylor
General American Texas 1 Viersen Unit
Sunray DX (Phillips) 1-A Wesner

Subsurface, Deep Anadarko Basin and Adjacent Shallow Fault Blocks

Chimneyhill strata appear to extend northeastward from the outcrop area into the deep part of the Anadarko basin with little change in lithofacies, although they do thicken from about 60 feet to more than 200 feet (see Stanolind 1 Groves Unit and Lone Star 1 Baden; panel 10, sections *A-A'*, *C-C'*; panel 1, map D; panel 2, map D). Throughout most of this area the Sylvan Shale is overlain by light-gray to pinkish-gray low-magnesium, organo-detrital limestones, here referred to the Chimneyhill on the basis of lithology and lithostratigraphic position. In almost all of the wells studied, the basal beds in this limestone sequence are oolitic and are here assigned to the Keel Formation. The Keel has been identified in the following wells: Lone Star 1 Baden, Arkla 1-21 Beauchamp, Cities Service 1 Chalepah, Pure 1 Fuqua, Goff-Leeper 1 Giles, Stanolind 1 Groves Unit, Inexco 1 Kendall, Carter 1 State Taylor.

The Chimneyhill limestones are overlain by low-magnesium marlstones, the lower part of which is correlated with the Henryhouse Formation. This lithostratigraphic sequence is readily distinguished in well samples (especially where sample study is supplemented by thin sections) and can also be detected in some mechanical logs (text-fig. 4). These strata can be recognized in the deep part of the Anadarko basin and in the shallow fault blocks lying between the basin and the Wichita uplift. The shallow fault blocks were then clearly a part of the sediments deposited in the basin proper, which were subsequently separated from the deep basin by faulting that occurred after deposition of the Sylvan-Hunton-Woodford strata and before or during the period of Early Pennsylvanian deposition.

It is difficult to evaluate the Chimneyhill-marlstone boundary in the deep wells, owing to the lack of biostratigraphic control. The lower organo-detrital limestones here assigned to the Chimneyhill are widely distributed in the deep basin, and their lithologic contact with the overlying marlstones (?Henryhouse and/or Haragan) is well defined. However, in two wells, the Texas 1 Rolls and the Howell, Holloway, and Howell 1 Anadarko Basin, the Chimneyhill limestones are not represented and the marlstone lithology rests directly on the Sylvan Shale. This could be the result of (1) faulting, (2) a pre-marlstone unconformity (?pre-Henryhouse; ?pre-Devonian) similar



Text-figure 8. Frequency diagram showing distribution of $MgCO_3$ in surface samples of Chimneyhill Subgroup in Arbuckle Mountains and Criner Hills, Oklahoma. Data largely from Amsden (1960, Appendix).

to that at the surface, or (3) facies changes, the marlstones merging into and replacing the organo-detrital limestones. At present, there is no conclusive answer to this question, although I am inclined to doubt that it is produced by facies changes; the two lithostratigraphic units are distinct and well defined, and both the surface and the subsurface data give little indication of a merging of rock types.

During Chimneyhill time a similar environment of deposition must have prevailed over a large area, extending westward from the Arbuckle Mountains region for some 200 miles. The present location roughly parallels the Wichita uplift (panel 1, map D; panel 2, map D), although its original distribution is uncertain because the effects of post-Chimneyhill erosion cannot now be determined. During this time most of the sediments were of intrabasinal origin, relatively little terrigenous detritus having been derived from outside areas. (See section directly following.)

Subsurface, North-Central and Northwestern Oklahoma and Texas Panhandle

In the outcrop area the Chimneyhill Subgroup is a distinctive lithologic unit comprising organo-detrital limestones and oolites that are readily distinguished from the overlying Henryhouse marlstones, and, as noted before, this lithostratigraphic sequence can be traced into the deep part of the Anadarko basin. However, toward the north and west, Chimneyhill strata become increasingly dolomitic and tend to lose their lithologic identity (panel 1, map D; panel 2, map D; panel 10, section *A-A'*). Moreover, the Henryhouse marlstones grade laterally into the *Kirkidium* biofacies, which consists mainly of low-insoluble limestones and dolomites (panel 1, map C; panel 2, map C; panel 10), and thus the lithostratigraphic distinction between the Chimneyhill and the *Kirkidium* biofacies becomes obscure. Therefore, throughout much of the central and western region, fossils are the only reliable means for establishing the presence of Chimneyhill equivalents (see discussion of stratigraphic relations under section on *Kirkidium* biofacies).

Unfortunately, Chimneyhill megafossils are relatively uncommon in the subsurface. I have examined only 25 cores that can be assigned with some assurance to the Chimneyhill Subgroup, and of these the following 10 yield identifiable megafossils.

Kirkpatrick 1 Blevins unit, Clarita-type trilobites, depth 6,990-7,000 feet. (Identified by Prof. K. S. W. Campbell, letter 8/20/70.)

Calvert Mid-America 2 Bloyd, *Triplesia alata* Ulrich and Cooper, depth 6,210 feet. (This brachiopod is present in the Cochrane and Blackgum Formations, Oklahoma, and the Cason Shale, Arkansas; Amsden, 1971b, p. 145.)

Sunray DX 1 Davis, *Brevilamnulella thebesensis* (Savage), depth 3,835 feet. (This brachiopod is present in the Edgewood Group, Missouri, and the Keel Formation, Oklahoma; Amsden, 1974, p. 65.)

Pan American 1 Droke Unit, *Microcardinalia protriplesiana*? Amsden, depth 8,878 feet. (This species is present in the Blackgum Formation, Oklahoma; Amsden, 1966, p. 1010.)

Carter 1 Hester, *Triplesia alata* Ulrich and Cooper, depth 7,777 feet. (See listing for Calvert Mid-America 2 Bloyd.)

Payne 1 Houck, *Kozlowskiellina vaningeni*? (Thomas), depth 7,057 feet. (This brachiopod is present in the St. Clair Limestone, Arkansas, and the Clarita Formation, Fitzhugh Member, Oklahoma; Amsden, 1968, p. 71-75.)

Phillips 1-D Franklin, *Microcardinalia protriplesiana* Amsden, depth 11,930 feet. (Numerous specimens that appear identical to *M. protriplesiana* in the Blackgum Formation; Amsden, 1966, p. 1010.)

Midwest 1 Hughes Unit, *Eospirifer acutolineatus acutolineatus* Amsden, depth 8,145 feet. (This brachiopod is present in the St. Clair Limestone, Arkansas; Amsden, 1968, p. 64-69, pl. 1, figs. *1a-1w*.)

Jones and Pellow 1 Reherman, *Plicocyrtia arkansana* Amsden, *"Dolerorthis" nanella*? Amsden, *Resserella* sp., and *Cliftonia* sp., depth 7,911-7,912 feet. (Species present in the St. Clair Limestone, Arkansas, and/or Clarita Formation, Fitzhugh Member, Oklahoma; described and illustrated in Amsden, 1968.)

California 1 Ticer et al., *Resserella* sp., depth 3,945 feet. (Similar to specimens of *Resserella* sp. from the St. Clair Limestone, Arkansas; Amsden, 1968, p. 29, pl. 3, figs. *5a-5h*.)

Chevron 1 Zellers, *Triplesia alata* Ulrich and Cooper, depth 9,868 feet. (See listings for Calvert Mid-America 2 Bloyd and Carter 1 Hester.)

Keel fossils have been obtained only from the Sunray DX 10-A Rentie. However, lithologically the Keel oolite is readily recognizable and has been identified in the following cores: Kirkpatrick 1 Blevins Unit, Shell 1 Boley, Huber 1 Cherokee Methodist Church, Sunray DX 1 Davis, Getty 1 Luetkemeyer Unit, and Gulf 1 Mainka Ring (in all cases the oolite rests directly on the Sylvan Shale). This information, combined with that of the deep-well study (panel 10, sections *B-B'*, *C-C'*), shows that the Keel is widely distributed over the western part of Oklahoma and the Texas Panhandle. However, since a number of wells examined by cores or samples did not have any oolite above the Sylvan, it would appear that its distribution in the subsurface is patchy, just as it is in the Arbuckle Mountains and Criner Hills. Whether this is the result of local erosion, as I believe to be the case in the outcrop area (Amsden, 1960, p. 42; 1963b, p. 633, 634), or is due to the disappearance of the oolite lithology because of facies changes, cannot be determined from the data now available.

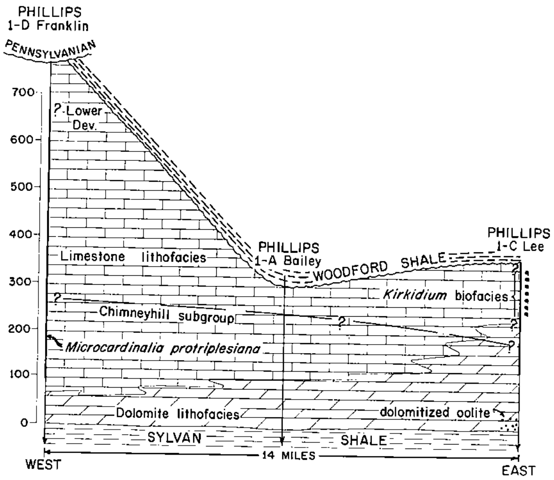
Cochrane fossils have been recovered from the five cored wells just cited, and these are distributed over a large area extending from the Ardmore basin northward to Woodward County and west to the Phillips 1-D Franklin in Gray County, Texas. The latter well is interesting, because excellent specimens of the Cochrane brachiopod *Microcardinalia protriplesiana* are present 180 feet above the Sylvan Shale. Clarita fossils have been found in four cored wells, all in the central part of Oklahoma. However, the lithostratigraphic relations suggest that equivalents of this formation are extensively distributed in western Oklahoma and the Texas Panhandle.

The evidence described in the foregoing paragraphs indicates that the Chimneyhill Subgroup is probably present over much of the Anadarko basin. In the north-central and northwestern areas the lithostratigraphic boundary with the overlying *Kirkidium* biofacies is generally obscure, and it is quite possible that this subgroup is locally absent (see previous section on the subsurface of the deep Anadarko basin and adjoining fault blocks). Under these circumstances it is difficult to determine the exact thickness, but the Chimneyhill probably does not exceed 175 feet in the northern parts of the basin. In the deep part of the basin it appears to thicken to more than 200 feet and locally may attain a thickness of 250 feet or so (see *Kirkidium* Biofacies, Stratigraphic Relations).

$MgCO_3$ Content

The distribution of $MgCO_3$ in the Chimneyhill Subgroup is shown on panel 2, map D, and in stratigraphic sections on panel 10. The facies map is based on chemical analyses of surface samples plus the 28 cores previously listed; for the deep part of the basin, $MgCO_3$ distribution is based on visual estimates of thin sections prepared from samples obtained from 20 wells. The data are minimal for an area of this size, but the wells are reasonably well spaced, and this fact, combined with the similarity of the facies pattern in the Chimneyhill to that of the overlying Henryhouse-*Kirkidium* strata, suggests that the map represents a generalized, but reasonably reliable, facies interpretation.

The Chimneyhill Subgroup in the outcrop area is a low-magnesium limestone; this facies extends westward into the deepest part of the Anadarko basin. Northward and westward from the outcrop area, the Chimneyhill $MgCO_3$ content increases, grading into dolomitic limestone and calcitic dolomite and locally passing into crystalline dolomite. Farther west, in northwestern Oklahoma, this subgroup grades back into low-magnesium limestone; however, in the central part of western Oklahoma, lower Hunton strata are represented almost entirely by crystalline dolomite, and this facies is strongly developed in the Phillips 1-C Lee and 1-A Bailey in the Texas Panhandle (panel 10, section *B-B'*). Still farther west, in the Phillips 1-D Franklin, most of the Hunton, including the *Microcardinalia* zone of the Cochrane Formation, is a low-magnesium limestone. As shown in the stratigraphic section (text-fig. 9; panel 10, section *B-B'*), the biostratigraphic control for the *Kirkidium*-Chimneyhill contact is meager; therefore, the exact relationship of the limestone-dolomite boundary to the biostratigraphic boundary is unknown.

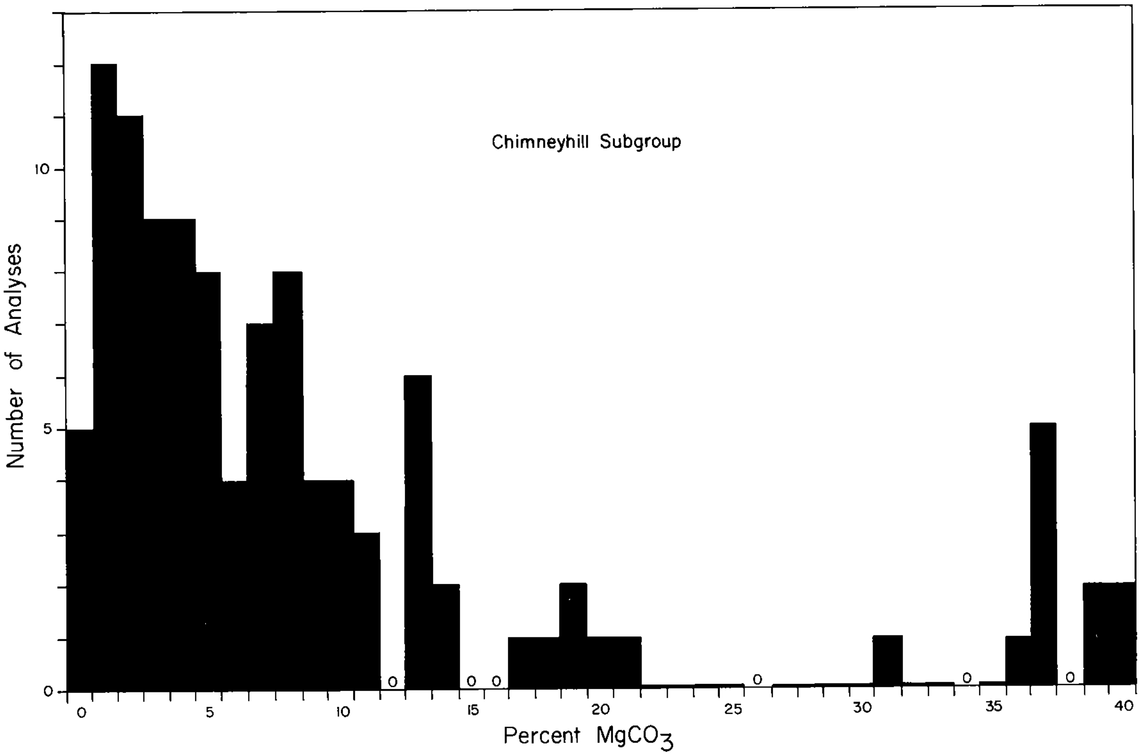


Text-figure 9. Stratigraphic sections showing limestone-dolomite relationship in Phillips 1-D Franklin (Gray County, Texas), Phillips 1-A Bailey, and Phillips 1-C Lee (Wheeler County, Texas). Position of *Kirkidium* biofacies-Chimneyhill Subgroup boundary is uncertain, the only control being the zone of *Kirkidium* sp. from 1-C Lee and *Microcardinalia protriplesiana* from 1-D Franklin. Hunton thickness in 1-D Franklin (760 feet) exceeds that in Standard of Texas 1 Wheeler Unit, Wheeler County, Texas (717 feet), which includes Lower Devonian strata, suggesting presence of Devonian strata in the former. (Thicknesses shown are those drilled, with no structural distortion assumed; datum is Sylvan Shale.) Interpretation based on cores (heavy lines) and well samples (light lines) described in Appendix; well locations shown on panel 1, map A.

The range of $MgCO_3$ in Chimneyhill cores from the Anadarko basin is shown in text-figure 10. The $MgCO_3$ has a bimodal distribution, a pattern that is common in Paleozoic dolomites (see later section on Silurian Dolomite). It should be pointed out that relatively few cores are available from the strongly dolomitized areas in western Oklahoma and the Texas Panhandle (this area has been studied largely by means of well samples); if more analytical data were available from this area, the frequency diagram would be more heavily weighted in the 30- to 40-percent range and would thus be even more markedly bimodal.

HCl-Insoluble Residues

The distribution of HCl-insoluble residues in the Chimneyhill Subgroup is shown in text-figure 11 and panel 1, map D. The percentage of this insoluble material, most of which is clay- and silt-size detritus, is fairly low in most areas. There

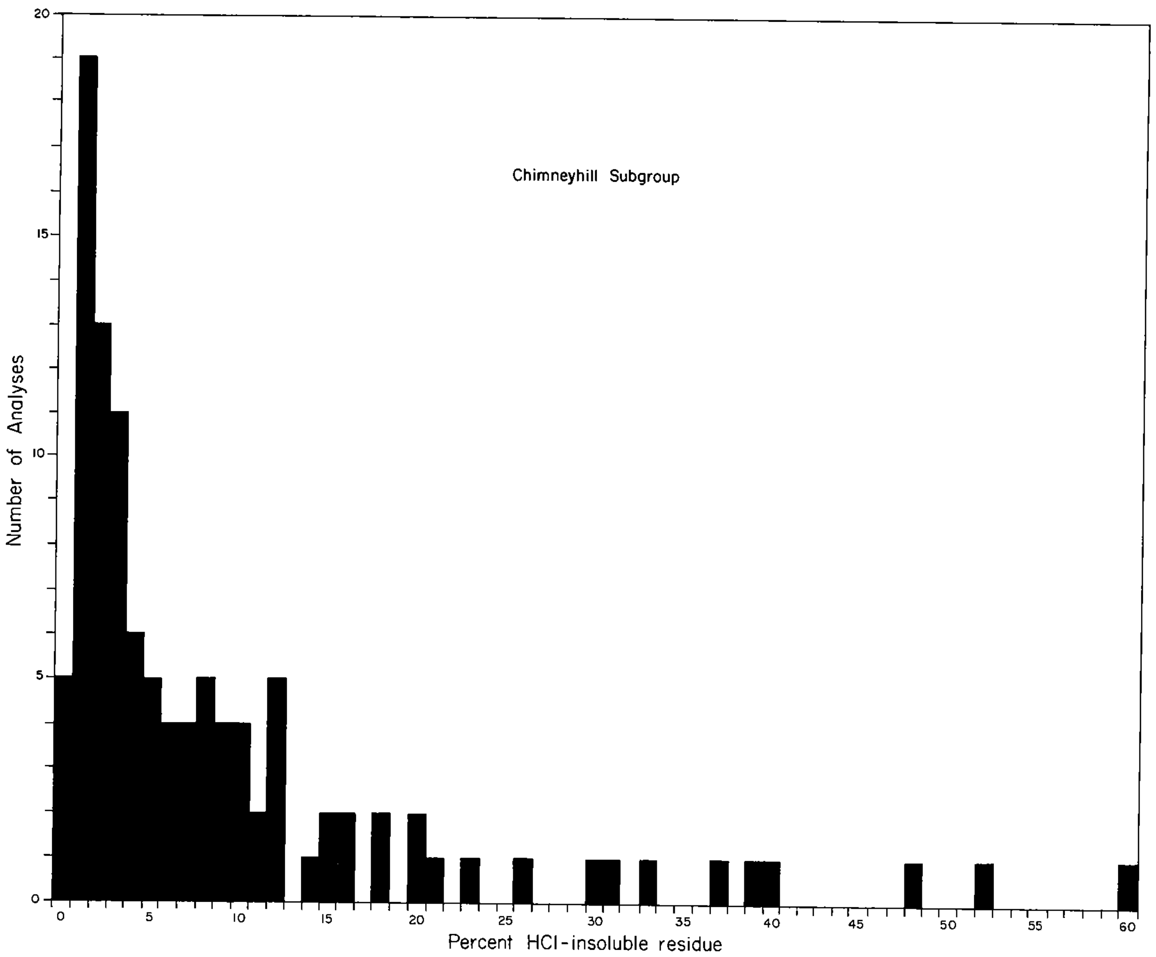


Text-figure 10. Frequency diagram showing distribution of $MgCO_3$ in Chimneyhill cores from Anadarko basin. Based on analyses given in Appendix.

is a substantial increase in the central part of the State, but it should be noted that in this region of highest residues (e.g., Mobil 1 Horton, 24.61 percent; Getty 1 Luetkemeyer Unit, 29.72 percent; Gulf 1 May, 12.43 percent) Chimneyhill strata include much chert, indicating that a considerable part of the insolubles probably represent silicification rather than detritus (in sampling, chert was excluded insofar as possible, but much small-scale silicification was unavoidably included). Excluding this silicified region, the average percentage of insoluble residue in the Chimneyhill rarely exceeds 10 percent, and the mode for both the outcrop area (text-fig. 7) and the basin (text-fig. 11) falls in the 1- to 3-percent range. There is no well-defined distributional pattern to the insolubles, and consequently the source of the detritus is uncertain.

Sedimentation and Biofacies

Chimneyhill sedimentation was initiated by oolitic deposition that appears to represent a shallow-water, reasonably high-energy deposit (Amsden, 1960, p. 159-160). This deposition covered a large part of western Oklahoma (panel 10, sections *A-A'*, *B-B'*, *C-C'*), being well represented in the dolomitized and the undolomitized regions (pl. 12, figs. *5*, *6*). This type of sedimentation also extended over much of the central United States during very Late Ordovician time. The Keel oolite represents a sharp change from the preceding fine clastic sedimentation of the Sylvan Shale, initiating a long period of carbonate deposition that lasted from Late Ordovician through Silurian and most of Early Devonian time. During this time the sediments were largely of intrabasinal origin, with only moderate amounts of terrigenous detritus being supplied from outside. The Keel oolite was followed by deposition of the Cochrane and Clarita, which represent sheets of organic debris spread out on the sea floor cemented with micrite or spar. Some terrigenous detritus was introduced, but this is minor in amount and almost entirely in the clay- to silt-size range. There are no known reefs (or boundstone), and calcareous algae are rare or absent. Disarticulation and breakage of the fossils is minimal, and both the Cochrane and Clarita appear to have been deposi-



Text-figure 11. Frequency diagram showing distribution of HCl-insoluble residues in Chimneyhill strata from cores in Anadarko basin. Based on analyses given in Appendix.

ted in relatively quiet water, possibly the outer neritic zone. Benthonic forms such as crinoids, trilobites, and ostracodes are abundant, along with brachiopods and mollusks; corals are uncommon. This type of environment was present throughout the Arbuckle Mountains-Criner Hills region, and all presently available evidence suggests that it extended over a large area in the subsurface. Exclusive of the dolomite facies (whose origin is discussed in the section on Silurian Dolomite), the Chimneyhill shows little change in lithofacies or biofacies over most of western Oklahoma. (I am presently making a more detailed biofacies study based on thin-section point counts, and, when completed, this will provide for a more detailed biofacies analysis.)

Porosity and Permeability

Cores from the following three wells were tested for porosity and permeability.

Sample number	$MgCO_3$ %	Porosity %	Permeability md
Calvert 1 Bertie			
P10–B	38.48	6.08	0.00
P10–C	42.52	7.62	0.52
P10–D	40.97	16.66	22.17

Calvert Mid-America 2 Bloyd (Chimneyhill directly overlain by Woodford Shale; *Triplesia alata* just below Woodford contact)

P10–A	33.84	8.90	13.37

Sunray DX 10-A Rentie (Chimneyhill directly overlain by Woodford Shale; the following numbers represent averages—see Appendix and text fig. 24)	7.90	7.28	1.82

The cores from the 1 Bertie and 2 Bloyd represent porosity developed in high-magnesium, crystalline dolomite, whereas the core from the 10-A Rentie shows porosity in a relatively low-magnesium limestone. This is discussed more fully in the main section on Porosity and Permeability in Late Ordovician and Silurian Strata and is here only summarized to demonstrate that significant porosity is developed in both the limestone and the dolomite facies.

Oil and Gas Production

Production has been widely reported from Chimneyhill strata in Oklahoma. Kunsman (1967, p. 167-197) reports Chimneyhill production, either alone or in combination with other Hunton zones, from 78 fields, most of which I have not investigated. Of the well cores studied in the present report, the following obtained some production from the Chimneyhill: American 4-A Bayne, Calvert 1 Bertie (Withrow, 1969, p. 82), Calvert Mid-America 2 Bloyd, Anadarko 1 Hilpert, Sunray DX 10-A Rentie, Gulf 1 Shade, California 1 Ticer et al., Chevron 1 Zellers. In addition, it seems probable that the Phillips 1-C Lee and the Phillips 1-A Bailey produce from the Chimneyhill. As noted previously, production occurs from both the limestone and the dolomite facies of the Chimneyhill Subgroup.

Henryhouse Formation

The Henryhouse Formation crops out over much of the Arbuckle Mountains and Criner Hills region (Amsden, 1960, fig. 27). It was named by Reeds (1911, p. 261) for exposures on Henryhouse Creek in the western part of the Arbuckle Mountains region and has been recognized by practically all subsequent investigators. Although almost universally designated a formation, thus implying that it is a distinct lithostratigraphic unit, for all practical purposes it is lithologically indistinguishable from the overlying Haragan Formation (see following section on stratigraphic relations). The Henryhouse megafauna is, however, readily distinguishable from that of the Haragan, and it is thus a distinctive biostratigraphic unit and as such is certainly mappable. Insofar as the outcrop area is concerned, I recommend that the Henryhouse continue to be assigned formational rank, but in considering its relation to other Silurian lithostratigraphic and biostratigraphic units in the Anadarko basin it is convenient and informative to designate it as the Henryhouse biofacies (see discussion under following section on *Kirkidium* biofacies).

Lithostratigraphy

The Henryhouse has a mud-supported fabric with fossils scattered through the matrix in varying degrees of concentration (pl. 8, figs. *1-4*; pl. 9, figs. *4*, *5*). The matrix is composed of finely divided carbonate mixed with HCl-insoluble detritus, much of which is silt-size, angular quartz detritus commonly including some mica plus a considerable quantity of material in the clay-size fraction. For my 1960 study, 64 Henryhouse samples were analyzed, and these ranged from 6 percent to 43 percent insolubles, averaging 20 percent (Amsden, 1960, p. 68). The insoluble detritus increases in the central and southern parts of the Arbuckle Mountains (Amsden, 1960, p. 69; panel 1, map C, this report). Recently a number of analyses have been made of Henryhouse samples from the fresh road cut made for the Interstate-35 interchange near the north end of the Arbuckle Mountains (near my stratigraphic section M17—Amsden, 1960, p. 256; Amsden, 1973, fig. 35). This new exposure has a relatively high insoluble-residue content, the HCl insolubles of 11 Henryhouse samples ranging from 19.48 to 62.09 percent and averaging 40.83 percent; the $MgCO_3$ content ranges from 1.43 to 13.66 percent, averaging 9.92 percent. Much of the insoluble material is angular, silt-size quartz detritus plus considerable mica.

In the central and western parts of the Arbuckles, red or reddish-gray beds are common in the Henryhouse Formation, and these are also present in the marlstone beds in the deep part of the Anadarko basin (see following section on the subsurface Henryhouse). The red beds commonly have substantial detritus, and their distribution correlates in general with the area of increased Hunton detritus. Dolomite in the Henryhouse is invariably concentrated in the matrix, and only rarely is it abundant enough to corrode the fossil boundaries. No porosity or permeability tests have been made of Henryhouse outcrop samples, but thin sections show little or no visual porosity. For additional details on Henryhouse lithology, see Amsden (1960, p. 66-84).

The Henryhouse Formation attains a maximum thickness at the surface of about 250 feet. It has been truncated from above by pre-Haragan-Bois d'Arc (Helderbergian), pre-Frisco, and pre-

Woodford erosion, and it has been completely removed from a fairly large area in the southeastern part of the outcrop region (Amsden, 1960, fig. 27).

Biostratigraphy

The Henryhouse has a richly varied shelly fauna dominated by brachiopods (Amsden, 1951), along with many corals (Sutherland, 1965), trilobites (Campbell, 1967), crinoids (Strimple, 1963), and ostracodes (Lundin, 1965) as well as some mollusks and representatives from other groups. Calcareous algae are absent or extremely rare in the Henryhouse as well as in other Silurian formations of Oklahoma. The fossils are well preserved, and almost all retain their original microtexture (pl. 8, figs. *1-4*; pl. 9, fig. *4*).

The Henryhouse is essentially an organo-detrital mudstone with only a few very local areas having any boundstone. No reefs are known from the Henryhouse, or from any of the other Silurian strata in Oklahoma. Although almost none of the fossils appear to be in growth position, depositional or pre-depositional breakage is at a minimum and disarticulation for the bivalved brachiopods is moderate (text-fig. 12). The average disarticulation for all brachiopods in the Henryhouse collections is 31 percent, which is somewhat higher than that of the overlying Haragan (21 percent; Amsden and Ventress, 1963, p. 18).

Corals, mostly small solitary types, are dispersed throughout the Henryhouse Formation, but on the Lawrence uplift at the north end of the Arbuckle Mountains (Amsden, 1960, panel II, pl. A) the upper 40 feet of the Henryhouse Formation has a fairly rich coral fauna. These are primarily rugose corals that are not in growth position, although locally there are small colonies of *Entelophyllum* and *Halysites*, which may be in, or nearly in, growth position (Sutherland, 1965, p. 9, 10). The entire Lawrence uplift, which is the northernmost outcrop of the Henryhouse, has probably the greatest concentration of shelly fauna in the entire Arbuckle Mountains-Criner Hills region, and some of the beds on the uplift undoubtedly have a grain-supported texture. Although no specimens of *Kirkidium* have been found in the uplift area, the closest known representative being from the Apco 1 Leon well about 50 miles to the northwest in Cleveland County, the general character of the rock is similar to the facies developed in Oklahoma County (Gulf 1 Streeter, 1 Schroeder, and 1 Holtzschue). The insoluble detritus is less on the Lawrence uplift than in the Henryhouse beds that crop out to the south and west. In general, those areas with the greatest amount of detritus have a somewhat reduced number of megafossils, although there is no evidence of any dwarfing or marked faunal impoverishment (see discussion of biofacies under section on Paleoenvironment of Late Silurian Strata).

Graptolites are present in the central part of the outcrop area, in the region of much terrigenous detritus. These were first described by Decker (1935a, p. 436), who reported 3 graptolite localities from the lower 17 feet of the Henryhouse in Carter and Murray Counties (panel 1, map C; panel 2, map C). Two of these localities have not been re-collected, but his Honey Creek locality is very near my stratigraphic section M17, where fresh cuts associated with Interstate 35 have exposed graptolite-bearing calcareous shales 11 to 17 feet above the base of the Henryhouse. Decker assigned an early Ludlovian age to the Henryhouse graptolites; however, Jaeger (1967, p. 282) has restudied Decker's collections and has assigned them a late rather than early Ludlovian age. Berry (Berry and Boucot, 1970, p. 160), who has also restudied Decker's collections, suggests that they may range in age from late Wenlockian into the *Monograptus scanicus* zone. However, Jaeger (letter), who has now examined the entire Decker collection as well as my collections from stratigraphic section M17 (near Honey Creek), believes that at least the Cool Creek collection of Decker is not older then the *M. leintwarinensis*, *M. fritschi linearis* zone, as indicated by the presence of *Linograptus*, and not younger than eB1 (Kopanina), as indicated by the presence of *M. bohemicus*. Whether more than one graptolite zone is represented in the Decker-Amsden collections is apparently not determinable at the present time. Berry and Boucot (1970, p. 159-160) and Berry and Satterfield (1972, p. 495) indicate that the Henryhouse Formation ranges well up into, perhaps through, the Pridolian Stage of the Upper Silurian. The shelly faunas thus far studied do not contribute any greater precision toward solving this problem other than that the brachiopods (Amsden, 1962b, p. 1507-1510), trilobites (Campbell, 1967, p. 6-7), and ostracodes (Lundin, 1965, p. 10) (text-fig. 5) show no zonation within the Henryhouse Formation.

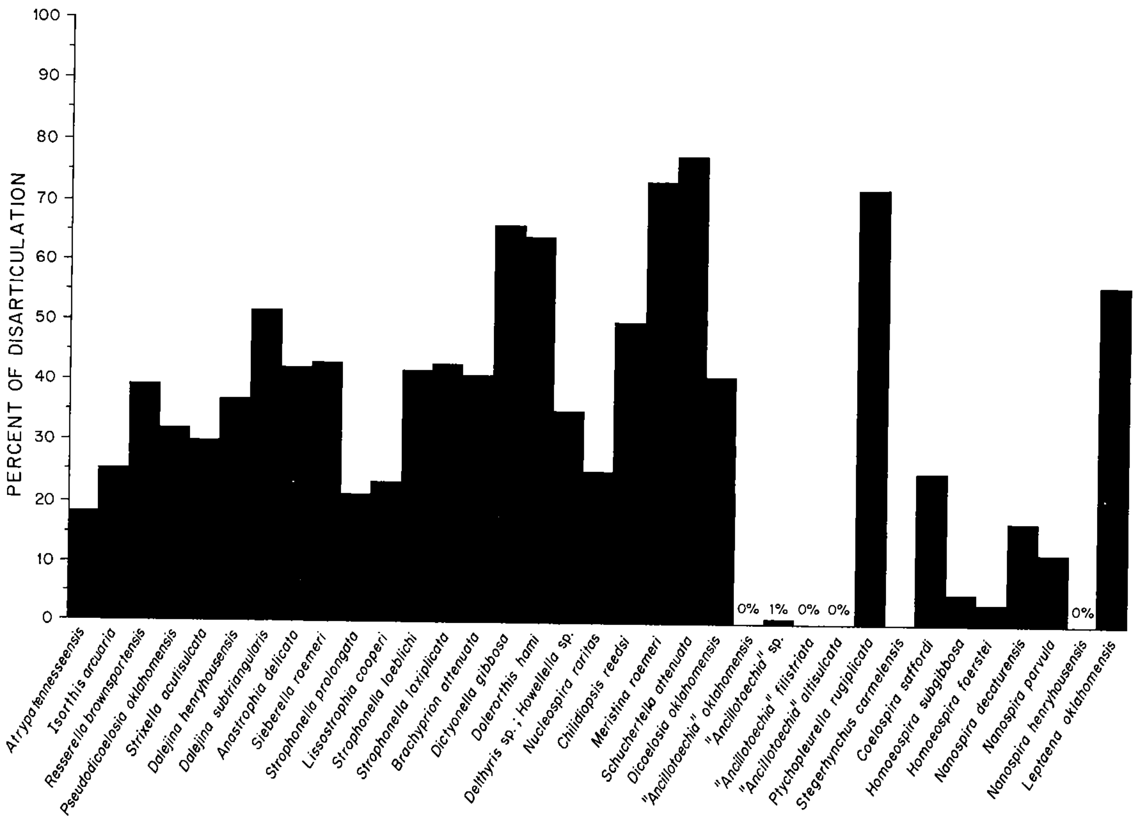
Stratigraphic Relations

The Henryhouse Formation overlies the Chimneyhill Subgroup and generally rests on the Clarita Formation, although locally it comes in contact with the Cochrane or the Keel Formation (Amsden, 1960, p. 73-74). Throughout much of the Arbuckle Mountains and Criner Hills, the Henryhouse-Clarita contact is reasonably well defined and easily mappable. However, in places, notably in the central part of the Arbuckles, the upper part of the Clarita becomes marly and resembles the Henryhouse, thus leaving a few feet of strata whose stratigraphic position has been in question. In my earlier discussion of this problem (Amsden, 1960, p. 61-62), I noted that the typical Clarita beds carry a prolific microfauna and that this fauna could be traced upward into the questionable marly beds from which point it declined abruptly. This abrupt decline in the flood of microfossils was arbitrarily used to define the boundary. Recent excavations for an interchange on Interstate 35 have improved the exposures of my section M17, producing fresh and complete exposures of the complete Hunton; this reveals a well-marked lithostratigraphic boundary between the Clarita and the Henryhouse (pl. 8, figs. *4a*, *4b*). At this contact there is an abrupt increase in the quantity of angular detrital quartz and mica, and a corresponding decrease in fossil content. A restudy of the Henryhouse-Clarita relation at stratigraphic sections M2, M8, and near Ca2 (Amsden, 1960, Appendix) reveals a similar well-defined lithologic contact, as shown in the following analyses of samples taken just above and below the boundary:

Formation	HCl insolubles %	$MgCO_3$ %	$CaCO_3$ %
Stratigraphic secion M17 (new; pl. 8, figs. *4a*, *4b*)			
Henryhouse Fm. (basal 1 in.)	33.18	0.63	64.71
Clarita Fm. (upper 1 in.)	25.06	0.84	73.59
Near stratigraphic section Ca2 (east side U.S. 77)			
Henryhouse Fm. (basal 2 in.)	30.25	9.50	58.10
Clarita Fm. (upper 1 in.)	23.84	4.50	70.59
Stratigraphic section M2			
Henryhouse Fm. (M2-D; basal 1 in.)	35.56	0.71	62.76
Clarita Fm. (M2-C; upper 1 in.)	22.37	0.50	75.66
Stratigraphic section M8			
Henryhouse Fm. (M8-G; basal 1 ft)	34.39	1.12	63.33
Clarita Fm. (M8-F; upper 1 ft)	18.13	3.34	77.20

Formic acid residues prepared from the above samples show a sharp decline in the flood of microfossils at this contact. Regardless of the significance assigned to this contact, the recent study clearly shows that (1) it is a well-defined lithostratigraphic boundary accompanied by a change in the microbiofacies, and (2) it is the same contact as that used in my earlier work.

The Henryhouse Formation is overlain by the Haragan-Bois d'Arc Formations, or by the Woodford Shale in those areas where these formations have been removed by pre-Woodford erosion. (The Haragan Formation and Bois d'Arc Formation are interpreted as facies of one another, which for convenience are here treated as a single lithostratigraphic and biostratigraphic unit; see discussion of these units under Devonian Stratigraphy.) The Henryhouse and Haragan Formations are remarkably similar to one another in their general lithologic characters. Both have a mud-supported fabric with fossils scattered through the matrix in varying degrees of concentration. This mudstone matrix is composed of a mixture of finely divided carbonate, mostly $CaCO_3$, and clay- to silt-size detritus, the latter being mostly angular to subangular quartz. On average, the insoluble detritus in the two formations differs, that of the Haragan averaging approximately 16 percent and that of the Henryhouse as a whole about 20 percent or somewhat higher in the central part of the Arbuckle Mountains region (panel 1, map C). Accompanying this increase in insolubles is an increase in disarticulation of the brachiopod shells, the Haragan being about 21 percent disarticulated and the Henryhouse about 31 percent disarticulated. These differences are, however, not usable for identification, as there is substantial intraformational variation in these characteristics. The faunas of the Henryhouse and Haragan are similar in general composition, both having richly varied shelly faunas dominated by the brachiopods. Taxonomically the two can be separated, the Henryhouse having an Upper Silurian fauna and the Haragan an Early Devonian fauna; the Henryhouse brachiopods (Amsden, 1958a, p. 15-17), ostracodes (Lundin, 1968, p. 14-17), trilobites (Campbell, 1967, p. 7, 10), and other groups are distinct from the Haragan. This biostratigraphic boundary is readily mappable, and I have traced it throughout the Arbuckle Mountains and Criner Hills. This study shows that Henryhouse beds are absent over a large area in the central and southeastern parts of the Arbuckle Mountains region, a region where Haragan-Bois d'Arc strata of Early Devonian age rest on the Clarita Formation (Wenlockian), the Cochrane Formation (Llandoverian), or locally on the Ordovician (Maxwell, 1931, pl. 5; Amsden, 1960, text-figs. 27, 28, 32, 35; panel III, pl. B; Amsden, 1962a, p. 212-216; Amsden, 1962b, p. 1512, 1517).

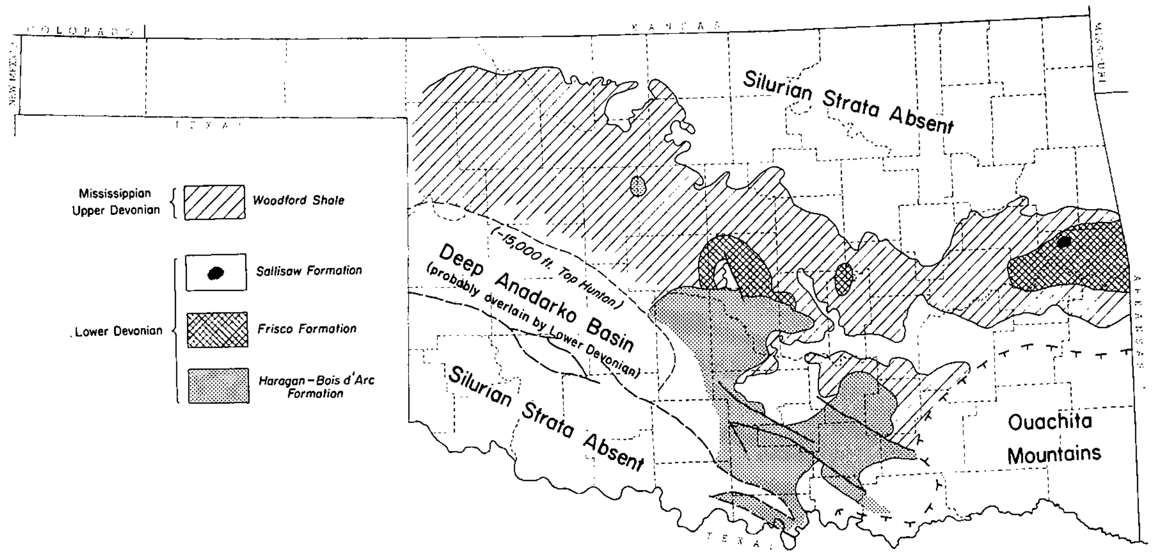


Text-figure 12. Chart showing percentage of disarticulation for various Henryhouse brachiopod species. Arithmetic mean for all specimens is 31 percent.

The Silurian-Devonian relationship in Oklahoma and adjacent states has been the subject of considerable discussion in recent years, and it might be helpful to briefly review this subject, since substantial faunal control is now available for most of the State with the exception of the Ouachita Mountains region (for which only meager faunal data are available). This relationship can perhaps be best understood by considering (1) the strata that overlie the Silurian, and (2) the strata that underlie the Devonian:

1. The oldest rocks overlying Silurian strata (text-fig. 13) are of Early Devonian (Gedinnian, Helderbergian) age, and these are largely confined to the south-central part of the State, probably extending into the deep part of the basin (panel 9). Elsewhere these Early Devonian beds are absent, and the Silurian is overlain by strata of younger Devonian age. In Oklahoma, Pottawatomie, and adjacent counties, and in eastern Oklahoma, Silurian strata are directly overlain by the Frisco Formation of middle Early Devonian (Siegenian, Deerparkian) age, and in Sequoyah County the Silurian is overlain by rocks of latest Early Devonian (Emsian, Esopusian) age. For the remaining areas in which Silurian rocks are known to be present, these rocks are directly overlain by the Woodford Shale (in places with the Misener Sandstone at its base), the basal part of which is Middle to Late Devonian in age (Amsden and Klapper, 1972). It is possible, even probable, that in parts of the subsurface of western Oklahoma (at depths of less than –15,000 feet) small erosional remnants of Early Devonian rocks are present between the Silurian and the Woodford Shale, but in all probability such Devonian outliers are localized and thin.

2. The Silurian-Devonian relationship can also be examined by considering the strata that underlie the Devonian. In parts of the Arbuckle Mountains-Criner Hills, and over most of western Oklahoma, the Devonian is underlain by the



Text-figure 13. Silurian supracrop map, showing formations overlying Silurian strata in Oklahoma (exclusive of Ouachita Mountains). In small localized areas Silurian rocks are directly overlain by Pennsylvanian strata.

Henryhouse-*Kirkidium* biofacies of Late Silurian age. Over a fairly large area in the southeastern part of the Arbuckle Mountains, Devonian beds are underlain by Early Silurian strata (see above). In most of eastern Oklahoma the Devonian is underlain by early Late Silurian strata (Wenlockian). There is at least one area in southwestern Oklahoma where Early Devonian strata are underlain by Ordovician strata (Tidewater 1 Johnson, Jackson County). Finally, the Woodford Shale of Middle and Late Devonian to Early Mississippian age (in places including the Misener Sandstone) overlies pre-Silurian beds over much of northern Oklahoma. These relations indicate that there was at least a local unconformity developed in pre-Gedinnian, post-Silurian time (Gedinnian strata have a restricted distribution in Oklahoma); a widespread unconformity in pre-Siegenian time; and probably another widespread unconformity in pre-Emsian time. An extensive regional unconformity was also developed in pre-Woodford-Misener time.

Subsurface

Core data bearing on the Henryhouse Formation are meager, probably because toward the north and west, in the area of greatest concentration of cores, this formation grades rather abruptly into the *Kirkidium* biofacies. The Henryhouse megafauna has been identified with reasonable certainty in only three wells: American 4-A Bayne, *Dalmanites rutellum* Campbell, depth 2,686-2,712 feet (identified by K. S. W. Campbell, 1970); California 1 Goodell et al., *Merista* sp., *Homoeospira* sp., *Atrypa* sp., *"Camarotoechia"* sp. (Henryhouse type), depth 9,483-9,490 feet; California 1 Mullen et al., calymenid trilobite (?Henryhouse species), depth 9,265 feet. (See Appendix.)

No cores are available in the deep part of the Anadarko basin or adjoining shallow fault blocks, but well samples from this area show the marlstone lithofacies extending into this region (panel 1, map C; panel 2, map C; panel 10, section *C-C'*). Although the samples do not supply any faunal data, the lithology, lithostratigraphic sequence, and stratigraphic position strongly suggest that at least a part of these beds is correlative with the Henryhouse of the outcrop area.

Environment of Deposition

Before speculating on this subject, it will be helpful to review the known factors upon which any interpretation must be based:

1. The Henryhouse has a mud-supported fabric with the matrix almost exclusively in the clay- and fine-silt-size fraction. Much of the insoluble material is fine-silt-size angular to subangular quartz grains, which in total represents a sizable volume of terrigenous detritus.

2. Henryhouse strata are almost totally lacking in shallow-water features. Such features as cross-bedding, ripple marks, and mud cracks are largely

if not entirely absent. The bedding tends to be nodular, but except for this irregularity it is uniform.

3. The fossils are well preserved and appear to have been subjected to only minor breakage before and during deposition. Such delicate structures as bryozoan fronds, brachiopod spines, and trilobite carapaces can be found nearly intact. Many of the bivalved shells are articulated; 31 percent of the brachiopod shells are disarticulated, and this combined with their excellent preservation indicates that they were not moved far by wave and (or) current action. Moreover, the shells are scattered through the mudstone, almost never being concentrated into shell banks with a grain-supported fabric. The graptolites, which are present in the central part of the Arbuckle Mountains, give further evidence of quiet-water deposition.

4. The Henryhouse has a richly varied shelly fauna, a large percentage of which are representatives of the sessile or vagrant benthos, such as the brachiopods, trilobites, bryozoans, ostracodes, pelmatozoans, and mollusks. Solitary and some colonial corals are dispersed throughout the Henryhouse Formation; and in the upper 40 feet of the Henryhouse on the Lawrence uplift at the north end of the Arbuckle Mountains region there is a concentration of large solitary corals along with a few *Halysites* and *Entelophyllum*, although few if any are in growth position and here as elsewhere in the formation there is no reef development. In fact, throughout the Henryhouse very few of the organisms are in growth position, although in all probability none have moved far after death; thus the Henryhouse for all practical purposes is biocoenosis. (See later section on Paleoenvironment of Late Silurian Strata.)

5. The HCl-insoluble residues, much of which represent terrigenous detritus, have their maximum concentration in the south-central part of the Arbuckle Mountains, in the area that also carries graptolites and mudstones. The latter are calcareous siltstones with much angular silt-size quartz detritus and some mica.

The foregoing data point to deposition in a low-energy environment well removed from active wave and (or) current action. The virtual absence of shallow-water features, and of calcareous algae, indicates water of some depth, although it seems probable that the mud being deposited may have created some turbulence that reduced light penetration. This suggests deposition in a quiet-water, offshore environment with a muddy and silty bottom, but with sufficient energy available to transport a sizable volume of terrigenous detritus, especially into the south-central area. On the other hand, the richly varied marine fauna would seem to militate against deposition in water of great depth. For all practical purposes, it is not possible to set any firm depth limits for the above set of conditions because of the many variables involved. Perhaps the environment best suited to these conditions would be the outer neritic, as defined by Hedgpeth (1957, p. 18-19). (See discussion of facies relationships under *Kirkidium* Biofacies.)

Porosity and Oil and Gas Production

The Henryhouse has been widely reported as a producing zone. Kunsman (1967, p. 176-197) records Henryhouse production, alone or in combination with other zones, from 58 different fields; however, many of these certainly represent strata that are herein referred to the *Kirkidium* biofacies. I have no direct information bearing on Henryhouse production. The undisturbed-mudstone lithology would seem to be an unlikely texture for primary porosity, and the numerous thin sections examined show little visual porosity.

Kirkidium **Biofacies**

The *Kirkidium* zone was first recognized by Rowland and me (as *Rhipidium* zone; Amsden and Rowland, 1967a, 1967b) and was later more fully described and defined by me (Amsden, 1969, p. 962-969). This zone was considered to be correlative with the Henryhouse Formation of Late Silurian age, and it was reported to be present throughout much of the subsurface of central and western Oklahoma and the Texas Panhandle. The *Kirkidium* zone was defined on the basis of the pentamerid brachiopods *Kirkidium pingue pingue* (Amsden) and *K. pingue latum* Amsden; however, it now appears more suitable to refer to the *Kirkidium* biofacies rather than *Kirkidium* zone. The term zone has been defined in different ways, but it is probably most commonly used as a faunal unit having a restricted time range and a rather wide geographic range. Information on the precise range of *K. pingue pingue* and *K. pingue latum* is presently lacking; moreover, many of the specimens recovered from cores are not sufficiently well preserved or complete to be specifically identified. It does not seem desirable to use the term formation, because of problems in lithostratigraphically defining this unit; the upper boundary of the *Kirkidium*-bearing beds is reasonably well marked, but the lower contact with the Chimneyhill is not clearly defined, owing at least in part to the lack of adequate well control. In this report the unit will be called the *Kirkidium* biofacies and defined as a *Kirkidium*-bearing biofacies that is at least in part, probably largely, correlative with the Henryhouse Formation of the Arbuckle Mountains-Criner Hills region. It should be pointed out that intensive collecting over many years has failed to reveal a single representative of this genus in the Silurian rocks exposed at the surface in Oklahoma. To my knowledge, *Kirkidium* has not been reported from Silurian strata in Arkansas or Missouri, although specimens are locally present in the Brownsport Formation of western Tennessee (Amsden, 1969, p. 968, text-fig. 7).

Subsurface

The *Kirkidium* biofacies is widely distributed in the subsurface, extending from central Oklahoma (Cleveland County) northward and westward into the Texas Panhandle (panel 1, map C; panel 2, maps A, B, C; panels 9, 11). The following 28 cores are known to cut some part of the *Kirkidium* biofacies.

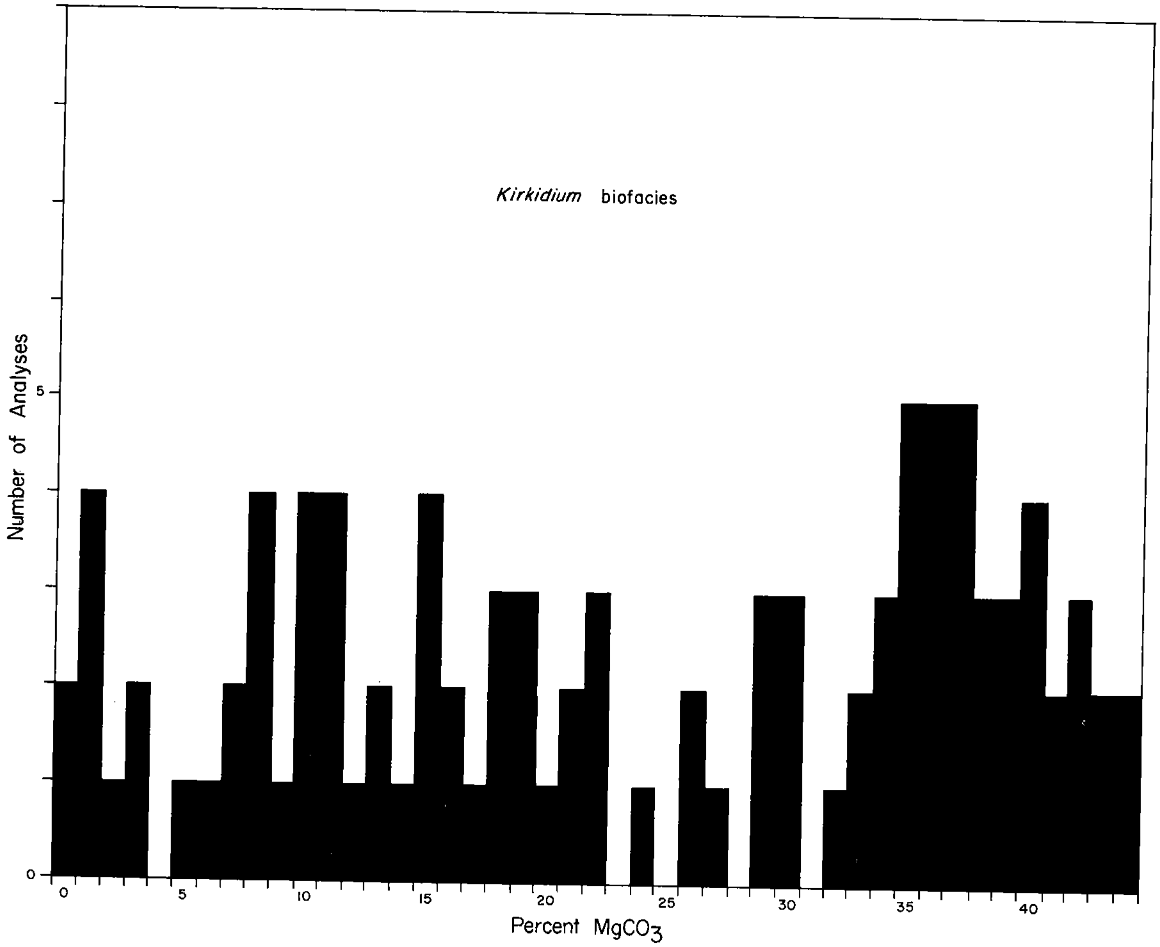
Calvert 1 Bertie
Atlantic 1 Choate
Getty 1-B Coffman
Shell 1-15 Dill
Pan American 1 Droke Unit
Jones and Pellow 1 Farrell
Sunray DX 1 Frans
Cleary 1-21 Gilbert
Lone Star 1 Hannan Unit
Glover Hefner Kennedy 1-1 Hoffman
Gulf 1 Holtzschue
Mobil 1 Horton
Midwest 1 Hughes Unit
Mobil 1 Jones Unit
Tenneco 1-A Jordan Unit
Cleary 1-24 Kramp-Cobb
Apco 1 Leon
Getty 1 Luetkemeyer Unit
Yinger 1 Mayes
Pan American 1 Roetzal Unit
Pan American 1-B Roetzal Unit
Barnes 1 Rounds
Gulf 1 Schroeder
Mobil 1 Sharp-Hunt Unit
Humble 1 State Hunton
Gulf 1 Streeter
Texaco 1 Thompson
Gulf 1 Triplett

These wells are described in the Appendix and are located on panel 1, map A.

No representative of *Kirkidium* has been recognized in any wells studied by cuttings only, although it seems possible that wells like the Phillips 1-A Bailey, Texas Pacific 1-33 Libby, and others nearby penetrated the *Kirkidium* biofacies.

Lithostratigraphy and Biostratigraphy

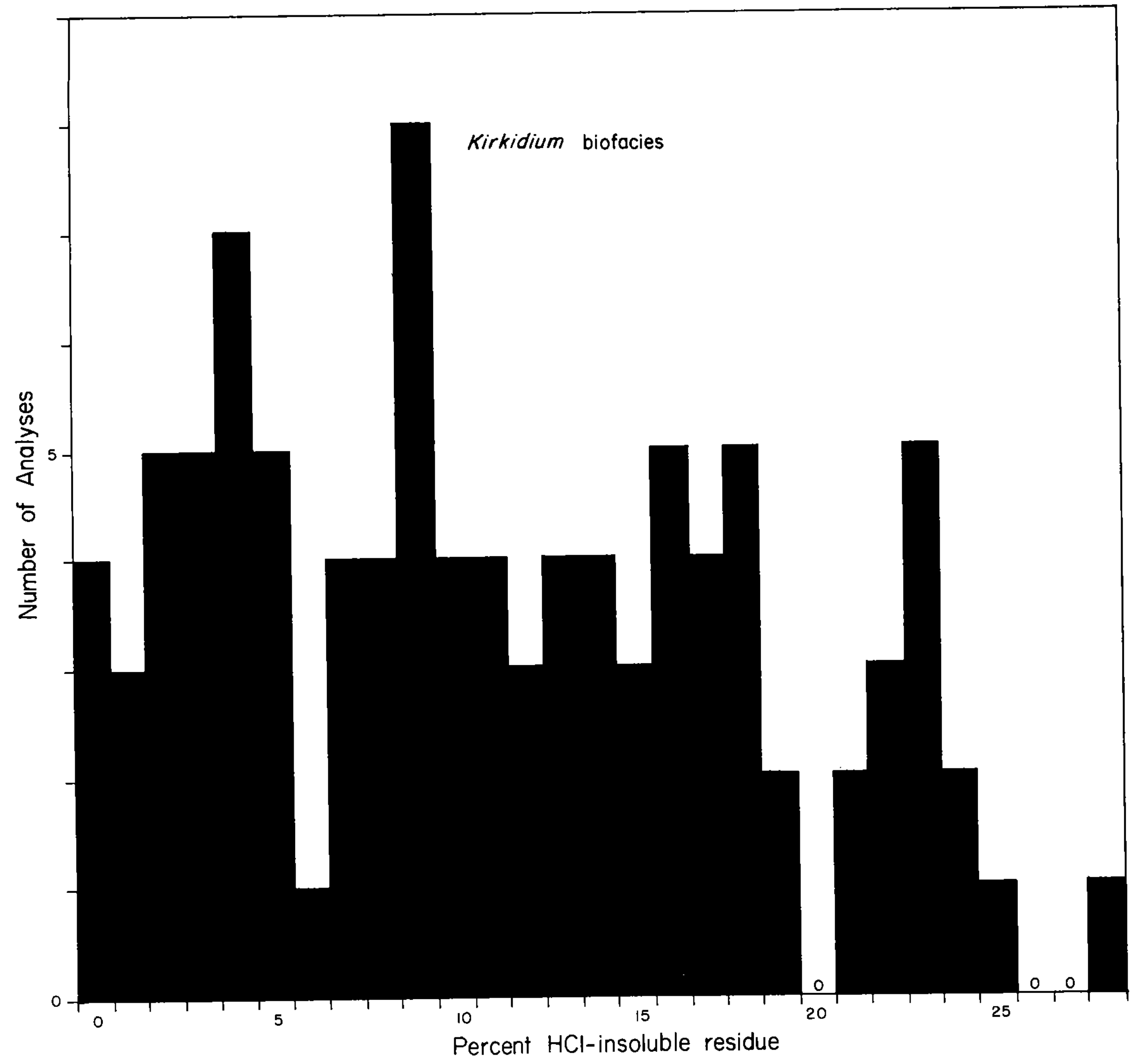
Kirkidium-bearing strata range from low-magnesium limestones to nearly pure dolomites (text-fig. 14). In the relatively undolomitized southeastern area, in the Gulf 1 Holtzschue, Gulf 1 Schroeder, Gulf 1 Streeter, and Jones and Pellow 1 Farrell (panel 1, map A), the rock is an organo-detrital limestone, mostly cemented with micrite, and with 10- to 15-percent acid insolubles, much of which is silt-size angular quartz detritus (text-fig. 15). The quartz detritus in those beds with appreciable quantities of crystalline dolomite usually is corroded or partly replaced by the dolomite. It is therefore common for the boundaries of the quartz grains to be partly or completely defined by the crystal faces of the dolomite, thus increasing the angularity of the detrital grains. These low-magnesium limestones are dominated by brachiopods—mainly *Kirkidium* but including a few other genera—and crinoids. In addition, most beds contain small solitary and colonial corals, especially tabulates; halysitid corals are commonly present, and a few stromatoporids have been observed. Trilobites may be present but are not common, and a few beds include ostracodes. None of this fauna appears to be in growth position, and no reefs or boundstones have been recognized. *Kirkidium* shells are fairly common, although they tend to be concentrated into beds. Many shells are broken (pl. 10, figs. *1*, *2*); but complete or nearly complete valves are preserved (pl. 10, fig. *3*), and some articulated shells are preserved (pl. 10, fig. *3*; Amsden, 1969, figs. 2, 3, 11). Considering that these *Kirkidium* specimens have large, thin-walled shells, the breakage in this area is not extreme, and their present concentration probably represents banks of shells that have been somewhat disassociated by wave and (or) current action. The most southeasterly oolite bed known in the *Kirkidium* biofacies occurs in the Gulf 1 Streeter, in Oklahoma County. This consists of 4 or 5 feet of well-developed oolite, mostly cemented with spar, with very low acid insolubles (1.30 percent) and $MgCO_3$ (0.62 percent). The specimens of *Kirkidium* that are interbedded with this oolite include some nearly complete valves. Excluding the beds of *Kirkidium* and oolite, the texture of the Silurian strata in this area is similar to that of the Henryhouse biofacies, except that the terrigenous detritus has decreased moderately and the concentration of shelly debris has increased so that in places the rock probably has a grain-supported texture. The dolomite content, which has increased over that of the Henryhouse, ranges from 10 to 15 percent and is present as euhedral



Text-figure 14. Frequency diagram showing distribution of $MgCO_3$ in cores from *Kirkidium* biofacies. Data given in Appendix.

crystals replacing the matrix. No beds of crystalline dolomite have been observed, and only infrequently is the dolomite seen to be sufficiently concentrated to heavily corrode the fossil boundaries; the fossils retain their microtexture and no spar replacement has been seen (pl. 10, fig. *1*; pl. 11, figs. *2, 3*). The beds of oolites and the partial fragmentation of the shelly debris suggest that the depositional-energy level had increased over that found in the Arbuckle Mountains-Criner Hills region. There is less terrigenous detritus, and the bottom may have been firmer and the water less turbid.

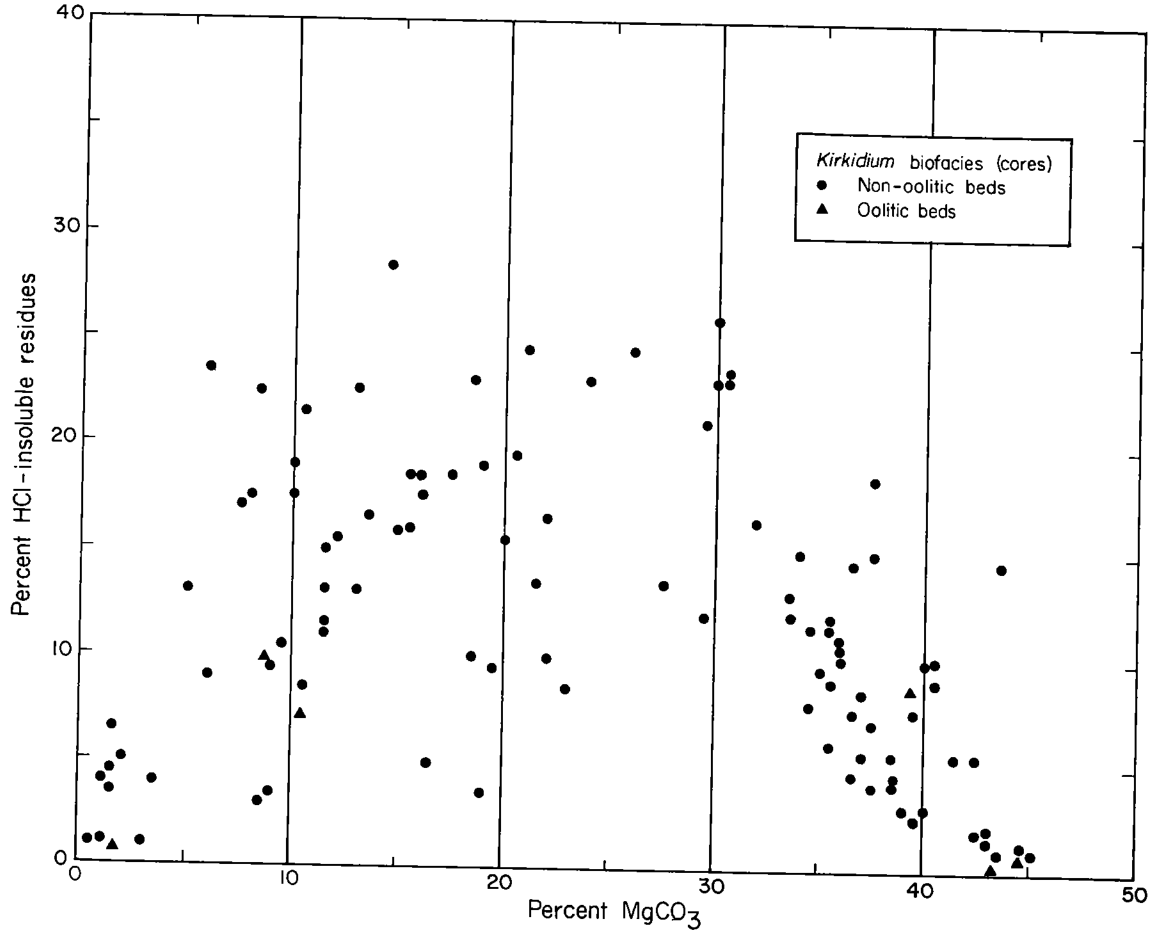
North and west of the area of dolomitic limestone discussed above, the *Kirkidium* biofacies passes into a strongly dolomitic facies (panel 2, map C). Thin sections show a nearly complete gradation from low-magnesium limestone to dolomite, although, as shown in text-figure 14, $MgCO_3$ in the range from 23 to 28 percent is poorly represented, indicating that the distribution of dolomite in the *Kirkidium* biofacies is bimodal. Thus the calcitic dolomite in the range of 23 to 28 percent is poorly represented, and this probably correlates with the rather abrupt change from calcitic dolomite to crystalline dolomite (see discussion under the section on Silurian Dolomite). In parts of Woodward, Ellis, Dewey, Custer, Major, Blaine, and Kingfisher Counties, core analyses reveal a large area in which the *Kirkidium*-bearing beds average over 35 percent $MgCO_3$, or 75 percent dolomite (panel 2, maps A, C). The texture of this rock is invariably crystalline dolomite, and, in fact, all rocks observed in the present study with more than 28 percent $MgCO_3$ have such a texture. Fossils are present in some parts, and these are preserved as either hollow molds or by calcspar or dolospar, which is coarser than the



Text-figure 15. Frequency diagram showing distribution of HCl-insoluble residues in cores from *Kirkidium* biofacies. Data given in Appendix. Unweighted arithmetic mean, 11.33 percent.

enclosing dolomite (pl. 4, figs. *3a-3b*; pl. 5, figs. *1-4*; pl. 9, figs. *2*, *3*; see also discussion under Silurian Dolomite and also under Porosity and Permeability in Late Ordovician and Silurian Strata). The fossils represented—at least those well-enough preserved to identify—are mostly *Kirkidium* shells or pelmatozoan plates. However, in places, dolomitization obliterates the fossils, and many thin sections show shells that have been partly destroyed by dolomite (pl. 5, figs. *4a*, *4b*). It is possible that this destructive dolomitization was partly selective and that some groups of organisms were more readily destroyed than others, thus giving some bias to the fossils now preserved in the rocks. Many of the *Kirkidium* shells observed on broken core surfaces and in thin section are fairly large specimens of complete or nearly complete valves, and articulated shells are not uncommon, indicating that pre-depositional breakage was not excessive (pl. 5, figs. *1-4*; Amsden, 1969).

From the outcrop area in the Arbuckle Mountains to northwestern Oklahoma, Late Silurian strata have an irregular but persistent increase in $MgCO_3$ and a corresponding decrease in HCl insolubles (panel 2, maps B, C). This suggests a possible genetic relationship, increased $MgCO_3$ being accompanied by decreased insolubles (Amsden, 1960, p. 16-18, text-figs. 4, 5; Amsden and Rowland, 1965, text-figs. 4, 10). However, the



Text-figure 16. Scatter diagram showing relationship of $MgCO_3$ to HCl-insoluble residues in *Kirkidium* biofacies. Based on core analyses given in Appendix.

facies maps show that west of the strongly dolomitic areas the *Kirkidium* biofacies grades back into low-magnesium limestone that *also* has low acid insolubles. This distribution of low insolubles in both high- and low-magnesium carbonates is clearly brought out in the scatter plot where $MgCO_3$ is plotted against HCl insolubles (text-fig. 16).

Oolite

Six of the wells coring the *Kirkidium* biofacies include beds of oolite: Kirkpatrick 1 Cronkite, Shell 1-15 Dill, Jones and Pellow 1 Farrell, Cleary 1-24 Kramp-Cobb, Gulf 1 Streeter, Texaco 1 Thompson. These oolitic beds are near the top of the *Kirkidium* biofacies, within 8 feet or less of the overlying formation, and range up to 20 feet in thickness. In the Gulf 1 Streeter the *Kirkidium* beds are overlain by the Frisco Formation of Early Devonian age, and in the other wells by the Woodford Shale.

The wells with *Kirkidium* oolites are aligned in a northwest-southeast direction, extending from the Gulf 1 Streeter, in Oklahoma County, to the Shell 1-15 Dill, in Blaine County (panel 2, maps A, B, C). Their geographic distribution is of interest because they extend from the limestone facies (with less than 2 percent $MgCO_3$) to the dolomite facies (almost 45 percent $MgCO_3$) and thus clearly participate in the same dolomitization that affects the other parts of the *Kirkidium* biofacies. The HCl-insoluble residues are low, less than 10 percent, regardless of the $MgCO_3$ content (text-fig. 16; Appendix). In the limestone facies, oolitic beds are composed in large part of well-formed oolites, generally with a fossil nucleus and cemented with either spar or micrite (pl. 12, fig. 4). Fossils, including *Kirkidium* shells, are present. In the dolomite facies, the oolites are largely crystalline dolomite set in a dolomite matrix with considerable voids (pl. 3, fig. *5*; pl. 4, figs. *2a*, *2b*). Shells of *Kirkidium* are common in the dolomitic oolites and are usually preserved as molds (pl. 3, figs. *2-4*). Six porosity-permeability tests (see above) were made and show that the high-magnesium dolomites have porosity ranging up to 16 percent (see section on Porosity and Permeability in Late Ordovician and Silurian Strata).

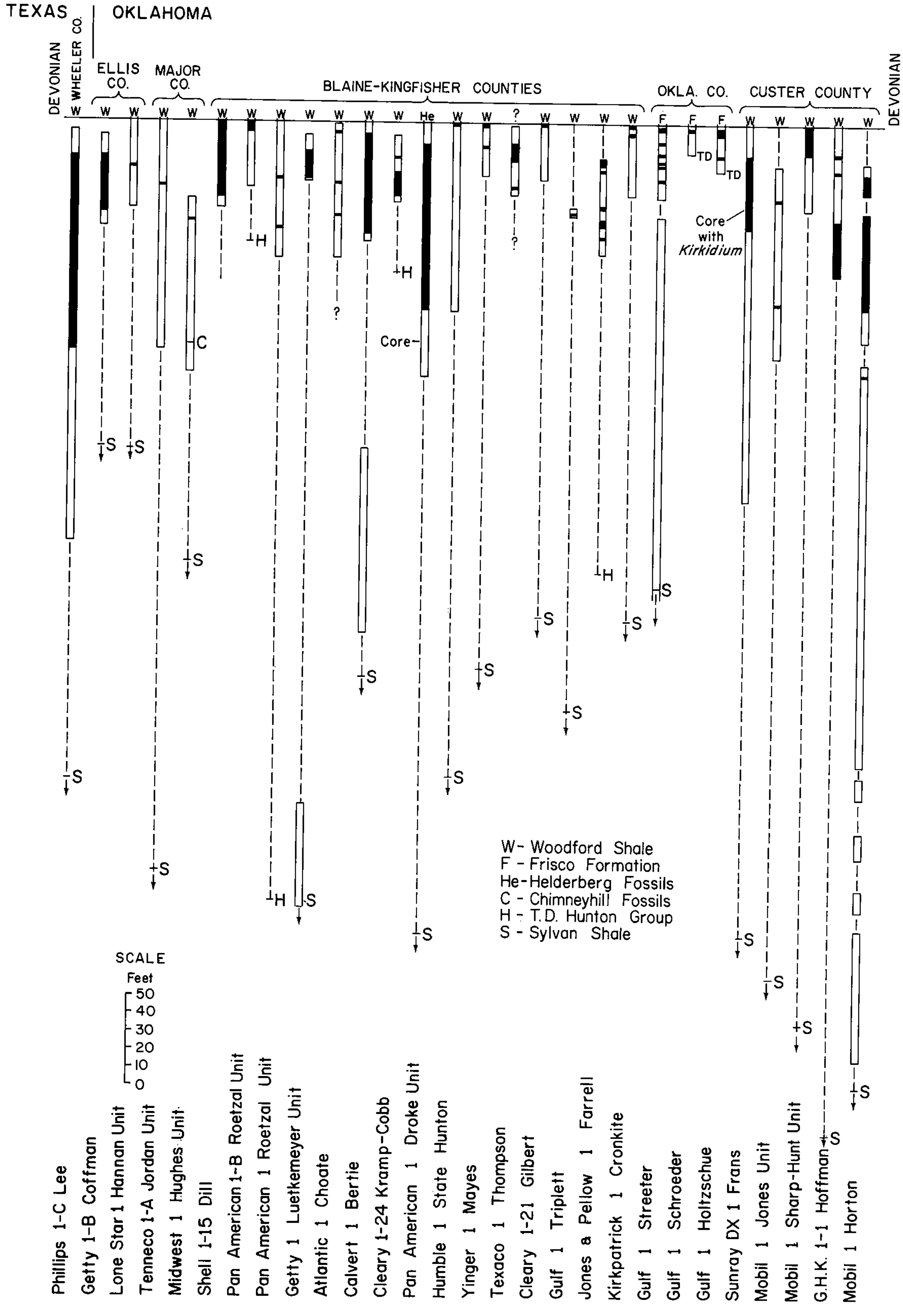
Western Limestone Facies

West of the prominent dolomite facies are two wells in which the *Kirkidium* biofacies is represented by low-magnesium limestones with much reduced acid insolubles. These are the Getty 1-B Coffman, in northern Ellis County, which averages 1.56 percent $MgCO_3$ and 3.76 percent HCl-insoluble residues, and the Phillips 1-C Lee, in the Texas Panhandle, with 2.6 percent $MgCO_3$ and 1.54 percent insolubles (Appendix). The 1-C Lee cored 230 feet of strata, of which the upper 125 feet is *Kirkidium*-bearing low-magnesium limestone (starting just beneath the Woodford Shale), underlain by porous crystalline dolomite that has yielded no fossils (panel 10, section *B-B'*; Appendix). The upper limestones are primarily a *Kirkidium* coquina, although they also include pelmatozoan plates, solitary and colonial corals (including *Halysites* sp.), bryozoans, and other fossils. Both spar and micrite cement are present, the latter being predominant. The shells have undergone considerable pre-depositional breakage, but reasonably complete valves are not uncommon (pl. 9, fig. *1a*). In addition to pre-depositional breakage, the fossil debris has had substantial post-depositional solution, giving the rock an even more fragmented appearance. The 1-B Coffman cored 50 feet of limestone, with *Kirkidium* known to range from 10 feet below the top of the core (18 feet below the Woodford Shale) to 6 feet above the bottom of the core. This is an organo-detrital limestone largely cemented by micrite but with some spar. *Kirkidium* shells are common, along with numerous solitary and colonial corals (including specimens of *Halysites* sp. and *Entelophyllum* sp.) and some bryozoans, trilobites, and ostracodes. None appears in growth position, and, in fact, most of the shelly debris appears to have been subjected to much pre-depositional breakage (pl. 10, figs. *2a*, *2b*, *2c*).

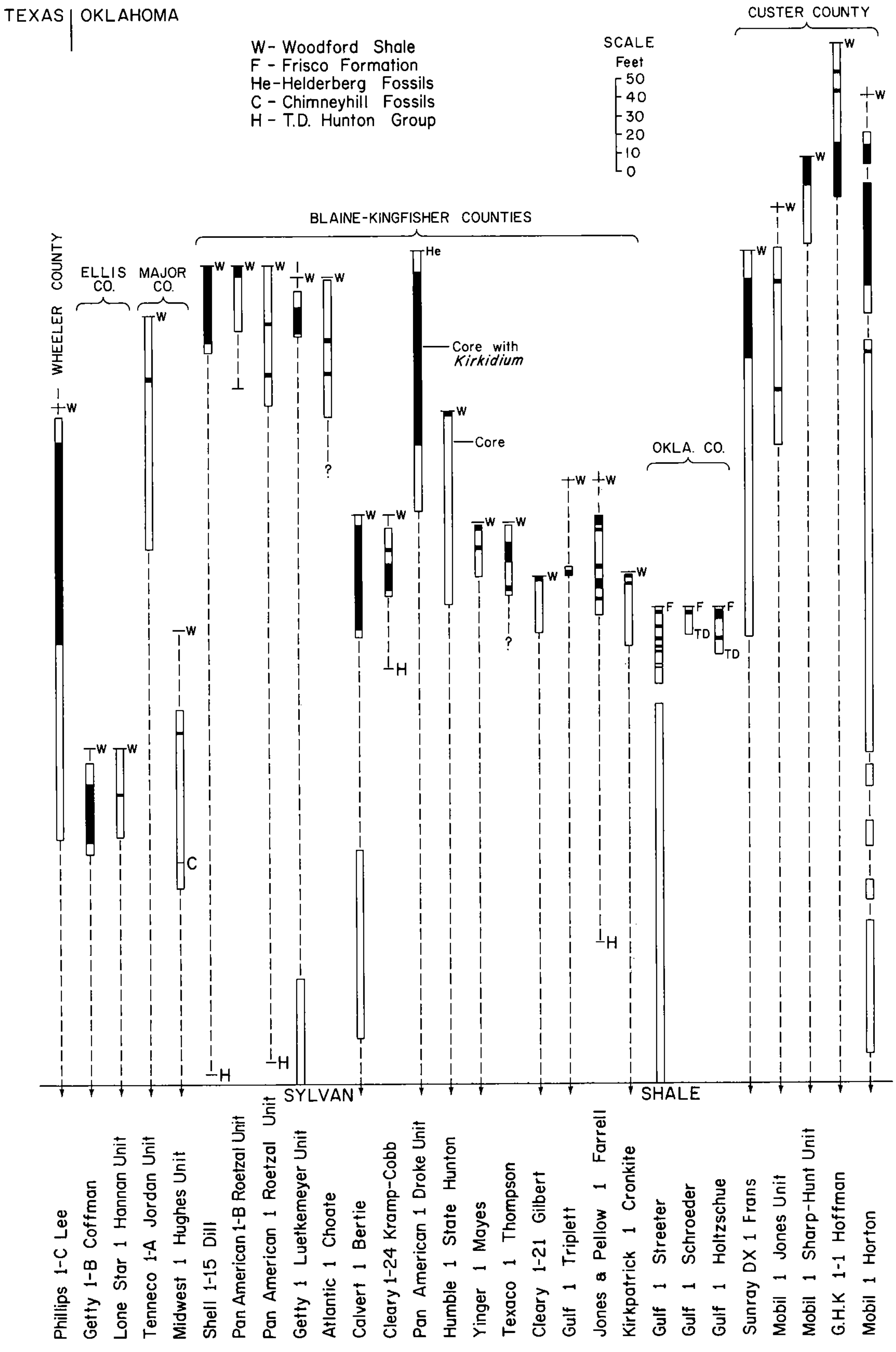
On the facies maps (panel 2, maps B, C), I have inferred that this limestone facies extends from the 1-B Coffman to the 1-C Lee, although no *Kirkidium*-bearing cores are known from the large area between these two wells. There is, however, some supporting evidence for this inference in the Samedan 2 Rio Bravo, in northeastern Hemphill County, about halfway between the two wells. This well cored 35 feet of strata, starting 26 feet below the Woodford Shale. Although no *Kirkidium* shells have been observed in the core, it does include numerous specimens of *Halysites* in the lower 18 feet, indicating that at least this part is Silurian. The rock is primarily a low-magnesium organo-detrital limestone with some oolitic beds in the upper part; it thus appears to represent a limestone facies similar to that of the 1-C Lee and the 1-B Coffman. It should be noted that this western, low-magnesium limestone facies is different from the low-magnesium limestones of the Henryhouse Formation in the outcrop area. The latter is a marlstone with substantial terrigenous detritus, whereas the western limestones are low-insoluble, organo-detrital limestones (see previous section on Lithostratigraphy and Biostratigraphy).

Stratigraphic Relations

Before discussing the stratigraphic relations of the *Kirkidium*-bearing strata, it will be useful to summarize the problems concerned with the recognition of this fauna. Representatives of the genus *Kirkidium*, including *K. pingue pingue* and *K. pingue latum*, have large, distinctive shells that are readily identified on broken core surfaces (pl. 10, figs. *3*, *4*) and on polished surfaces and thin sections (pl. 5, figs. *1-4*; pl. 9, fig. *1*; pl. 10, fig. *1*). Present information suggests that in life these brachiopods were gregarious and concentrated in shell banks or bioherms, which were subsequently somewhat disassociated by wave and (or) current action before burial (see previous section on Lithostratigraphy and Biostratigraphy). Some of these shell beds are thick, extending through as much as 100 feet of strata (e.g., Phillips 1-C Lee), but more commonly the shells are dispersed in relatively thin layers (text-figs. 17, 18). Individual banks almost certainly had limited geographic distribution, and since the wells supplying the cores are widely dispersed and concentrated in the upper part of the Hunton, it seems reasonable to suppose that present information on their stratigraphic and geographic distribution is incomplete. This problem is further complicated by the effect of dolomitization on the preservation of all fossils, including *Kirkidium* shells. The greatest concentration of *Kirkidium* is in the strongly dolomitic facies, where $MgCO_3$ exceeds 35 percent (panel 2, maps B, C). Dolomitization of this intensity commonly at least partly obliterates and obscures the fossils (pl. 5, fig. *4a*), thus reducing the



Text-figure 17. Chart showing known distribution of *Kirkidium* in cores studied. Datum is base of Woodford Shale.



Text-figure 18. Chart showing known distribution of *Kirkidium* in cores studied. Datum is top of Sylvan Shale.

number of shells preserved and making it more difficult to find those which are in the rock. In view of these problems, it is surprising that the shells are so well represented, and one would infer that this was a prolific brachiopod fauna that was widely distributed in the Late Silurian seas of central and western Oklahoma.

The *Kirkidium* biofacies is confined to the upper part of the Silurian section where it is unconformably overlain by Devonian rocks (Amsden, 1969, p. 965-966). In the western areas, in part of the Texas Panhandle and in Ellis, Major, Blaine, Kingfisher, and Custer Counties of Oklahoma, it is overlain by the Woodford Shale (panel 10, section *B-B'*), although in one well, the Pan American 1 Droke Unit, a few feet of Lower Devonian (?Helderbergian) strata are present (text-fig. 17). Farther south, in Oklahoma County, the *Kirkidium* biofacies is overlain by the Frisco Formation of Early Devonian age (panel 10, section *A-A'*). The lowest *Kirkidium*-bearing strata presently known are within 120 feet of the base of the Devonian (text-fig. 17). Lithostratigraphically, the *Kirkidium*-bearing carbonate strata are readily distinguished from the overlying Woodford Shale. Separation from the Frisco presents more of a problem, but the latter is largely biosparite with very few acid insolubles whereas the *Kirkidium* strata, which in this area are grading into the Henryhouse biofacies, are mostly biomicrites with substantially greater insolubles (panel 10, section *A-A'*). The biostratigraphic control for the *Kirkidium*-Devonian contact is, for the most part, excellent. In a number of cores, *Kirkidium* specimens can be found immediately below the contact, or within a few feet of the Woodford Shale or the Frisco Formation bearing a substantial Early Devonian fauna (Amsden, 1969, p. 965). In only a few cores is there as much as 25 feet of unidentified carbonate strata between the *Kirkidium* strata and identifiable Devonian beds, and the greatest interval is approximately 50 feet in the Midwest 1 Hughes Unit (text-fig. 17). The upper boundary of the *Kirkidium* biofacies is thus lithostratigraphically and biostratigraphically reasonably well defined, and this also means that the Silurian-Devonian boundary is well defined in this area (see a following section on Age and Correlation).

The lower boundary of the *Kirkidium* biofacies presents much more of a problem. This biostratigraphic unit is inferred to rest everywhere on the Chimneyhill Subgroup, but it should be emphasized that Hunton cores are stratigraphically concentrated in the upper part of the unit and that relatively few cut any considerable part of the Woodford-Sylvan interval. Moreover, Hunton cores are geographically concentrated in those areas where intense dolomitization affects the entire Silurian and thus tends to obscure the lithostratigraphic and biostratigraphic relations. Text-figure 18, in which the Sylvan-Hunton contact is plotted as the datum, emphasizes the thickness variation between the lowest observed *Kirkidium*-bearing bed and the Sylvan Shale (see also panel 10, section *A-A'*).

The lowest (oldest) observed *Kirkidium*-bearing beds are from the 1-B Coffman, within 125 feet stratigraphically of the Sylvan Shale. In only one well, the 1 Hughes Unit, were specimens of *Kirkidium* and Chimneyhill brachiopods observed in the same core, about 70 feet apart; the latter include *Eospirifer acutolineatus acutolineatus* Amsden, indicating the Clarita Formation (see discussion of Chimneyhill Subgroup; Appendix). In the shallower parts of the basin, where Hunton rocks do not exceed 400 feet in thickness, *Kirkidium* specimens appear to range from about 125 feet above the Sylvan to the top of the Group at about 400 feet (1-15 Dill, 1-B Roetzal Unit; text-fig. 18). The only core that might be considered to be at variance with this range is the 1 Streeter, which cored the entire Hunton and which yields no *Kirkidium* specimens in the lower 220 feet of the Hunton. In Custer County, where Hunton rocks are much deeper and thicker, *Kirkidium* specimens occur through an interval ranging from about 350 feet to almost 550 feet above the Sylvan Shale. The interval beneath the lowest *Kirkidium*-bearing bed was partly cored in the 1 Frans and almost completely cored in the 1 Horton, so there is a substantial non-*Kirkidium*-bearing interval which in the shallower wells yields numerous specimens of this brachiopod. Several possible explanations can be advanced to account for this relationship:

1. *Kirkidium* ranges through this entire interval but is locally absent from the area penetrated by the 1 Streeter, 1 Frans, and 1 Horton. As noted previously, large pentamerid brachiopods were gregarious organisms and are commonly found concentrated in beds or banks separated by areas with few or no individuals. It is difficult to evaluate this explanation in view of the large geographic area covered and the relatively sparse well control. In my opinion, the remarkable fact concerning this biofacies is the abundance and widespread distribution of these brachiopods.

2. *Kirkidium* specimens are absent because ecological conditions were not favorable for these large brachiopods. This may well explain their absence in the 1 Streeter, because it is in an area that is transitional between the typical *Kirkidium*

lithofacies and the Henryhouse marlstone lithofacies; in fact, Silurian strata in the 1 Streeter include a considerable amount of fairly typical marlstone. This may also explain the Custer County cores, because they are in an area that I regard as not too far removed from the northern margin of the Arbuckle Mountains lithofacies as developed in the deep part of the Anadarko basin; in fact, the 1 Horton does include marly beds (the 1 Frans is entirely crystalline dolomite).

3. The distribution of *Kirkidium* with respect to the Sylvan Shale is certainly affected by variations in the thickness of the Chimneyhill Subgroup. Although subsurface control on the Chimneyhill is sparse, there is evidence that this unit varies in thickness in the shallower parts of the basin as shown in panel 10, section *A-A'*. The entire Silurian is known to thicken basinward (panel 6), and this may well account for some of the barren *Kirkidium*-Sylvan interval; in fact, in the 1 Horton I provisionally place the upper boundary of the Chimneyhill approximately 240 feet above the Sylvan. According to this interpretation, there are approximately 160 feet of barren strata in the 1 Horton between the top of the Chimneyhill and the lowest *Kirkidium*-bearing bed, and this may be the result of the factor cited above or possibly of the introduction of a pre-*Kirkidium*, post-Chimneyhill sequence. Evidence for the latter is almost totally lacking, and there would appear to be no present justification for recognizing any divisions other than *Kirkidium* biofacies and Chimneyhill Subgroup.

It should be emphasized that at no place in the surface or subsurface have I observed *Kirkidium* specimens associated with Chimneyhill fossils, and all evidence derived from the present study indicates that the *Kirkidium* biofacies is a discrete biostratigraphic entity that is younger than Chimneyhill. The thickness of the Chimneyhill strata in the Anadarko basin may have been affected by one or more unconformities. Such unconformities are known to be present in the Arbuckle Mountains-Criner Hills (Amsden, 1960; 1963a), but at the present time there is very little evidence available to me to demonstrate such relationships in the shallower parts of the basin. At no place have I observed *Kirkidium*-bearing strata in close stratigraphic proximity to the Sylvan Shale, a condition that would indicate truncation of the Chimneyhill, and all available evidence suggests that this subgroup is widely distributed in the Anadarko basin (see section on Chimneyhill Subgroup).

Thickness

The problems associated with this topic have already been discussed in the preceding section dealing with the relationship of the *Kirkidium* biofacies to the underlying and overlying strata. The maximum *known* thickness penetrated in any one core is 105 feet in the Phillips 1-C Lee, and the most reasonable interpretation of the core data now available suggests that in any particular area these brachiopods probably ranged through some 300 feet of strata (text-figs. 17, 18).

Age and Correlation

The diagnostic brachiopods of this biofacies are two subspecies assigned to the genus *Kirkidium: K. pingue pingue* (Amsden) and *K. pingue latum* Amsden (Amsden, 1969, p. 969-974). These are representatives of the Subfamily Pentamerinae, Family Pentameridae, Order Pentamerida, a distinctive subfamily of large brachiopods that are presently known only from the Silurian (Berry and Boucot, 1970, pl. 2). There is no basic reason why this genus (or other representatives of this subfamily) could not range into the Devonian, but the fauna that is associated with the *Kirkidium* biofacies, though small, is typically Silurian. This fauna includes the following species, associated with the following cores: Mobil 1 Horton, *Halysites* sp., *Enterolasma* cf. *E. waynense* (identified by Prof. P. K. Sutherland, The University of Oklahoma), *Heliolites* sp.; Pan American 1 Droke Unit, *Coelospira saffordi*; Humble 1 State Hunton, *Halysites* sp. and *Resserella* sp.; Tenneco 1-A Jordan Unit, *Tryplasma* cf. *T. radiculum* (identified by Prof. P. K. Sutherland) and *Enterolasma* sp., which occur about 70 feet below the lowest *Kirkidium*-bearing bed; Gulf 1 Schroeder, *Dictyonella* sp. and *Eospirifer* sp.; Getty 1-B Coffman, *Entellophyllum* sp. (identified by Prof. P. K. Sutherland) and *Halysites* sp., present just above the *Kirkidium*-bearing strata; Atlantic 1 Choate, *Halysites* sp.; Calvert 1 Bertie, *Sphaerirhynchia saffordi*?, *Halysites* sp., *Merista*? sp., and *Strophonella loeblichi*.

Independent evidence for the Silurian age of the *Kirkidium* biofacies has recently been supplied by the palynological studies of Jenkins (1971, p. 490-491). This author determined that the spores in the upper part of the Hunton cores (*Kirkidium* biofacies) in Custer County are Silurian in age, and he concludes by stating (p. 491), "Most particularly, the palynological evidence supports Amsden and Rowland's (1971) conclusions that in the Custer City oil field of western Oklahoma the

'Hunton' succession is entirely, or almost entirely, Silurian. . . ." Thus the *Kirkidium*-bearing strata would seem to be reasonably interpreted as Silurian, and because of its position at or near the top of the Silurian this zone makes an excellent marker for the Silurian-Devonian boundary.

Gilbert Klapper (The University of Iowa, written communication, 1972) reports *Polygnathoides siluricus* from the Pan American 1 Post Unit at a depth of 8,325 feet, which is 111 feet below the Woodford-Hunton contact and 229 feet above the Sylvan-Hunton contact. No specimens of *Kirkidium* have been reported from this well, and its relationship to *Kirkidium*-bearing strata is uncertain. According to Klapper, the *siluricus* zone is present in the upper Kopanina in Bohemia and the Bainbridge Formation at Lithium, Missouri.

In 1969 (Amsden, 1969, p. 964) I correlated the *Kirkidium* biofacies (as a zone) with the Brownsport Formation of western Tennessee, primarily on the basis of the occurrence of *Kirkidium pingue pingue* (Amsden) in both formations. The Brownsport Formation is now assigned by Berry and Boucot (1970, p. 129) to the Ludlovian on the reported presence of the conodont *Polygnathoides siluricus*. I also correlated this biofacies with the Henryhouse Formation on the basis of its stratigraphic position and fauna (the Brownsport, Henryhouse, and Moccasin Springs Formations were considered to be essentially the same age; Amsden, 1969, text-fig. 3). Certainly the faunas associated with *Kirkidium* have Henryhouse affinities, with most of the genera and species previously cited being common in the Henryhouse Formation; however, this list is small, and several of the identifications are provisional. Moreover, the present expanded investigation reveals a considerable thickness of non-*Kirkidium*-bearing beds between the *Kirkidium* strata and strata that I assign to the Chimneyhill Subgroup. In areas such as Custer County, where the thickness of the Silurian has increased substantially, the *Kirkidium*-bearing strata constitute only a small, upper part of the total Silurian (text-figs. 17, 18), whereas in the Arbuckle Mountains-Criner Hills the Henryhouse Formation (where not thinned by post-Silurian erosion) makes up a substantial part of the total Silurian (panel 10, sections *A-A'*, *B-B'*). The apparent absence of *Kirkidium* specimens below their observed position may be due to a lack of core control, or the beds may correlate with only a part of the Henryhouse (see under previous section Stratigraphic Relations). Possibly the *Kirkidium*-bearing beds are in part post-Henryhouse in age, although the assignment by Berry and Boucot (1970, p. 159-160) and Berry and Satterfield (1972, p. 495) of the Henryhouse to almost the entire Ludlovian-Pridolian time interval would, if correct, virtually preclude such a relationship. The megafauna found in the *Kirkidium* beds does not contribute to a precise age assignment, although it has unmistakable Henryhouse-Brownsport affinities. This question is not critical insofar as the facies study in the Anadarko basin is concerned, because the facies pattern developed in the *Kirkidium* strata is similar to that of the Chimneyhill Subgroup and to that of the entire Silurian.

Oil and Gas Production

Numerous porous beds are developed in the dolomitized parts of the *Kirkidium* biofacies, and these produce oil and gas over a considerable area in western Oklahoma (Amsden and Rowland, 1971, p. 106-108). The porosity of these strata is discussed later in the chapter on Porosity and Permeability in Late Ordovician and Silurian Strata .

Paleoenvironment of Late Silurian Strata

The following discussion will consider the various biofacies represented in Late Silurian strata, try to relate them to the different lithofacies, and then suggest the paleoenvironment which each represents. In this discussion it is assumed that the Henryhouse and *Kirkidium* biofacies are approximately correlative, and that the environment and place of deposition were not significantly different from the place in which the fauna lived. It should be noted that the goal of the present report is to give the regional lithofacies and biofacies framework for western Oklahoma. I am presently making a more detailed Silurian facies study based on a quantitative thin-section analysis and plan to present the results of this investigation in future reports.

The Henryhouse Formation throughout its outcrop area is a low-magnesium marlstone. It has a mud-supported fabric composed of finely divided carbonate mixed with clay- and silt-size insoluble detritus. The bedding is uniform with no evidence of cross-bedding, and mud cracks and other evidence of shallow-water deposition are absent. The shelly fauna is large, varied, and well preserved and includes a relatively high percentage of articulated shells. This megafauna, predominantly composed of representatives of the sedentary and vagrant benthos, is dominated by brachiopods with about 40 species, of which most are of small to medium size. The Henryhouse also includes numerous ostracodes, along with locally abundant trilobites, bryozoans, corals, mollusks, and other forms. Pelmatozoan plates are abundant, and the calyces of small inadunate crinoids are common in some beds. Calcareous algae are rare or absent, and no reefs or boundstones have been observed. Although few if any of the fossils appear to be in growth position, their excellent preservation and relatively low disarticulation ratio, combined with the low-energy characteristics of the enclosing sediments, indicate that this fauna is essentially a biocoenosis. Within the Arbuckle Mountains-Criner Hills region, the Henryhouse Formation exhibits changes in lithofacies and biofacies that are related to and help in understanding environmental changes in the Anadarko basin (panel 11). On the Lawrence uplift, at the northeastern tip of the Arbuckle Mountains region, megafossils are especially abundant, and locally the rock grades into a grain-supported (fossil-clast) texture. In the upper Henryhouse beds at the northern end of the Lawrence uplift, corals, which elsewhere constitute a relatively minor part of the Henryhouse megafauna, become abundant, being represented by numerous solitary and colonial forms, including *Halysites* (Sutherland, 1965, p. 6-7). Few of the corals appear to be in growth position, although they have probably not moved far. No *Kirkidium* brachiopods have been observed in this area, or at any place in the Henryhouse, but this coral-rich facies appears to be the southernmost tip of the *Kirkidium*-coral-crinoid biofacies that is so well developed in the subsurface strata lying to the north. On the Lawrence uplift, Henryhouse insoluble detritus is moderate, no red beds have been observed, and the $MgCO_3$ content is somewhat higher than elsewhere. South of here, especially in the central and southern parts of the Arbuckle Mountains, the $MgCO_3$ content decreases, insoluble detritus increases, and red beds are locally common. As a general rule, the marlstone red beds in both the surface and subsurface have a higher percentage of quartz detritus (usually with considerable mica) than do the gray to greenish-gray marlstones. Megafossils are generally less abundant in the southern areas, and graptolite-bearing shales are present in the central part of the Arbuckles. The brachiopods offer additional evidence that this change in lithofacies is reflected in the biofacies. Of the total brachiopod fauna comprising some 40 species, there are 17 species which are well represented in the fauna and which range throughout the entire, or almost the entire, Henryhouse Formation; these 17 species are widely distributed geographically, being present in all major outcrop areas of the Arbuckle Mountains and in the Criner Hills (Amsden, 1951; 1960, p. 178-286; 1962b, p. 1508-1509). These species are listed below.

Resserella brownsportensis
Dalejina henryhousensis
Pseudodicoelosia oklahomensis
Isorthis arcuaria
Dicoelosia oklahomensis
Dictyonella gibbosa
Sieberella roemeri
Anastrophia delicata
Strophonella prolongata
Strophodonta (Brachyprion) attenuata
Lissostrophia cooperi
Leptaena oklahomensis
Atrypa tennesseensis
Nanospira concentrica
Coelospira saffordi
Nanospira parvula
Merista oklahomensis

On the other hand, some brachiopod species are confined to the Lawrence uplift in the northeastern corner of the Arbuckle Mountains region. Of these, the following are abundant enough to be of some significance in determining the distribution of the brachiopod fauna.

[1]*"Ancillotoechia" carmelensis*
"A." altisulcata
"A." filistriata
"A." oklahomensis
Coolinia reedsi
Homoeospira foerstei
H. subgibbosa

These species range through almost the entire Henryhouse, where they are associated with the characteristic Henryhouse megafauna, including the 17 brachiopod species previously listed. They thus occur in strata that are believed to be correlative with the Henryhouse in other geographic areas, and their restricted distribution may have been controlled by changing ecologic conditions in the Henryhouse seas. Emphasizing this geographic restriction, it should be noted that no representative of the rhynchonellids, rhynchospirinids, or meekellids have been observed south or east of the Lawrence uplift, and it may be that these elements were more sensitive to ecologic conditions than the other elements in the brachiopod faunas. Unfortunately I have very little information on the distribution of these brachiopods in the *Kirkidium* biofacies to the north, a situation that *may* simply reflect the difficulty in recognizing these small shells in the cores.

The marlstone lithofacies can be traced westward into the deep part of the Anadarko basin and adjacent shallow fault blocks (panel 10, section *C-C'*; panel 11). The marlstone in the deep basin

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[1] The generic position of these and many other Silurian rhynchonellids is uncertain.

includes red beds, and the lithology and lithostratigraphic sequence is very much like that of the surface exposures. No fossils have been obtained from the subsurface marlstones, but it is reasonable to assume that the marlstones include Henryhouse correlatives.

The typical marlstone facies is interpreted as a low-energy environment, well removed from any considerable wave and (or) current action. It must have had a muddy substrate, and the water probably was somewhat turbid. At the north end of the marlstone outcrop, in the coral and rhynchonellid biofacies, the energy level of the sea increased, the water cleared somewhat, and the bottom was cleaner and more calcareous. In the central and southern areas where the detritus increases substantially, the water must have been quite turbid and the bottom muddy, locally grading into a calcareous-shale environment in some of which were graptolites. This suggests an environment representing the outer neritic zone (or deeper part of the sublittoral zone), grading into the inner neritic zone (i.e., the shallower part of the sublittoral zone) at the north end (Hedgpeth, 1957, p. 18-19). No precise water depth can be established because of the many unknown variables, but in all probability it was in the 50- to 200-meter range.

The *Kirkidium* biofacies can be recognized over a wide area in the subsurface of central and western Oklahoma. Its extension into the deep part of the Anadarko basin cannot be determined with certainty because of a lack of core data; however, the known presence in the deep basin of marlstone, a lithofacies not known to contain *Kirkidium*, makes it appear unlikely that this biofacies is present (panel 11). In central Oklahoma, in the area lying north of the Arbuckle Mountains outcrop area, the *Kirkidium* biofacies is represented by dolomitic limestone, usually with 10 to 15 percent terrigenous detritus. Locally some marlstone may be present, but mainly this is a grain-supported, organo-detrital limestone, mostly with micrite cement but including some spar. None of the fossils appear to be in growth position, and many are broken, although some complete valves are present including articulated shells. This rock is similar to the Henryhouse on the Lawrence uplift, differing primarily in its reduced insolubles, increased fragmentation of fossils, and increased concentration of fossil debris.

The fauna is dominated by *Kirkidium* brachiopods and crinoids along with some solitary and colonial corals, including *Halysites*, and a few stromatoporoids. These limestones may also include trilobites, bryozoans, ostracodes, and other forms. It is difficult to compare precisely this fauna, known only from cores, with the Henryhouse fauna, which is based on extensive collections from the outcrop. The *Kirkidium* megafauna does appear to be reduced in number of species and genera; moreover, corals make up a considerably greater part of the total megafauna, with the exception of the previously-mentioned Henryhouse beds on the Lawrence uplift.

North and west of central Oklahoma the *Kirkidium* rocks become increasingly dolomitic, the terrigenous detritus decreases, and the strata grade into low-insoluble crystalline dolomites. In the crystalline-dolomite beds, the fossil content and faunal diversity are sharply reduced and the rock is composed largely of *Kirkidium* shells and crinoid plates. There is clear evidence that dolomitization has obliterated some of the fossils, and it is possible that this process has been selective, affecting some organisms more than others; however, it is here suggested that this apparent restriction represents, to a substantial degree, the original ecological conditions that were affected by magnesium-rich waters (see following section on Silurian Dolomite). A similar relationship appears to exist in the Edgewood Group of Missouri and Illinois, where Late Ordovician-Silurian limestones grade laterally into a dolomite lithofacies (Amsden, 1974, p. 17).

Oolitic beds are present in the *Kirkidium* dolomitic limestones of central Oklahoma and extend northwestward into the crystalline-dolomite facies. No oolites are known from the marlstones in the subsurface or the surface.

In the northwestern part of the State, the *Kirkidium* biofacies grades abruptly into a low-magnesium, organo-detrital limestone. Spar and micrite cement are present, the latter usually dominant. The shelly debris shows substantial breakage, and for the most part these limestones appear to represent shell banks of *Kirkidium* that were subjected to some disarticulation and breakage. Crinoid plates are abundant, and both solitary and colonial corals, including *Halysites*, are commonly present. The western *Kirkidium*-dolomite facies is thus enclosed, or nearly enclosed, on the west, south, and southeast by low-magnesium limestones; however, it should be emphasized that the western limestone facies is *low* in insoluble detritus, whereas the southern and southeastern strata are marlstones, relatively high in detritus.

The insoluble material in the Henryhouse-*Kirkidium* strata is largely terrigenous detritus, much of it being silt-size, angular to subangular quartz detritus, locally with considerable mica. This material has its greatest concentration along a depositional axis extending from the deep part of the Anadarko basin to the Arbuckle Mountains-Criner Hills region (panel 1, map C; panel 11). It is probably at a maximum in the latter area, where the Henryhouse Formation as a whole averages 20 percent insoluble debris, increasing in the central and southeastern areas to almost 40 percent with some of the graptolite beds grading into calcareous shales. From the southern margin of the Anadarko basin, the insoluble debris decreases toward the north and west, and over most of the northern region the *Kirkidium* biofacies averages less than 10 percent. It seems unlikely that any considerable part of this terrigenous detritus could have been obtained from a reworking of the underlying strata, as both the Chimneyhill Subgroup and the Sylvan Shale contain very little silt-size material. Therefore, it must have been derived from the erosion of some land mass, although the size and character of the detritus suggests that this mass was some distance removed. In 1969, I (Amsden, 1969, p. 968-969, text-fig. 7) suggested that the terrigenous materal in the *Kirkidium*-Henryhouse strata, as well as that in the correlative Moccasin Springs Formation of Illinois and Missouri and Brownsport Formation of Tennessee, were derived from a source now largely covered by Coastal Plain sediments. The present, more detailed study on the distribution of detritus in Late Silurian rocks of Oklahoma provides additional evidence bearing on this explanation. Terrigenous detritus is strongly developed in the central and southeastern parts of the Arbuckle Mountains region, in fairly close proximity to the Ouachita Mountains province (panel 11). Some of the calcareous siltstones in the graptolite facies grade toward the Missouri Mountain Slate of the Ouachita province. The Henryhouse Formation is commonly correlated with at least some part of the Missouri Mountain Slate, although it should be noted that no diagnostic fossils have been found in this formation, no fauna being known between the Blaylock Sandstone (Early Silurian) and the middle division of the Arkansas Novaculite (Late Devonian) (Amsden and others, 1967, p. 928). Assuming that these formations are correlative, it is not here suggested that the Upper Silurian clastics of the Anadarko basin were derived from the Missouri Mountain but that both had a common source to the south and possibly east of the Ouachita Mountains region.

The dolomites of the Henryhouse-*Kirkidium* strata have an unusual distribution. The strata along the deep Anadarko basin-Arbuckle Mountains axis are low-magnesium marlstones that grade northward and westward into increasingly dolomitic strata, finally passing into the *Kirkidium*-bearing crystalline dolomites of northwestern Oklahoma. This change matches the irregular but persistent decrease in insoluble detritus; however, these low-insoluble dolomites pass abruptly into a low-magnesium, low-insoluble bioclastic limestone facies, which at its southern extremity must merge into, or nearly merge with, the western extension of the marlstone facies (panel 11). Thus the insoluble detritus has no clearly discernible relationship to the dolomite, and in all probability any apparent local correlation between the two is fortuitous.

The *Kirkidium* lithofacies and biofacies bear evidence pointing to an increase in energy level, as indicated by the following: (1) fossil breakage and disarticulation increases from the marlstone into the *Kirkidium* beds; (2) beds of oolites are present in the *Kirkidium* biofacies; (3) some spar matrix appears in the *Kirkidium* strata, suggesting that these deposits locally represent washed, organic sands.

These facies changes point to an increase in wave and (or) current action toward the northwest, probably caused by a shoaling of the water away from the quiet, deep-water marlstone environment. This was accompanied by a reduction in available terrigenous detritus, owing to increased distance from the source area and producing a decrease in water turbidity and a change from a muddy to a cleaner, calcareous bottom. Banks or beds of *Kirkidium* brachiopods, crinoids, and corals are evident, although these do not appear to have produced any well-defined reefs. Farther to the northwest the sea water was enriched in magnesium, probably associated with increased evaporation, and the faunal diversity decreased, leaving mainly *Kirkidiums* and crinoids. Presumably this was in a relatively high-energy environment with a bottom composed almost entirely of calcareous sand. Anderson (1971, p. 298-299) suggests that this *Kirkidium*-dolomite facies represents a tidal- or subtidal-flat environment and that an "*Eocoelia* Community" might be present beyond this. There is, however, no evidence whatsoever for a tidal-flat environment or strandline in this area (see section on Silurian Dolomite). To the west, the sea water apparently returned to a more normal salinity, presumably owing to a deepening of the water, and the fauna was again dominated by *Kirkidium*, corals, and crinoids.

North of the *Kirkidium*-dolomite facies, Hunton strata are truncated by pre-Woodford erosion (panel 11).

Kirkidium *Distribution*

Kirkidium specimens are common in the Late Silurian beds of western Oklahoma but are unknown in the correlative Henryhouse Formation, notwithstanding the fact that this formation has been intensively collected for many years. Their absence from the latter is especially noteworthy because the Henryhouse has a rich shelly fauna, including some 40 brachiopod species (Amsden, 1960, p. 146), indicating that this absence was related to changes in environment (Amsden, 1969, p. 968). The Henryhouse fauna occupied a relatively quiet environment with some water turbidity and a muddy substrate, whereas *Kirkidium* generally lived in more active water with a clean, calcareous substrate. Depth of water, a major factor in the energy level of any marine habitat, may have been an element affecting the distribution of *Kirkidium*, but the evidence suggests that a low level of suspended matter in the water combined with a clean, calcareous bottom was the primary control. The concentration of magnesium in the sea water seems to have had an effect on faunal diversity, but this does not appear to have affected the specimens of *Kirkidium*, as they are well represented in both the crystalline dolomites and the limestones (see section on Silurian Dolomite).

The regional distribution of these large brachiopods in the southern Midcontinent region is in accord with their distribution in Oklahoma. *Kirkidium pingue pingue* (Amsden), which is common in the *Kirkidium* biofacies, is present in the Brownsport Formation of western Tennessee (Amsden, 1969, p. 968, 969-974), a formation which is here considered to be essentially correlative with the Henryhouse Formation. This species is not widely distributed in the Brownsport, being concentrated into shell beds similar to their Oklahoma occurrence. The Brownsport is a marlstone, but its insoluble-detrital content is probably substantially lower than in the Henryhouse; moreover, the *Kirkidium*-bearing beds of the Brownsport appear to have less insoluble detritus than do the other parts of the formation (Amsden, 1951, p. 72). The Moccasin Springs Formation of southeastern Missouri and southwestern Illinois is also believed to be approximately correlative with the Henryhouse and Brownsport Formations. This formation is a reddish-gray to greenish-gray marlstone with relatively few clean limestone beds, and its lithologic character is more like that of the Henryhouse than that of the Brownsport or *Kirkidium* biofacies, which may explain the absence of these brachiopods from the Moccasin Springs. This is not to imply that representatives of the large pentamerid brachiopods could not survive in an environment receiving substantial terrigenous detritus, but it does appear that the silt-clay-rich, quiet-water habitat of the Henryhouse-Moccasin Springs was not favorable for this group of *Kirkidium* species.

Biofacies

Paleontologists have long been concerned with recurrent faunal associations that might characterize ancient life habitats, and recently interest in Silurian paleoecology has been stimulated in papers by Ziegler (1965; Ziegler *in* Berry and Boucot, 1970), Ziegler and others (1968), Anderson (1971), and Watkins and others (1973). Various efforts have been made to name and classify such ecologic assemblages, the latest being that of Watkins and others (1973), suggesting that the term community be employed in a different sense from its generally accepted biologic usage (Bretsky, 1973; Valentine, 1973). I prefer, however, the term biofacies, because it clearly implies that these were ecologically controlled assemblages, which, under the impetus of shifting environmental conditions, graded laterally (and vertically) into different assemblages. Insofar as the Silurian Period is concerned, efforts have been made to establish a set of universally recognized "communities" to which all assemblages could be referred and which presumably would everywhere represent similar ecologic conditions. Thus the two major biofacies herein recognized, Henryhouse and *Kirkidium*, might be correlated with Ziegler's (*in* Berry and Boucot, 1970, p. 104; Watkins and others, 1973, p. 57) *Salopina-Hyattidina* Community and *Kirkidium-Gypidula* Community, the former said to represent an inshore habitat and the latter an offshore habitat. There are, however, several difficulties that render such a comparison ineffective. First, the terms inshore and offshore are not well enough defined to be meaningful, as either can include a wide range in bottom conditions, salinity, turbidity, energy level, and other factors. For example, in the Henryhouse and *Kirkidium* biofacies, the Henryhouse is inshore in the sense that it occupied a position nearest to the land supplying the terrigenous detritus, but it is well removed from the sublittoral zone and represents much quieter, deeper water and different bottom conditions from the *Kirkidium* biofacies, which was far removed from any known strandline. Another problem concerns the taxonomic identity of the faunal elements included in the communities. Many of the genera recognized in the *Salopina-Hyattidina* Community are not present in the Henryhouse, and vice versa. Furthermore, there are anomalous generic associations, such as *Sieberella*, which is well represented in the Henryhouse but unknown in the *Kirkidium* biofacies. *Sieberella* is morphologically similar to *Gypidula* (the two can only be distinguished on the basis of the outer brachial plates), a genus that Ziegler (*in* Berry and Boucot, 1970) and Anderson and Makurath (1973, p. 386) consider to be an indicator of the *Kirkidium* biofacies. This is further complicated by the fact that *Gypidula* is present in the Haragan Formation of Early Devonian age, which is a marlstone lithofacies nearly identical to that of the Henryhouse, and presumably representing a similar habitat.

The importance of paleoecologic studies can hardly be overemphasized and certainly requires no endorsement here. However, it seems to me that attempts to establish a classification of Silurian communities that can be recognized throughout the world, and that are based largely on a taxonomic analysis of the faunas (preeminently brachiopod faunas) per se, require excessive generalization and simplification. The habitat of ancient marine organisms was controlled by so many variables and combinations thereof that any universal classification must be so broadly defined as to be largely ineffective. Moreover, a genus that may be represented at one locality and time by a species adapted to a particular environment may be represented at another time and place by a species adapted to a quite different environment. For example, species representing the genus *Gypidula* may have occupied different ecological niches at different times in its phylogeny. Finally, I strongly believe that a careful examination of the lithology and lithostratigraphy of the enclosing sediments is of critical importance. Far too many paleontological studies are concerned with the taxonomy of the fossils themselves, with little or no regard to the rocks in which they occur. Much vital information on paleoecology–in many cases, the most vital information–is to be found in a thorough examination of the sediments, including the preservation of the fossils.

Silurian Dolomite

This study is a continuation of an investigation on Hunton dolomites begun several years ago (Amsden, 1960, p. 15-20; 1961, p. 69; 1969, p. 966, 970; Amsden and Rowland, 1965, p. 12, 53-57). The present report, which provides information on the stratigraphic and geographic distribution of dolomite in the subsurface of western Oklahoma, is of some economic significance because of the relationship between porosity and dolomite content (see main section on Porosity and Permeability in Late Ordovician and Silurian Strata).

Dolomite in the Silurian strata of Oklahoma is largely a replacement mineral for which the general term dolomitization is herein used. I believe these particular dolomites represent an early, penecontemporaneous replacement, although the expression dolomitization would appear to be equally appropriate for a late-stage, epigenetic replacement (see later section, Origin).

Methods of Study

The methods employed in the present investigation are essentially the same as in the earlier works cited previously. The cores have been studied by means of chemical analysis, thin sections, and Alizarin Red-S staining. Almost all available cores have been analyzed for HCl-insoluble residues, $CaCO_3$ and $MgCO_3$, and the results are tabulated in the Appendix. Several hundred thin sections were prepared, some being stained with Alizarin Red-S; in addition, a number of polished surfaces have been stained. This method makes it possible to quantify the distribution of $MgCO_3$ in those areas for which cores are available. Furthermore, thin sections make it possible to correlate the texture with the chemical composition, thus providing additional details on the transition from low- to high-magnesium strata. The staining has been particularly helpful in distinguishing between calcspar and dolospar. Wells penetrating the deeper part of the Anadarko basin and the adjoining shallow fault blocks have been studied exclusively by means of thin sections. Several hundred thin sections were prepared, most being stained with Alizarin Red-S; the dolomite content was visually estimated from the thin sections. With this method it is possible to make a reasonably reliable distinction between low-magnesium limestones (less than 10 percent $MgCO_3$), dolomitic limestone, and crystalline dolomite (28 percent and more $MgCO_3$). However, these data lack the quantitative precision of those obtained from chemical analyses, and for this reason information obtained solely from thin sections is kept separate on the facies maps.

$MgCO_3$ Analyses

In this report the $MgCO_3$ content is generally stated as a percentage of the total rock volume (Appendix). This method seems to satisfy best the goals of the present study (see Introduction, Chemical Analyses), and unless otherwise stated the $MgCO_3$ content is cited on maps and graphs as a percentage of the total. However, the $MgCO_3$ as a percentage of the acid-soluble portion and the $CaCO_3/MgCO_3$ ratio, are also recorded for all samples tested. In addition, the percentage of the mineral dolomite is given for the porosity-permeability samples (Appendix, part IV).

One of the interesting discoveries in the present study is that the percentage of $MgCO_3$ in a number of Silurian rocks analyzed approaches that of a pure dolomite. (Theoretically, pure dolomite contains 54.35 percent $CaCO_3$ and 45.65 percent $MgCO_3$ and has a $CaCO_3/MgCO_3$ ratio of 1.19.) Several specimens analyzed have $CaCO_3/MgCO_3$ ratios in the 1.2 to 1.3 range, and $MgCO_3$ ranging from 44 percent to more than 45 percent (calculated as a percentage of the acid-soluble portion). It is surprising to find so many high dolomite analyses, especially since most of the rock analyzed covers a stratigraphic interval of about 10 feet. Some analytical error is to be expected, but the presence of so many low ratios (35 samples fall in the 1.2 to 1.4 ratio) would seem to rule out the possibility that this is the result of faulty laboratory technique (there is nothing in the wet-chemical analytical method used that biases the analysis toward magnesium). Some of the magnesium may be coming from other minerals such as chlorite, but it seems unlikely that this could provide any substantial amount, especially since some of the carbonates with low ratios have only 1 percent or so of acid insolubles; thus I conclude that beds of reasonably pure dolomite are present in the Silurian rocks of western Oklahoma.

Dolomite Lithofacies Maps

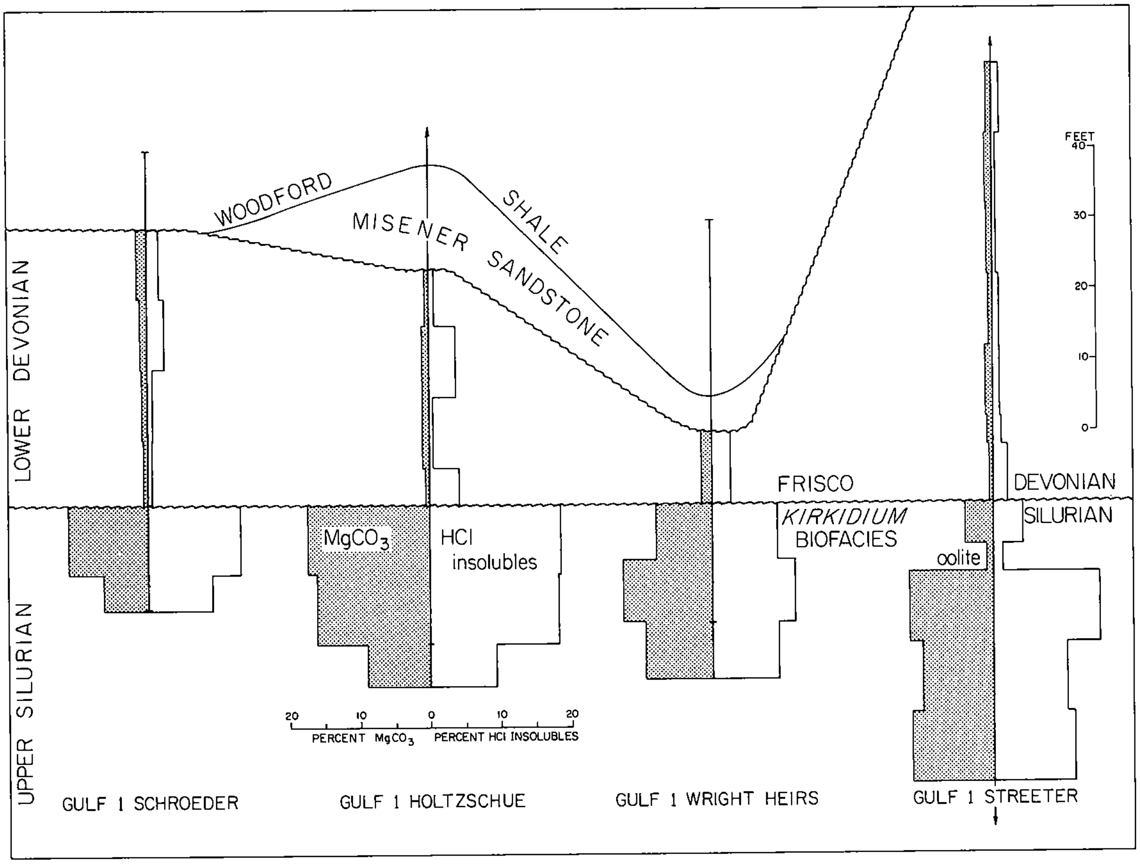
Several lithofacies maps showing the distribution of $MgCO_3$ for dolomite in Hunton strata have been published. I have presented magnesium carbonate maps for the Henryhouse and Haragan Formations in the Arbuckle Mountains-Criner Hills region (Amsden, 1960, p. 71, 90), and for the Henryhouse-*Kirkidium* strata in the western half of Oklahoma (Amsden, 1969, p. 970). In 1965 T. L. Rowland and I (Amsden and Rowland, 1965, p. 60-61) published a generalized map showing the distribution of Hunton dolomite in the eastern half of the State, and in 1967 we (Amsden and Rowland, 1967a) showed a similar map for the entire State. In 1967 Logsdon and Brown (p. 68-69) issued a Hunton dolomite map of the Anadarko basin. The present report includes maps showing the distribution of $MgCO_3$ in the Chimneyhill Subgroup, in the Henryhouse-*Kirkidium* strata, and in the total Silurian (panel 2, maps B-E). In those areas where Hunton strata are shallower than −15,000 feet, these maps are based on chemical analysis of cores, and below this depth they are based on well samples; stained thin sections were prepared from the cuttings, and the dolomite content was visually estimated. (A map showing the distribution of $CaCO_3$ in the Frisco Formation is shown in text-fig. 36.) I believe the control is adequate to give reasonably reliable regional dolomite maps, but some local adjustments and revisions will almost certainly be needed with the availability of additional information.

Stratigraphic Distribution of Dolomite

In the Arbuckle Mountains-Criner Hills, the entire Hunton section is represented by low-magnesium limestones (Amsden, 1960, p. 16-18), and consequently there is little evidence bearing on stratigraphic distribution; however, there is a marked stratigraphic control when the entire State is considered. Silurian rocks in the Arbuckle Mountains-Criner Hills are overlain by the Haragan-Bois d'Arc Formations of Early Devonian (Helderbergian-Gedinnian) age (see Haragan-Bois d'Arc Formations). These strata are fairly well confined to the region lying south of the Silurian dolomite front, but a small outlier of Early Devonian (?Helderbergian) age was penetrated in the Pan American 1 Droke Unit in Kingfisher County; a core from this well provided a small terebratuloid brachiopod with some similarity to *Rensselaerina* from the Haragan Formation (panel 9; Amsden and Rowland, 1967b, p. 954). This well is north of the Silurian dolomitic front, and the matrix enclosing the fossil is dolomitized, indicating that very Early Devonian strata are at least locally in a dolomite facies. In the northern part of the Arbuckle region, the Haragan-Bois d'Arc strata are overlain by the Frisco Formation of middle Early Devonian age (Deerparkian-Siegenian).

The Frisco Formation of Early Devonian age, which is separated from the underlying strata by an unconformity of sufficient magnitude to truncate all the underlying Hunton strata, appears to have been deposited as a thin but widespread organo-detrital limestone that was extensively breached by pre-Woodford erosion, leaving only scattered remnants (see Frisco Formation). This formation extends from the area of undolomitized Silurian rocks out onto the dolomitized Silurian, but does not participate in the dolomitization, being everywhere a low-magnesium limestone (text-fig. 36). This conspicuous time-stratigraphic control in the distribution of dolomite can be well documented in eastern Oklahoma, where low-magnesium limestones of the Frisco Formation directly overlie strongly dolomitized Silurian strata and are in turn directly overlain by dolomitized Sallisaw strata (Amsden, 1961, p. 69-73; Amsden and Rowland, 1965, p. 53-56). This can also be demonstrated in central Oklahoma where Frisco strata directly overlie the Silurian *Kirkidium*-bearing beds. The difference between the low-magnesium limestones of the Frisco and the dolomitized Silurian strata is clearly defined in spite of the fact that this area lies on the eastern margin of the Silurian dolomite lithofacies, where the limestone facies is just beginning to be dolomitized (text-fig. 19). This relationship is important to an understanding of Hunton dolomites and the associated porosity, because it demonstrates that most of the Silurian dolomite was in place *before* deposition of the Frisco Limestone (i.e., *prior* to middle Early Devonian time).

The entire Silurian section participates in the regional dolomitization, although there is evidence of some stratigraphic control in eastern Oklahoma (Amsden and Rowland, 1965, p. 53-56, 65) and locally in the Anadarko basin. Silurian strata north and west of the Arbuckle region are progressively dolomitized, although the dolomite is not uniformly distributed from top to bottom and exhibits numerous irregularities in its stratigraphic as well as its geographic distribution. In Kingfisher, Major, and Woodward Counties (panel 10, section *A-A'*), present evidence indicates that the *Kirki-*



Text-figure 19. Stratigraphic chart showing distribution of $MgCO_3$ and HCl-insoluble residues in selected cores cutting Frisco Formation and Upper Silurian strata of Oklahoma County. Descriptions and analyses of these cores are given in Appendix.

dium beds are more strongly dolomitized than the underlying Chimneyhill Subgroup, but there are exceptions, and in places lower Hunton strata are represented by crystalline dolomite. This is the situation in the Calvert 1 Bertie, where strata provisionally assigned to the Chimneyhill average 38 percent $MgCO_3$ and have excellent porosity (Appendix; panel 10, section *A-A'*). Moreover, south of this region, in Dewey and Roger Mills Counties and extending into Wheeler County in the Texas Panhandle, basal Hunton beds are almost exclusively in a crystalline dolomite facies (in places with excellent porosity), whereas the overlying *Kirkidium* biofacies grades into low-magnesium limestone (panel 10, section *B-B'*). However, in the Phillips 1-D Franklin, a short distance to the southwest in Gray County (text-fig. 9), most of the Chimneyhill strata grade into a low-magnesium limestone similar to that present in the outcrop area, thus providing another example of variation in the distribution of dolomite. Considering the large geographic area involved and the long time period spanned by Hunton deposition, such irregularities are expectable and would not appear to be at variance with a hypothesis of regional dolomitization.

Recently Isom (1973, p. 34-38) studied Hunton rocks in the Oakdale-Campbell trend of Woods, Major, and Woodward Counties, where he recognizes three zones: an upper dolomitic zone A, a middle limestone zone B, and a basal limestone zone C (the latter correlated with the Chimneyhill). This author notes that the best porosity occurs in the dolomites of zone A, which he interprets as intercrystalline and vuggy porosity associated with the pre-Woodford surface. This zonation accords roughly with that shown in section *A-A'*, panel 10, and as is to be expected where pre-Woodford erosion has removed a part of the Hunton, some potential producing horizons are deleted. However, I do not believe that Isom's (1973, pls. 8, 9) depiction of these zones as well-defined lithostratigraphic units persisting over considerable distances represents a viable interpretation of the known data. As noted before, dolomitization in western Oklahoma affects all of the Silurian strata, with well-developed crystalline dolomite (typically with good porosity) being present in the lower as well as the upper part of the Hunton. This is not to deny the existence of local zones of strong dolomitization or their economic significance, but even in a restricted area it is important to bear in mind that there is substantial stratigraphic and geographic variation in the degree of dolomitization. When this variation in the degree of dolomitization is coupled with the porosity variation known to exist within the crystalline dolomites, it becomes apparent that to interpret them as persistent porous zones interrupted only by pre-Woodford truncation is an oversimplification.

Isom (1973, p. 38) recognizes two types of dolomitization: an early-stage, penecontemporaneous replacement, and a secondary, late-stage type which he relates to the circulation of magnesium-rich waters moving along the Woodford unconformity and related fractures. There is certainly some late dolomitization, but I think the evidence clearly indicates that most of the Silurian dolomite represents a regional dolomitization unrelated to any tectonic features or to the Woodford unconformity (see following sections on Geographic Distribution of Dolomite; Origin; main section on Porosity and Permeability in Late Ordovician and Silurian Strata).

Geographic Distribution of Dolomite

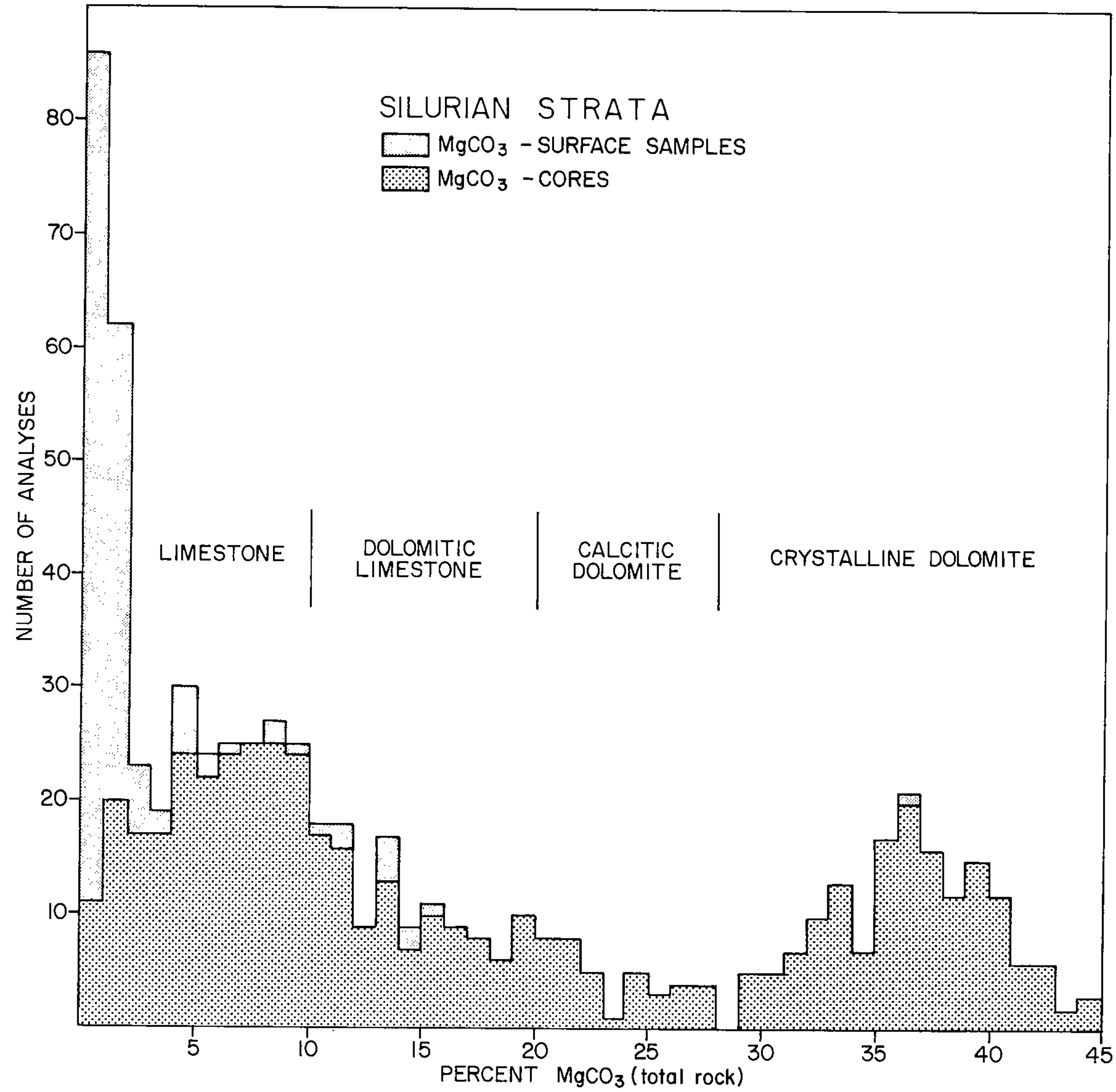
All evidence points to a regional concentration of dolomite in the Silurian of Oklahoma. The limestone facies of the Arbuckle Mountains-Criner Hills extends westward into the deep part of the Anadarko basin, and from this depositional axis the rocks grade northward and westward into magnesium-rich strata. Although this is, in a general way, a progressive trend, it is quite irregular, and within the dolomitic-limestone lithofacies are beds of high-magnesium dolomite and within the dolomite lithofacies there are low-magnesium beds (see also Amsden and Rowland, 1965, text-fig. 15). Northwest of the strongly dolomitized area, Silurian rocks grade back into low-magnesium limestone, a change that appears to be rather abrupt, although it should be noted that core control in this region is sparse. Regional studies by Berry and Boucot (1970, pl. 1) suggest that this limestone is a part of the North American dolomite facies, but this relationship is not at all clear as Silurian strata are truncated a short distance to the west and do not reappear for some distance. The transition from the low-magnesium-limestone facies of the Arbuckle region into the dolomite facies occurs in an area reasonably well supplied with cores, thus making it possible to quantify the chemical change by core analysis and to document the textural changes by means of thin sections prepared from these cores.

Dolomite-Limestone Textural Relations

All evidence available to me indicates that the dolomite-rich strata are a facies of the limestones, the low-magnesium marlstones and bioclastic limestones being progressively replaced by dolomite. This is also true of the oolitic beds in the *Kirkidium* biofacies and the Keel Formation, both of which extend from the undolomitized region into the dolomitized region, and which also participate in the dolomitization (pl. 3, fig. *5*; pl. 4, figs. *2a*, *2b*; pl. 12, figs. *4-6*). There is no indication that the dolomitization is related to any tectonic feature, nor does it appear to be related to any considerable extent to the overlying and underlying strata. This progressive dolomitization can be documented by a study of cores in thin section, polished surfaces, and stained specimens. It is perhaps best studied in the Henryhouse-*Kirkidium* sequence, as cores are most abundant in the upper part of the Silurian section, although most of the following description is equally applicable to the Chimneyhill Subgroup.

The Henryhouse in the outcrop area is mostly a low-magnesium marlstone with a matrix composed in large part of finely divided calcium carbonate and insoluble detritus. The fossils, which are scattered through this matrix, retain their original microtexture with little evidence of alteration (pl. 8, figs. *1-2*, *3a*, *3b*; pl. 9, fig. *4*). Minor dolomite is commonly present as euhedral crystals scattered through the matrix (pl. 9, fig. *5*). The marlstone averages less than 5 percent $MgCO_3$, and in only a few localized beds does it exceed 10 percent. Traced into the subsurface, the detritus decreases, the fossil content increases, and the rock grades into an organo-detrital, grain-supported (fossil-clast) carbonate. The magnesium carbonate content increases, and euhedral crystals of dolomite become common to abundant in the matrix (pl. 6, figs. *1-3*; pl. 10, figs. *1*, *2a*, *2b*, *2c*). As the dolomite crystals increase in the matrix, they begin to impinge against and corrode the fossil boundaries, although the latter still retain their original microtexture (pl. 11, figs. *2a*, *2b*, *2c*). With still further increase, the matrix becomes almost entirely dolomite crystals, and the fossils, although still retaining this microtexture, appear as corroded remnants (pl. 11, figs. *3a*, *3b*). The final stage in this sequence is a rock whose texture is composed of interlocking crystals of dolomite. Some of the fossils have been partly to completely obliterated by dolomitization (pl. 5, fig. *4a*), and those that remain are preserved as molds, or in calcspar or dolospar (pl. 3, figs. *2-4*, *6*; pl. 5, figs. *1-4*; pl. 6, figs. *5a*, *5b*). The correlation of numerous thin sections with chemically analyzed specimens demonstrates that the change to crystalline dolomite takes place at about 28-percent $MgCO_3$ (text-fig. 20), calculated as a percentage of the total rock volume (approximately 62 percent as the mineral dolomite), and 33-percent $MgCO_3$ (text-fig. 21) calculated as a percentage of the HCl-acid-soluble portion (approximately 73 percent as the mineral dolomite). In terms of the $CaCO_3/MgCO_3$ ratio, the change from calcareous dolomite to crystalline dolomite generally takes place at about 1.9 (text-figs. 22, 23, 24). The position of this transition with respect to the chemical composition is relatively stable in rocks with low acid insolubles; however, in rocks with relatively high insolubles the boundary may be shifted, even in high-magnesium strata, because the silt-size insoluble detritus tends to separate and break up the interlocking dolomite crystals. Thus sample P3B, with 41.47 percent $MgCO_3$ (percentage of acid solubles; 25.11 percent $MgCO_3$ of total rock) and $CaCO_3/MgCO_3$ ratio of 1.42, does not have the crystalline-dolomite texture, apparently because of its 38.12-percent insoluble detritus. Sample P14A, with 34.05 percent $MgCO_3$ and a 1.94 ratio, is similarly affected with 10.05-percent acid insolubles (see Appendix, porosity-permeability tests).

It should be noted that there is an abrupt transition from the dolomitized, bioclastic rocks in which euhedral crystals of dolomite occupy much of the matrix to the crystalline dolomites in which the fossils have either been removed by solution or replaced by spar. I can offer no satisfactory explanation for this seemingly sharp transition, but with this in mind it is interesting to examine a frequency diagram showing the distribution of $MgCO_3$ analyses. The distribution of $MgCO_3$ in the *Kirkidium* biofacies is bimodal (text-fig. 14); it is even more strongly so when the entire Silurian, which includes the complete range from low- to high-magnesium rock, is included (text-figs. 20, 21). This distribution is similar to that reported by Pettijohn (1957, p. 383-387) for a collection of Paleozoic limestones. Pettijohn concludes that, based on known chemical composition of recent marine invertebrates, a simple accumulation of skeletal material will not explain the distribution of dolomite in these older rocks, and he thinks that the high-magnesium-bearing Paleozoic strata must be either inorganic precipitates (?including penecontemporaneous replacement) or skeletal accumulations that have been enriched in this substance. Chilingar (1956, p. 2263), in a study involving 3,500 carbonate analyses, also noted a marked bimodal distributional pattern, and he concluded that the strong preponderance of analyses in the pure limestone class and in the high-

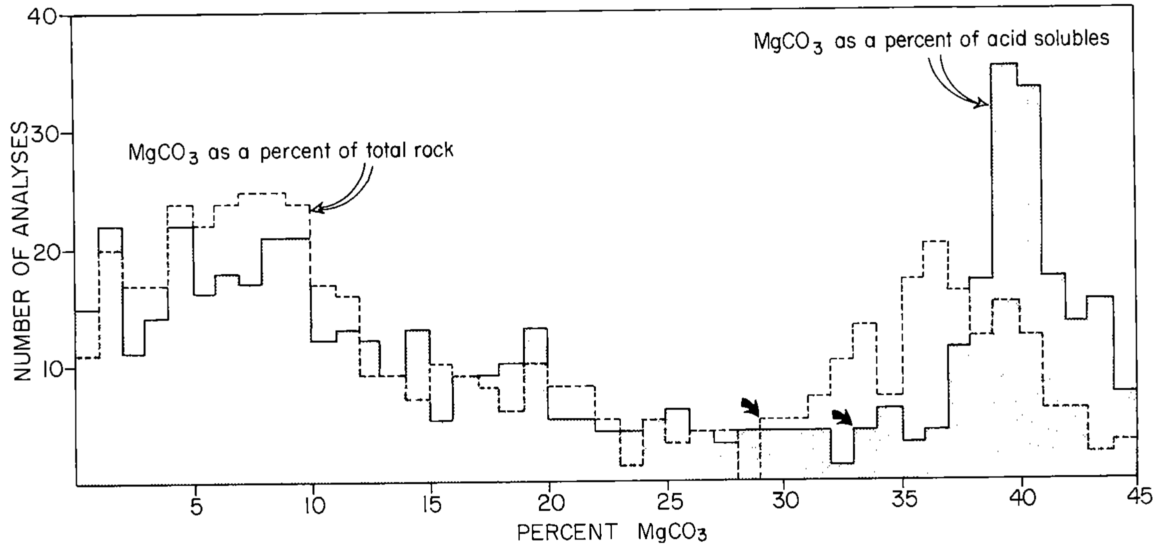


Text-figure 20. Frequency diagram showing distribution of $MgCO_3$ (as percentage of total rock volume) in Silurian rocks from Arbuckle Mountains-Criner Hills region (surface samples) and Anadarko basin (subsurface). Based on 148 analyses of surface samples and 510 analyses of core samples (see Amsden, 1960, p. 287-297; Appendix, this report).

dolomite class suggested that small changes in chemical composition of the sea water could bring about drastic changes in the composition of the limestones. This would provide an explanation for the bimodal pattern developed in what is here interpreted as penecontemporaneous dolomitization by assuming that in certain areas the sea water was slightly enriched in magnesium, perhaps induced by a moderate increase in evaporation. Regardless of the explanation offered for the genesis, these particular Silurian dolomites appear in large part to represent a regional dolomitization that was unrelated to any internal feature, such as crinoid-rich beds, or to any external feature, such as faults.

Relationship of Dolomite to HCl-Insoluble Residues

Silurian rocks in Oklahoma are generally low in HCl-insoluble residues (mostly terrigenous detritus), the mode for strata in the eastern outcrop

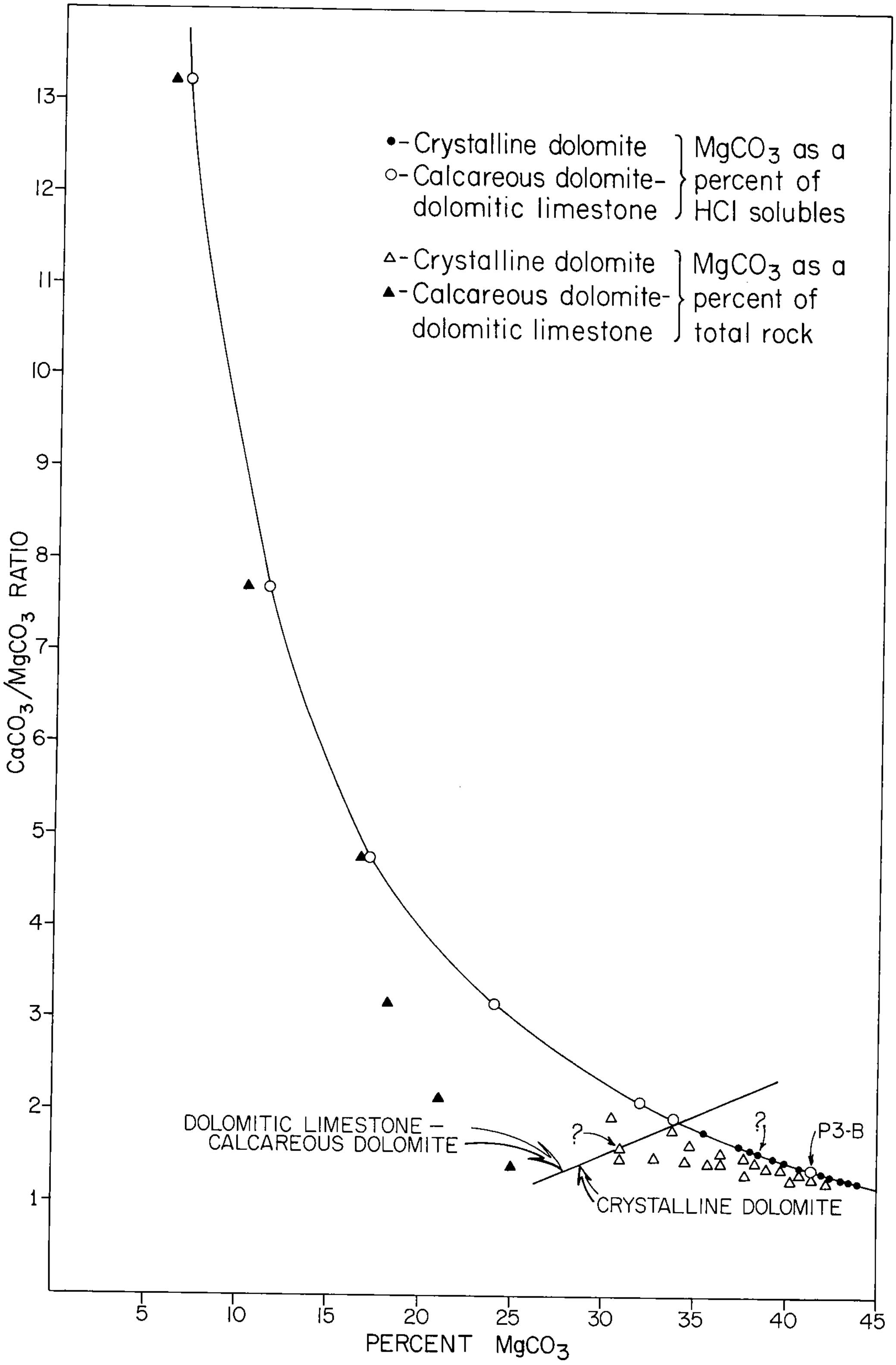


Text-figure 21. Frequency diagram showing distribution of $MgCO_3$ in Silurian rocks from Anadarko basin cores. $MgCO_3$ in stippled areas is shown as percentage of HCl-acid-soluble portion, and dashed lines show it as percentage of total rock volume. Based on 510 core analyses given in Appendix. Arrows mark approximate boundary between calcareous dolomite and crystalline dolomite.

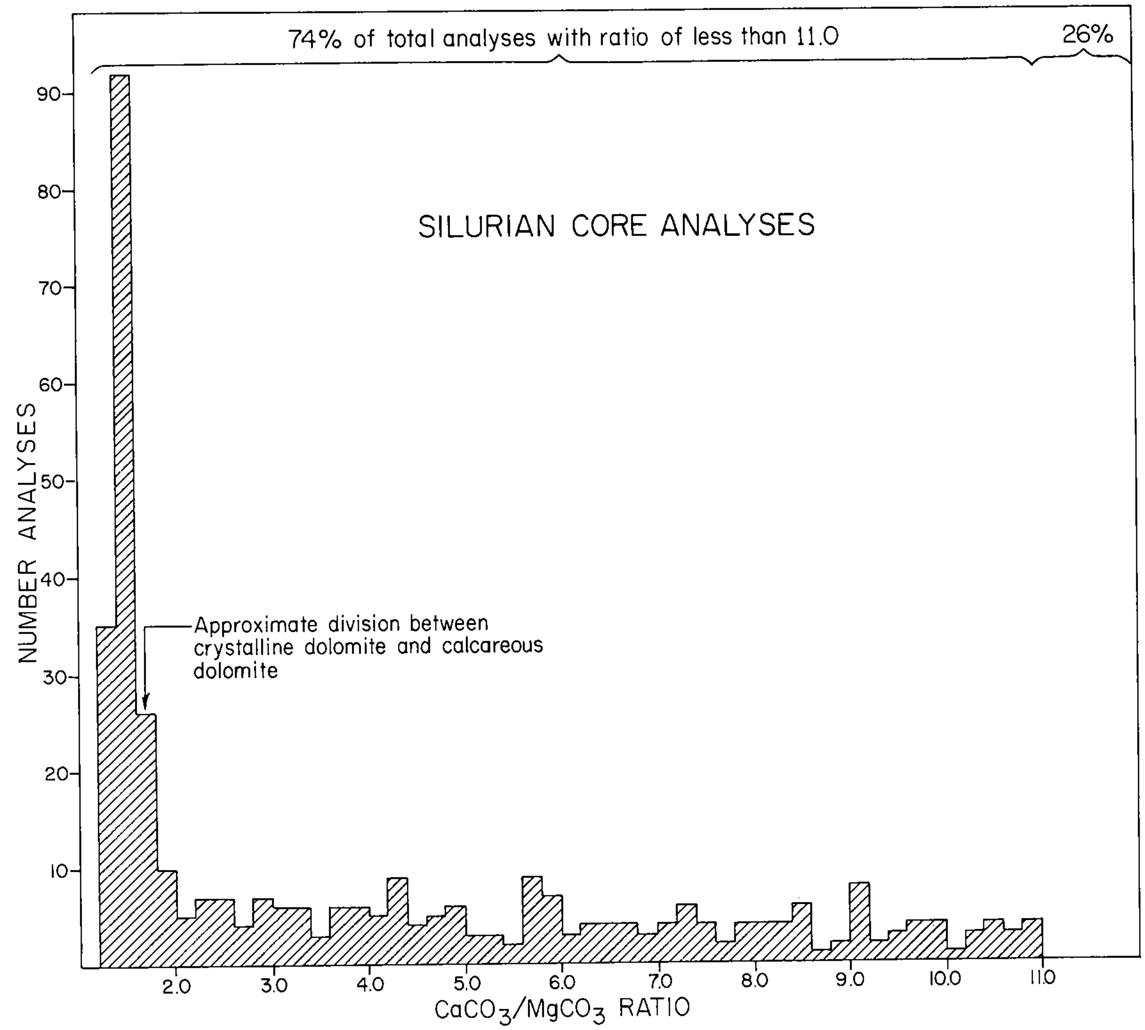
area being less than 1 percent (text-fig. 25) and in the western outcrop 2 to 3 percent (text-fig. 26). In the western region, insoluble detritus is most abundant in the marlstones of the Late Silurian, which are concentrated along the depositional axis extending from the Arbuckle Mountains-Criner Hills into the deep part of the Anadarko basin. In this region the detritus averages about 20 percent, only rarely ranging into a calcareous shale. North and west of the marlstone facies, the insolubles decrease and the carbonates are represented mainly by relatively clean limestones, dolomitic limestones, and dolomites (panels 1, 2). In earlier studies I (Amsden, 1960, p. 13-16; Amsden and Rowland, 1965, p. 33-38, 46) suggested that there might be some relationship between dolomite and insoluble residues, and the present investigation, which covers a much larger area, provides more comprehensive data on which to evaluate this question. The present lithofacies study indicates that in Late Silurian time the increase in dolomite toward the north and west was accompanied by a decrease in insolubles, thus suggesting an inverse relationship between the two. However, such an apparent relationship is vitiated when the western limestone facies is included, because in this rock the insolubles remain low *and* the dolomite content is also low. This is illustrated graphically in text-figure 27, in which insolubles are plotted against $MgCO_3$. It will be noted on this graph that the high-magnesium rocks are low in insolubles, reflecting the fact that the strongly dolomitized rocks of northwestern Oklahoma are in the area of low detritus. On the other hand, the low-magnesium strata are represented by rocks showing a wide range in insolubles, from less than 1 percent to 60 percent. This variation in insoluble content reflects the fact that the low-magnesium marlstones of the Arbuckle Mountains and Criner Hills are relatively high in insoluble detritus, whereas the low-magnesium limestones of western Oklahoma are low in insolubles, a relationship that is emphasized on the chart by distinguishing Henryhouse Marlstone samples from the *Kirkidium* biofacies samples. From this I conclude that any apparent correlation is local and fortuitous, and that basically these two components have no genetic relationship.

Relationship of Dolomite to Total Silurian Thickness

There does not appear to be any relationship between the total thickness of Silurian strata and their dolomite content. It is true that from the main body of dolomite in western Oklahoma Silurian rocks thicken into the deep part of the basin while also decreasing in $MgCO_3$ content. However, the western limestone facies is in an area where the total Silurian is relatively thin; moreover, the dolomitized Silurian rocks in Custer County range from 450 to 550 feet thick, whereas the low-magnesium limestones in the Arbuckle



Text-figure 22. Scatter diagram showing relation of $CaCO_3/MgCO_3$ ratio to $MgCO_3$; ratios are plotted against $MgCO_3$ calculated as percentage of total rock volume (circles) and $MgCO_3$ as percentage of HCl-acid-soluble portion only (triangles). Approximate position of crystalline dolomite-calcareous dolomite front is also shown. Analytical data are from porosity-permeability samples given in Appendix.

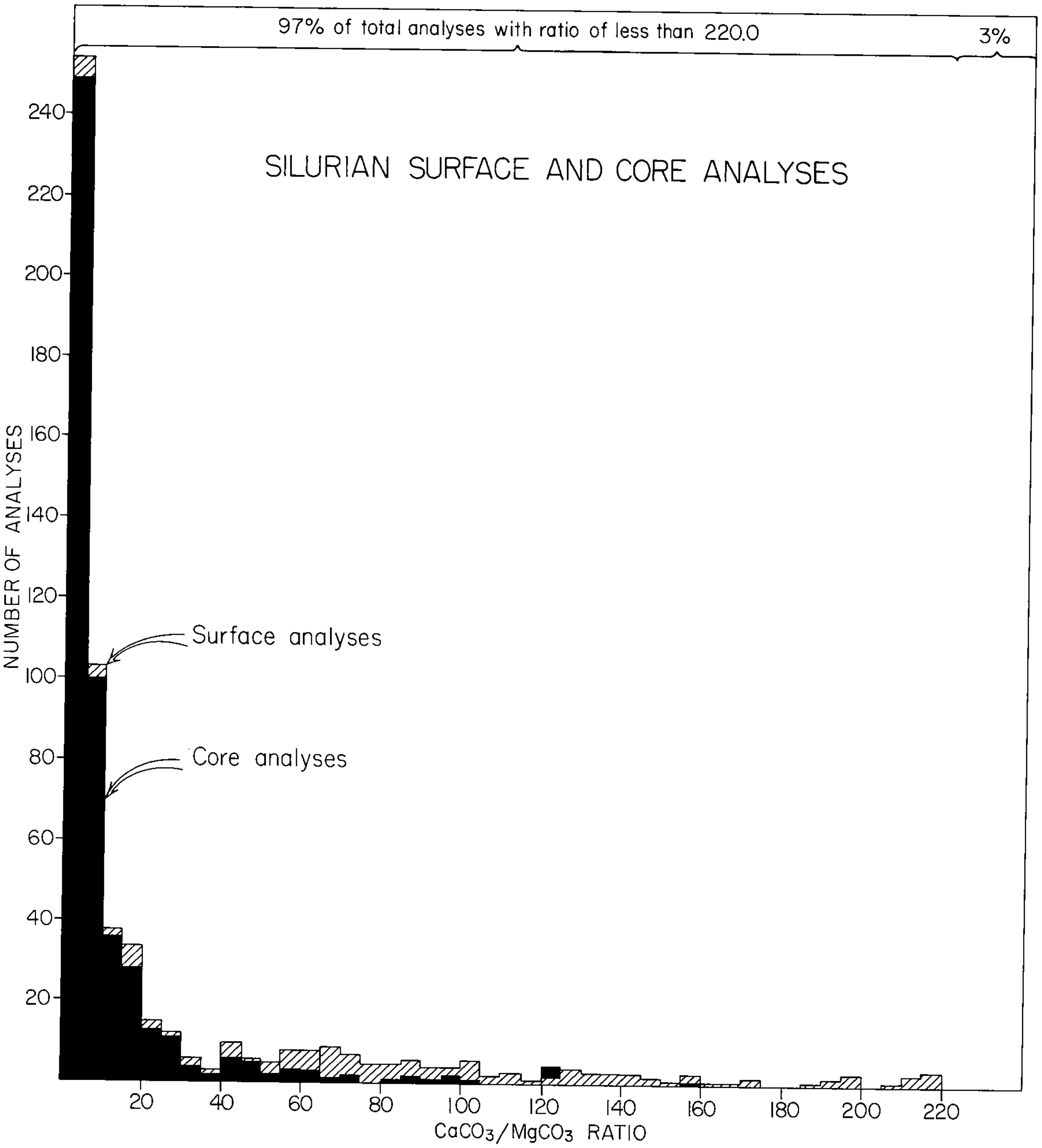


Text-figure 23. Frequency diagram showing distribution of $CaCO_3/MgCO_3$ ratios in Silurian rocks of Anadarko basin. Based on 492 core analyses; see Appendix.

region have a maximum thickness of only 300 feet (Amsden, 1960, p. 25; this report, panel 6). Thus, whereas the maximum Silurian thickness occurs in the limestone lithofacies, there is so much variation in the thickness of high-magnesium dolomites and low-magnesium limestones that no meaningful comparison can be made.

Origin

Dolomite occurs in many different ways, few of which provide direct evidence on the time, the place, or the method of emplacement, and thus studies concerned with the origin of this mineral are beset with problems. Past investigations have covered many facets of this problem, and an extensive literature is available on the subject. In recent years, several studies have been undertaken on the chemistry or geochemistry of dolomite formation, and a number of investigators have tried to synthesize dolomite in the laboratory, although none have been completely successful at the normal temperatures and pressures prevailing at the earth's surface (Zenger, 1972, p. 110). The geochemistry of Silurian dolomite is not here discussed, and this report deals only with its geographic and stratigraphic distribution and its textural characteristics. As noted previously, this dolomite is believed to be in large part a replacement mineral, although it occurs in other forms

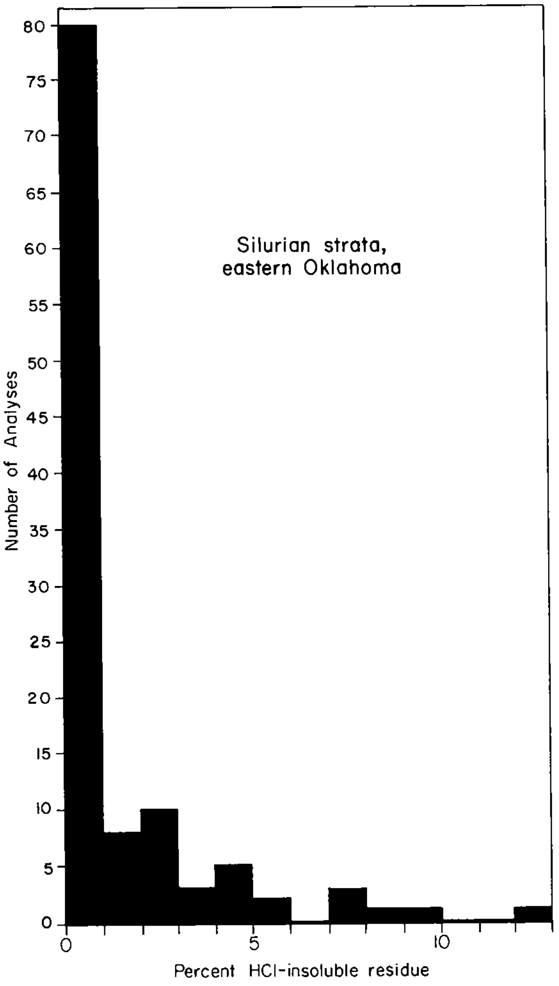


Text-figure 24. Frequency diagram showing distribution of $CaCO_3/MgCO_3$ ratios in Silurian rocks of western Oklahoma. Based on 137 analyses of surface samples and 492 analyses of core samples; see Amsden (1960, p. 287-297) and Appendix, this report.

such as spar-filled cavities (see Porosity and Permeability in Late Ordovician and Silurian Strata). The two basic questions that I will discuss are (1) the time of emplacement and (2) the site of emplacement.

1. The problem with respect to time is whether the main body of dolomite represents a penecontemporaneous replacement (here defined to include diagenetic replacement) or a late-stage, epigenetic replacement that took place long after deposition of the sediments.

2. Assuming that it is a penecontemporaneous replacement, as discussed in the following paragraphs, the site of emplacement is concerned with



Text-figure 25. Frequency diagram showing distribution of HCl-insoluble residues in Silurian rocks (Quarry Mountain, Tenkiller, and Blackgum Formations) that crop out in eastern Oklahoma. Compiled from Amsden and Rowland (1965, Appendix).

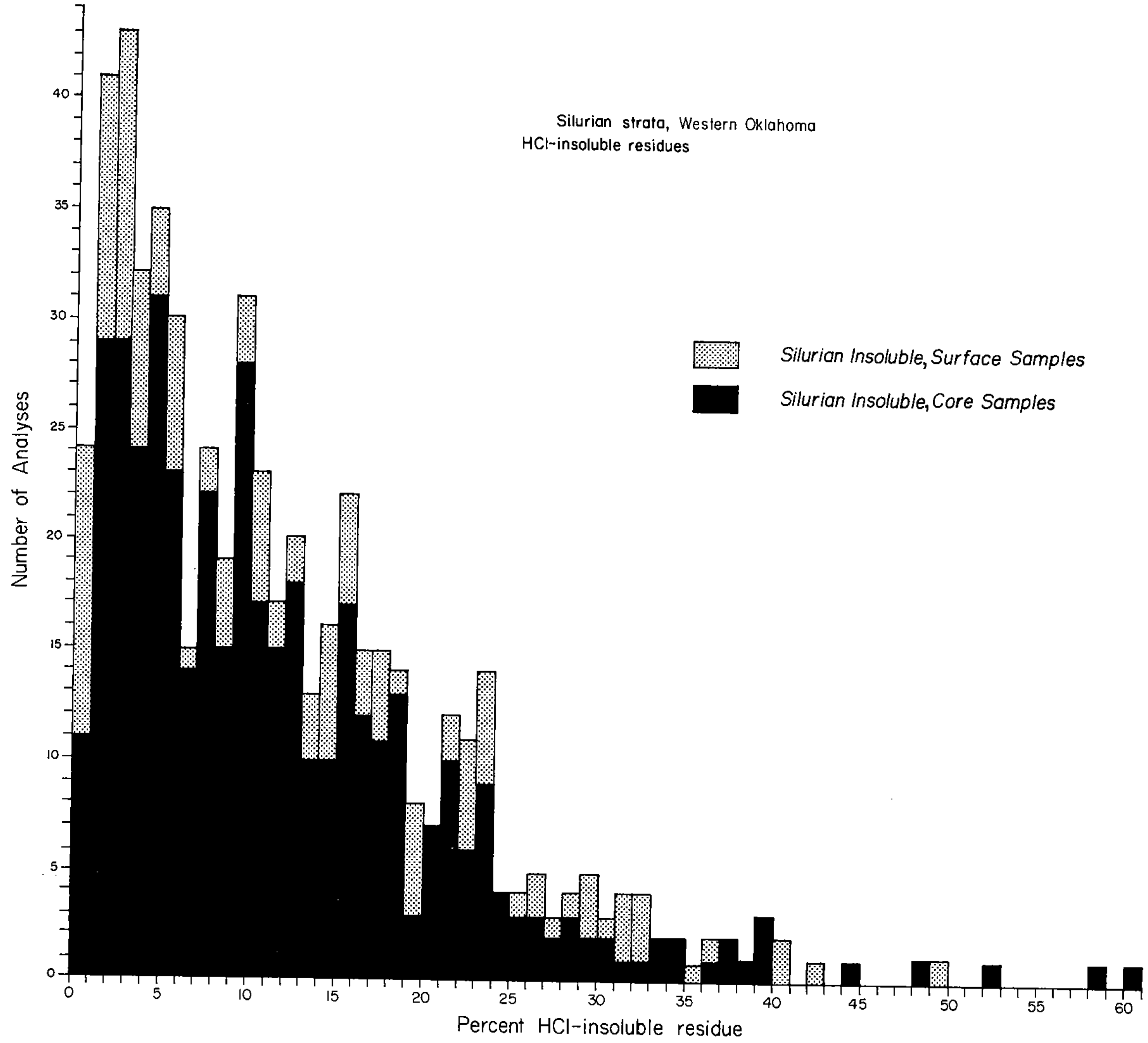
the depositional environment in which dolomitization took place, i.e., supratidal, intertidal, or removed from the tidal zone.

For some years it has been known that dolomites are much more abundant in Precambrian to early Paleozoic strata than in the Mesozoic to Holocene sediments (Chilingar, 1956, p. 2257), and, in fact, until recently relatively few Holocene dolomites were known. However, in the last few years a number of Holocene dolomites have been found and studied, most of these representing penecontemporaneous supratidal replacements (Zenger, 1972, p. 113-114). Several Paleozoic dolomites have characteristics similar to those of the Holocene deposits and are believed to represent supratidal and infratidal environments (see Laporte, 1967; Roehl, 1967). The following sedimentary features have been used as indicators of supratidal and infratidal environments: algal stromatolites, thinly laminated dolomite and interlaminated dolomite and limestone, desiccation cracks, oolites and coated grains, burrows, pellitoidal mud, flat-pebble conglomerates, sparse or absence of marine fossils, absence of shelly debris, birds-eye structure, dolomite occurring nearer to terrigenous sources than limestone (Zenger, 1972, p. 115; Roehl, 1967, p. 1983; Laporte, 1967, p. 78-84).

Most of the dolomite in the Silurian rocks of Oklahoma is here interpreted as resulting from replacement that took place at or near the depositional interface. This interpretation is based mainly on two lines of evidence:

1. These dolomites were in place before middle Early Devonian time, this conclusion being based on the fact that the Frisco Formation is at no place involved in the dolomitization that affected the underlying strata (see previous section, Stratigraphic Distribution of Dolomite). This relationship does not, however, in itself prove that Silurian dolomitization took place at the time of deposition. Deposition of the Frisco did not take place until after a period of erosion of sufficient duration to remove locally all the older Hunton rocks, allowing the Frisco to rest directly on Ordovician strata (see Frisco Formation); thus Silurian dolomitization could be the product of a secondary, epigenetic replacement that took place during this time of emergence and erosion.

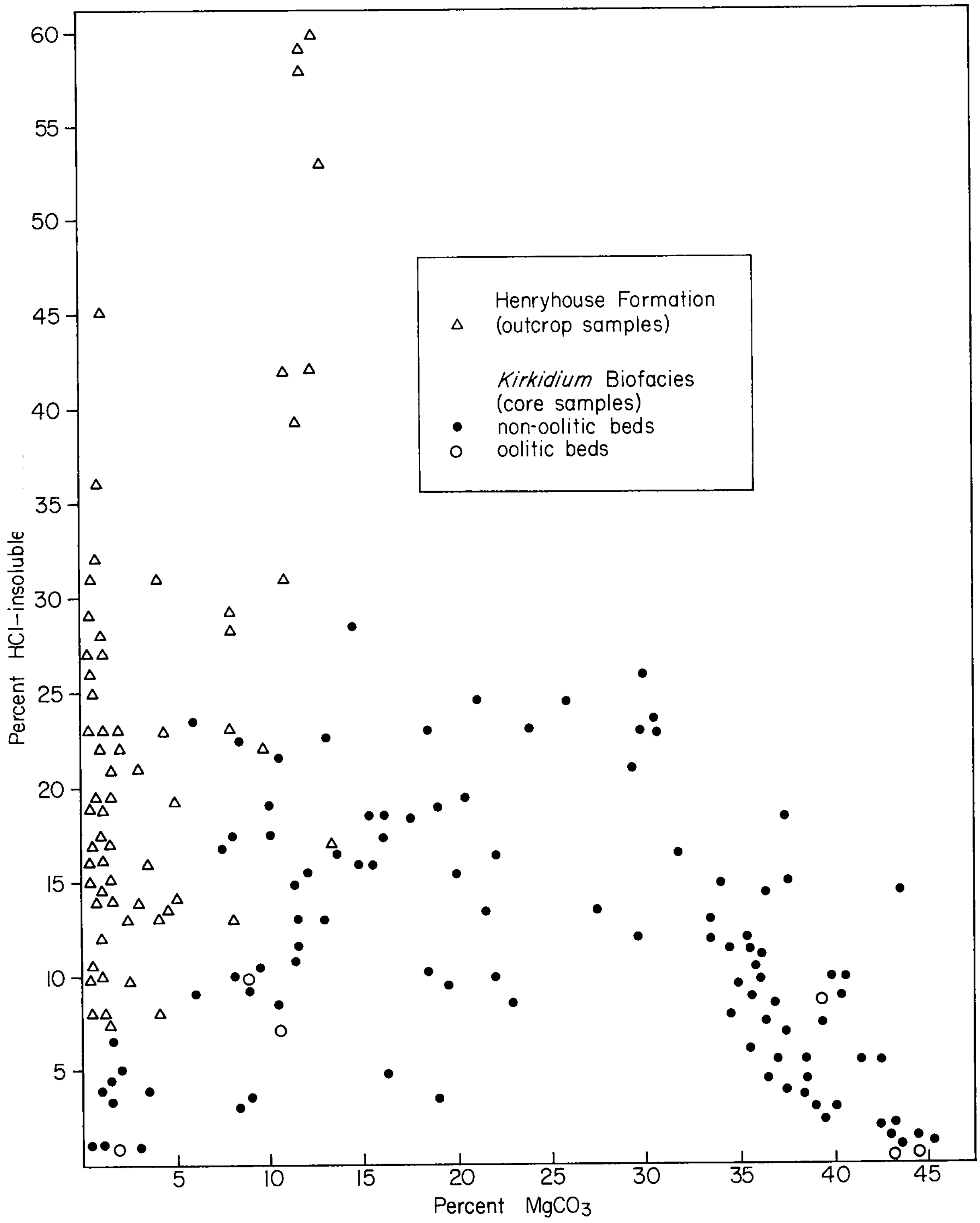
2. The second line of evidence is indirect and circumstantial, but it seems to me convincing for penecontemporaneous dolomitization. Silurian carbonate strata in Oklahoma are divided into distinct dolomite and limestone provinces separated from one another by a reasonably well-defined dolomite front. These dolomites are, in turn, a part of the great dolomite province of North America, which occupies much of the northern part of North America and which is distinct from the limestone provinces of this region (Amsden, 1955, p. 61-62; Berry and Boucot, 1970, pl. 1). The area occupied by the North American dolomite province, which covers thousands of square miles encompassing cubic miles of magnesium-rich strata, must have involved the transportation and concentration of a great volume of magnesium. Logistically, it is difficult to visualize any mechanism of secondary dolomitization involving the leaching, transportation, and precipitation of magnesium carbonate that could



Text-figure 26. Frequency diagram showing distribution of HCl-insoluble residues in Silurian rocks of central and western Oklahoma. Based on 422 core samples (Appendix, this report) and 114 surface samples from Arbuckle Mountains region and Criner Hills (Amsden, 1960, Appendix).

operate on a scale such as this, whereas the sea would seem to provide both an adequate source as well as a transporting medium for such quantities of magnesium. Moreover, an explanation which assumes that the dolomite is a primary part of the depositional fabric is in harmony with the stratigraphically controlled distribution of dolomite in the Silurian and Early Devonian rocks (see previous section on Stratigraphic Distribution of Dolomite; also Amsden, 1961, p. 69-73; Amsden and Rowland, 1965, p. 53-56). This does not preclude some later dolomitizing solutions, and, in fact, some of the dolospar occupies cavities produced by dissolution that clearly followed induration of the primary dolomite (see under following section, Porosity and Permeability in Late Ordovician and Silurian Strata).

The low-magnesium limestones of the Arbuckle Mountains-Criner Hills grade laterally into magnesium-rich rocks with reduced insoluble detritus. There is evidence in the form of oolitic beds, and increased disarticulation and breakage of fossils, that this change was accompanied by an increase in the energy level of the wave and (or) current action (see a previous section, Paleoenvironment of Late Silurian Strata). This increased energy level was probably produced by a shoaling of the water, although there is no evidence that it represents a supratidal or tidal environment. Aside from the oolites, the sedimentary features com-



Text-figure 27. Graph showing relationship between $MgCO_3$ content and HCl-insoluble residues in Henryhouse Formation (outcrop samples) and in *Kirkidium* biofacies (see Appendix).

monly associated with tidal deposition, such as desiccation cracks, algal mats, laminated dolomites, burrows, birds-eye structures, flat-pebble conglomerates, and an evaporite mineral suite, are totally lacking. The dolomite facies has a typical marine fauna dominated by large brachiopods and crinoids, and, although it does show some differences from the dolomitic limestone-limestone fauna, both *Kirkidium* and crinoids are present in both of these lithofacies (see a previous section, Paleoenvironment of Late Silurian Strata). Thus I interpret the Silurian dolomite as a penecontemporaneous replacement in a marine environment removed from the tidal zone. Some shallowing of the water is postulated to have occurred in the depositional environment from the limestone to the dolomitic limestone to the dolomite lithofacies, and presumably this triggered an increase in magnesium replacement. Chilingar (1956, p. 2263), in discussing the bimodal character of Paleozoic dolomites (see also text-fig. 20, this report), suggested that small changes in the composition of the sea water (such as might be caused by increased evaporation) could produce drastic changes in the composition of the carbonate, which could explain the sharp increase in $MgCO_3$ in some regions.

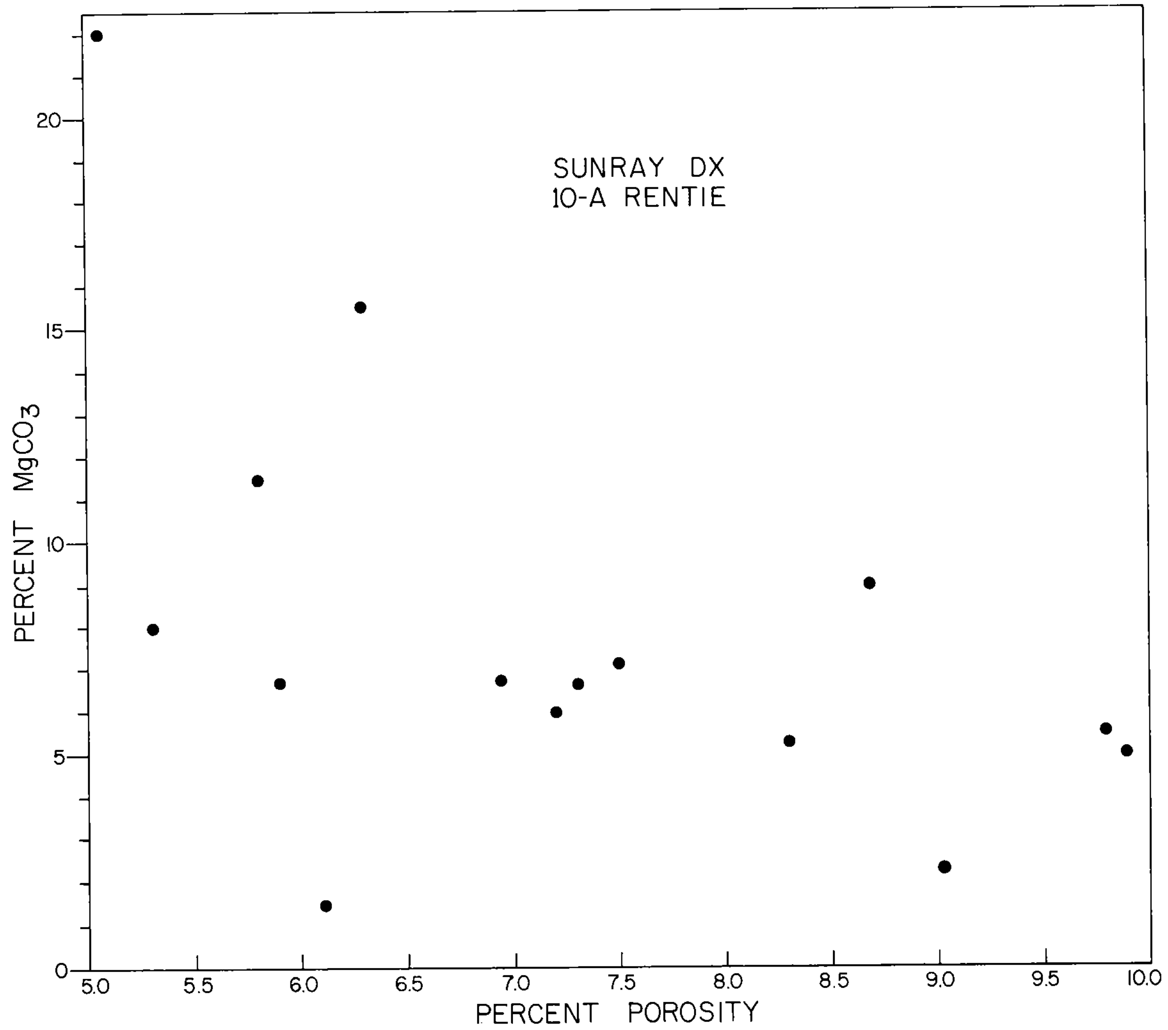
POROSITY AND PERMEABILITY IN LATE ORDOVICIAN AND SILURIAN STRATA

Late Ordovician and Silurian carbonate strata in western Oklahoma contain porous zones which are of economic significance because they provide the reservoirs for oil and gas accumulation, and which are also of general interest because they yield information bearing on the geologic history of these rocks. This particular type of porosity is related to dolomitization and is confined to strongly dolomitic strata that are well developed in the western part of the State and extend into the Texas Panhandle. It should be emphasized that not all Hunton porosity is associated with dolomite, as significant porous zones have been developed in some low-magnesium limestones. For example, porous beds are present in the Frisco Formation of Early Devonian age, which is everywhere a low-magnesium limestone; this porosity is different from that in the Silurian dolomites, as it appears to be in large part a primary feature of the rock, inherited from the original depositional fabric (see Frisco Formation, Porosity). Some low-magnesium limestones in the Chimneyhill Subgroup also have good porosity, as shown by the Sunray DX 10-A Rentie, in which limestones and mildly dolomitic limestones have porosities ranging up to almost 10 percent (text-fig. 28).

Method of Investigation

The Silurian dolomites in the western part of Oklahoma and the Texas Panhandle contain porous zones that are easily seen megascopically and in thin sections. Such zones are largely confined to high-magnesium dolomites, to rocks chemically analyzing about 28 percent or more $MgCO_3$ ($CaCO_3/MgCO_3$ ratio of 2 or less). In order to quantify and characterize these beds more precisely, two sets of porosity-permeability data have been assembled. The first of these consists of 37 core samples selected from 21 wells that were tested for porosity-permeability in the laboratory of the School of Petroleum and Geological Engineering at The University of Oklahoma, under the direction of Prof. Arthur W. McCray. These cores are from wells in central and western Oklahoma, mainly in Blaine, Kingfisher, and Major Counties, but also some from Custer, Ellis, and Woods Counties (panel 1, map A). Most of the coring in this area was in the upper part of the Hunton Group, in the *Kirkidium* biofacies just beneath the Woodford contact, and therefore most of the specimens selected for testing are from the upper 50 feet of the Hunton. However, a few core samples are from the lower beds in the Hunton, the deepest (P10-D) coming from a bed 281 feet below the base of the Woodford (text-fig. 29). The samples were selected to represent a range in chemical composition and texture from mud-supported, fossiliferous limestones with low dolomite content and low visual porosity to crystalline dolomites, some having substantial visual porosity and some with very little visual porosity. Each specimen was prepared as follows: The core sample was cut in two parts at right angles to the core axis, with one part being used for porosity-permeability testing; the other part was cut lengthwise, one part being made into a thin section and the other being chemically analyzed for $MgCO_3$, $CaCO_3$, and HCl-insoluble residues. Porosity has been calculated as the percentage of pore volume in cubic centimeters (cc) to bulk volume (mineral-grain volume plus pore volume, in cc). Permeability is the permeability to air, expressed in millidarcys (md) (data given in Appendix).

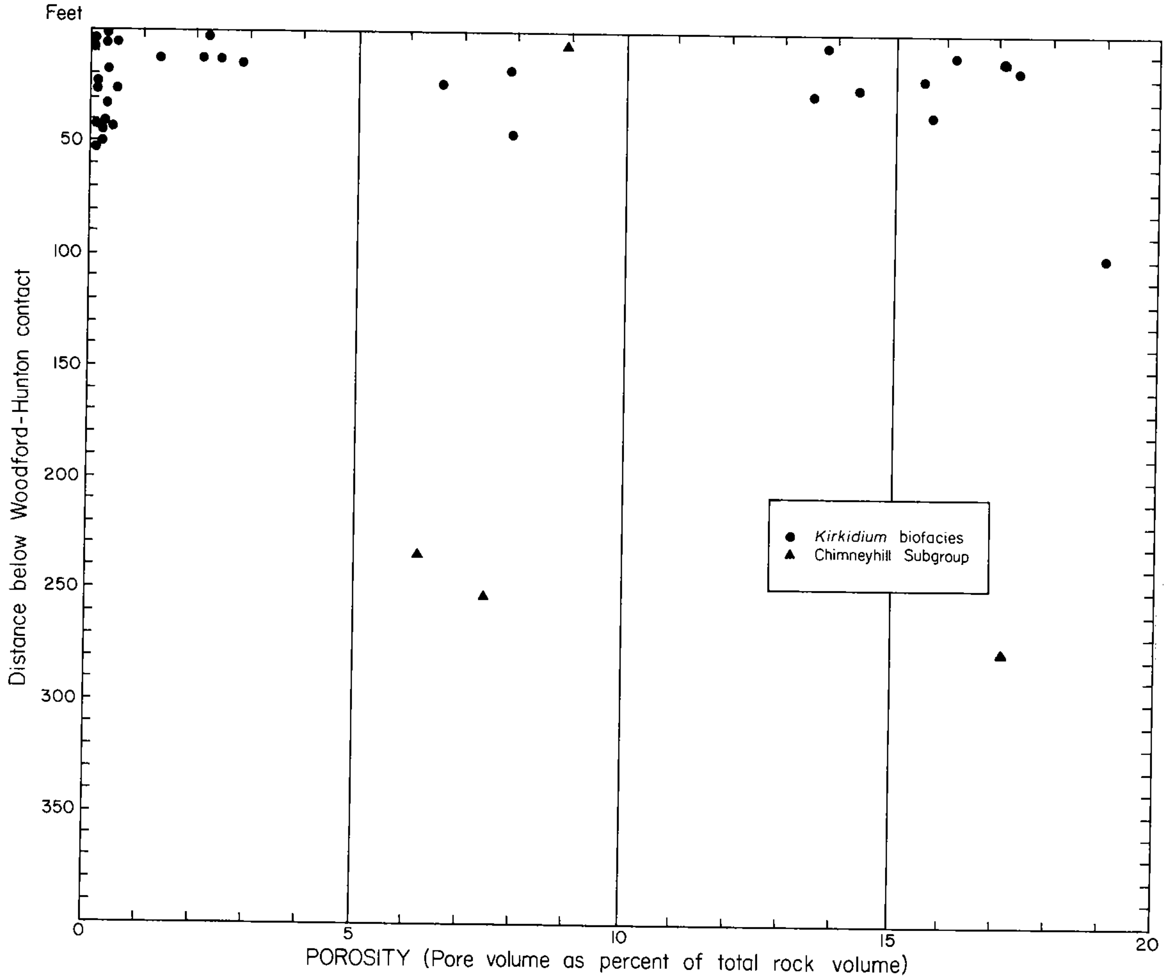
Mr. Ronald G. Mercer kindly provided a second set of porosity-permeability data from the Ferguson 1 Stinson in Kingfisher County. These consist of 45 samples from strata in the upper 131 feet of the Hunton, which are here correlated with the *Kirkidium* biofacies (Appendix). The porosity-



Text-figure 28. Chart showing relationship of porosity to $MgCO_3$ in Chimneyhill strata, Sunray DX 10-A Rentie.

permeability tests were made by Core Laboratories, Inc., Dallas, Texas, and the Oklahoma Geological Survey provided 46 chemical analyses and thin sections from the rocks in this interval. Thus the two sets of data were treated in essentially the same manner, although it should be noted that Core Laboratories used the entire core in testing porosity whereas The University of Oklahoma School of Petroleum and Geological Engineering utilized a 3/4-inch-diameter plug for this test. This difference in testing technique probably had some effect on the results, because in the low-porosity range The University of Oklahoma data include a number of specimens with essentially no porosity whereas those from Core Laboratories generally show at least 1 percent or so of porosity. These differences are not believed to be large enough to significantly affect the results from the present study.

In addition, Mr. L. A. Brandon of Sun Oil Company kindly provided porosity-permeability data from the Sunray DX 10-A Rentie, Seminole County. These consist of 68 samples from the lower 40 feet of the Hunton, here referred to the Chimneyhill Subgroup; 15 chemical analyses and 7 thin sections were prepared from this interval (text-fig. 28). The 10-A Rentie lies east of the dolomite front and is in a limestone to weakly dolomitic-limestone facies, which is of interest in showing that porosity is developed in low-magnesium Silurian limestones. Recrystallization has partially obscured the texture, but some of the



Text-figure 29. Chart showing stratigraphic position (distance below Woodford-Hunton contact) of samples tested for porosity-permeability in The University of Oklahoma School of Petroleum and Geological Engineering (samples P1-P21, Appendix).

porosity appears to be intergranular, suggesting that it may be the result of incomplete cementation, increased by later solution. There are also numerous vugs, many of which are either elongate cavities or consist of a series of cavities arranged in linear fashion, suggesting solution along fractures. The larger cavities are commonly lined with calcspar.

Lithostratigraphy

This topic is only briefly reviewed, as it is discussed at some length in the sections on Silurian Dolomite and Late Ordovician and Silurian Stratigraphy. The Henryhouse-*Kirkidium* biofacies relationship involves a transition from the Henryhouse Marlstone, with a mud-supported texture, to the *Kirkidium* biofacies, which is a grain-supported (fossil-clast) carbonate with low-insoluble detritus. Dolomitization accompanies this lithofacies transition. On the other hand, the Chimneyhill is everywhere an organo-detrital limestone, generally including a basal oolite, which is dolomitized in the western areas. Organo-detrital limestones, such as the Chimneyhill in the outcrop area, could have developed a primary porosity due to the incomplete cementation of the fossil clasts, and this appears to account for at least some of the porosity developed in the undolomitized Chimneyhill Subgroup and Frisco Formation (see discussion previously and under Frisco Formation). The beds of oolite could also have developed a primary porosity owing to incomplete cementation, provided of course that there had been an early, pre-cementation lithification of the individual ooids. On the other hand, it seems unlikely that a mud-supported texture such as that of the Henryhouse Marlstone would have developed this type of porosity to any significant degree, as the matrix of finely divided carbonate and insoluble detritus would have compacted to produce a fairly dense texture; and, in fact, the undolomitized marlstones everywhere appear to have low porosity.

As noted in the section on Silurian Dolomite, there is a nearly complete gradation from the low-magnesium limestones of the outcrop area to the crystalline dolomites of western Oklahoma. In this sequence the dolomite first appears as euhedral crystals scattered through the matrix, and as the magnesium increases the matrix becomes increasingly dolomitic and the crystals begin to impinge against and corrode the fossil boundaries. In the calcitic dolomites the matrix is largely occupied by dolomite crystals, and the fossils appear as corroded remnants although still retaining their original microtexture. In the final phase, which takes place rather abruptly at about 28 percent $MgCO_3$, the matrix is composed of interlocking crystals of dolomite, and the fossils, if present, are preserved as either molds or in spar. Some porosity is developed in the earlier stages, but it is in the crystalline-dolomite texture that it attains its maximum development. And, in fact, all the porosity-test data available for the present study show that specimens with more than 5-percent porosity are confined to rocks having a crystalline-dolomite texture and approximately 28 percent or more $MgCO_3$, where the $MgCO_3$ is expressed as a percentage of the total rock, or about 34 percent where the $MgCO_3$ is expressed as a percentage of the acid-soluble part only; this occurs in strata with a $CaCO_3/MgCO_3$ ratio of about 2 or less.

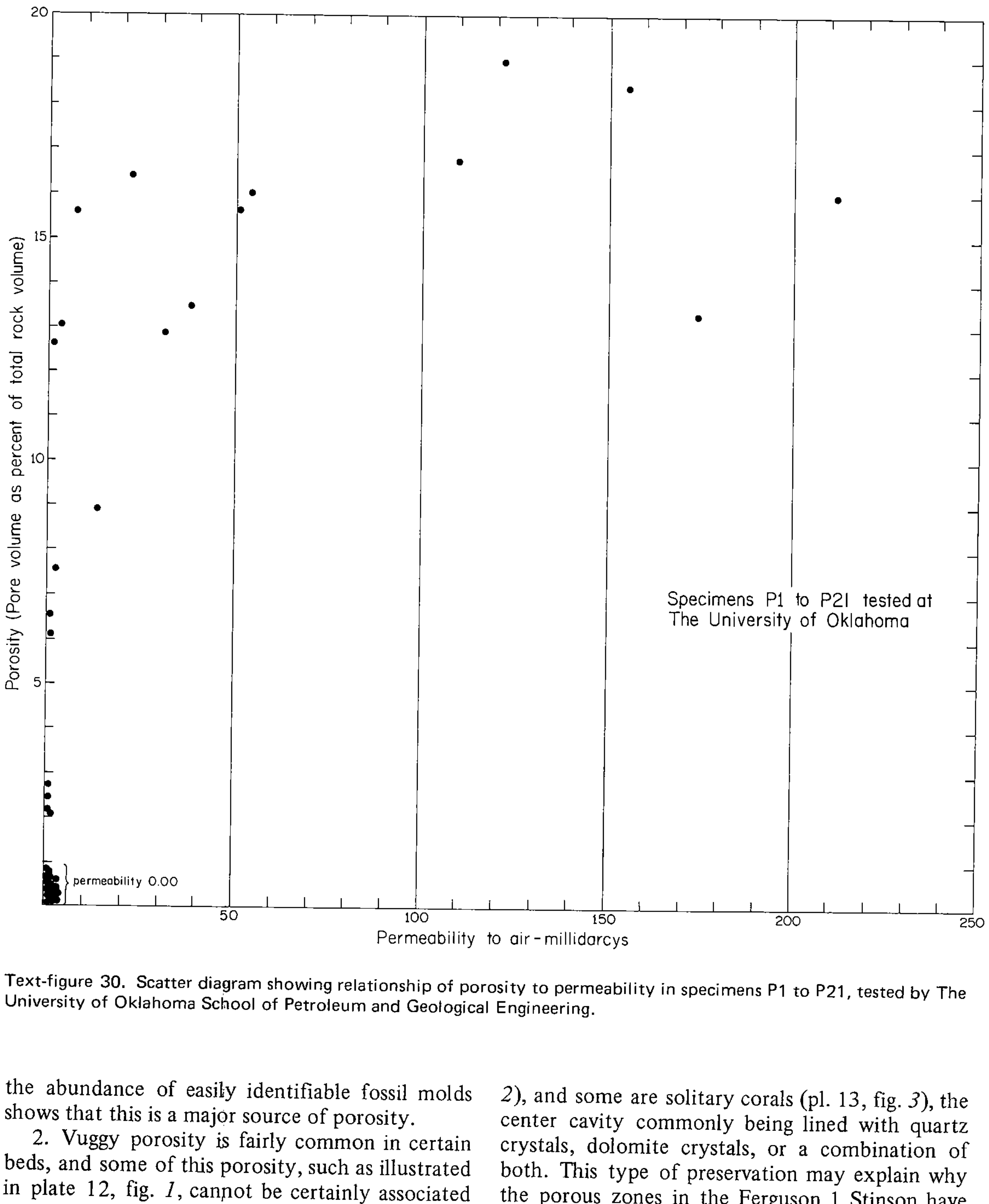
Porosity and Permeability

The rocks tested show a porosity range from less than 0.1 to almost 20 percent, and a permeability range from less than 0.1 to 211.28 md (Appendix). The specimens tested by The University of Oklahoma School of Petroleum and Geological Engineering (P1 to P21, Appendix) show a relationship between permeability and porosity, at least to the extent that all specimens with over 50 md permeability have more than 10-percent porosity; however, not all specimens with good porosity (5 percent plus) have appreciable permeability (text-fig. 30). In contrast, specimens from the Ferguson 1 Stinson have much lower permeability, with only one testing as much as 9.1 md and the remainder less than 3 md, even among the samples having over 8-percent porosity (text-fig. 31). A possible explanation for this difference is discussed in the following section.

Porosity, $MgCO_3$ Content, and Dissolution

The scatter diagram in text-figure 32, which is based on 82 core samples, shows the relationship of porosity to $MgCO_3$ content (left-hand side) and the mineral dolomite (right-hand side). All the specimens testing 26 or 27 percent $MgCO_3$ or less have less than 5-percent porosity, and all the specimens with more than 5-percent porosity are in the crystalline-dolomite lithofacies with 28 percent or more $MgCO_3$ (34 percent where the $MgCO_3$ is expressed as a percentage of the acid-soluble parts only, as shown in text-fig. 33, and a $CaCO_3/MgCO_3$ ratio of 2 or less, as shown in text-fig. 34). There is a suggestion of a gradual increase in porosity with increasing dolomitization, although it will be noted that within the crystalline dolomite lithofacies there is a wide range in porosity from specimens having effectively no porosity up to those with almost 20-percent porosity. At least a partial explanation for this wide variation can be obtained from a thin-section examination of the texture in the crystalline dolomites. Those specimens with over 5-percent porosity show clear evidence of solution. In large part this occurs as: (1) fossils that have had their shells dissolved and are preserved as molds; (2) relatively large cavities or vugs, many of which can be demonstrated to have a fossil nucleus; (3) the partial removal of the matrix surrounding dolomitized oolites, either alone or in combination with fossil molds. In contrast, the specimens showing less than 5-percent porosity commonly either have few or no fossils, or the fossils have been replaced with spar. The following paragraphs contain a more detailed description of the three types of solution porosity.

1. Fossils preserved as molds are common in the crystalline dolomites with more than 5-percent porosity, and they can be observed on broken or sawed surfaces (pl. 3, figs. *1-4*) and in thin sections (pl. 3, fig. *6*; pl. 6, figs. *5a, 5b*). The most common fossils in the dolomite facies are crinoids and corals, and most of the molds represent these groups; but corals, bryozoans, and others are also present. Most cavities are readily identified as organic molds; but in some cases, especially in the smaller cavities or those with considerable spar lining, their origin cannot be precisely identified, and some pores may represent incomplete cementation of the original matrix and (or) partial solution of the calcareous matrix. Nevertheless,

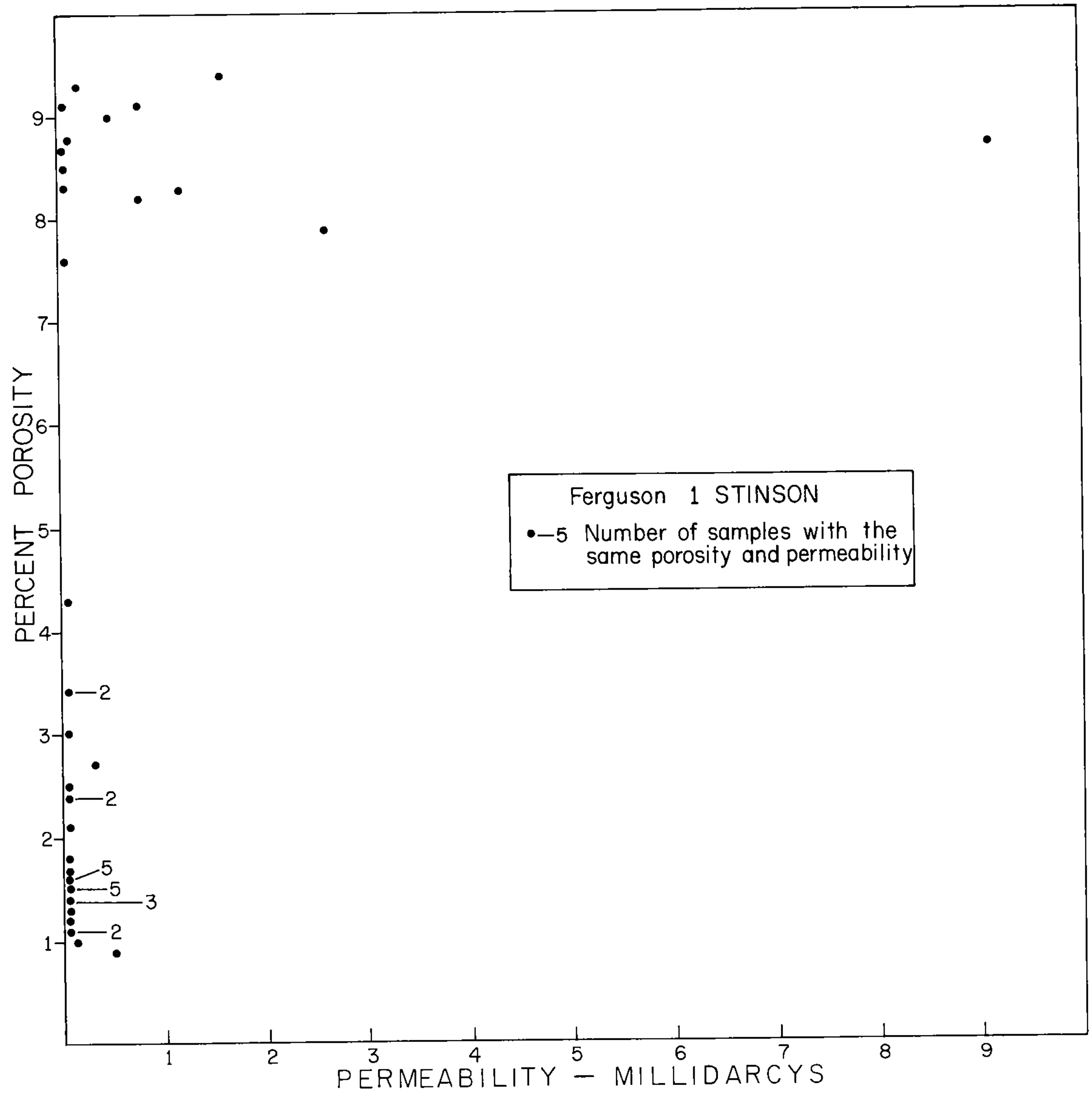


Text-figure 30. Scatter diagram showing relationship of porosity to permeability in specimens P1 to P21, tested by The University of Oklahoma School of Petroleum and Geological Engineering.

the abundance of easily identifiable fossil molds shows that this is a major source of porosity.

2. Vuggy porosity is fairly common in certain beds, and some of this porosity, such as illustrated in plate 12, fig. *1*, cannot be certainly associated with fossils. Many specimens, however, retain some organic structure, showing the locus to be a small colonial organism such as a tabulate coral or bryozoan, less commonly a solitary coral. The vugs in the Ferguson 1 Stinson are interesting because many are the result of incomplete silicification of corals, leaving a center that has been removed by solution. Some are colonial corals (pl. 13, figs. *1*, *2*), and some are solitary corals (pl. 13, fig. *3*), the center cavity commonly being lined with quartz crystals, dolomite crystals, or a combination of both. This type of preservation may explain why the porous zones in the Ferguson 1 Stinson have relatively low permeability, as the silicified parts surrounding the vugs may at least partly seal them off from the enclosing carbonate.

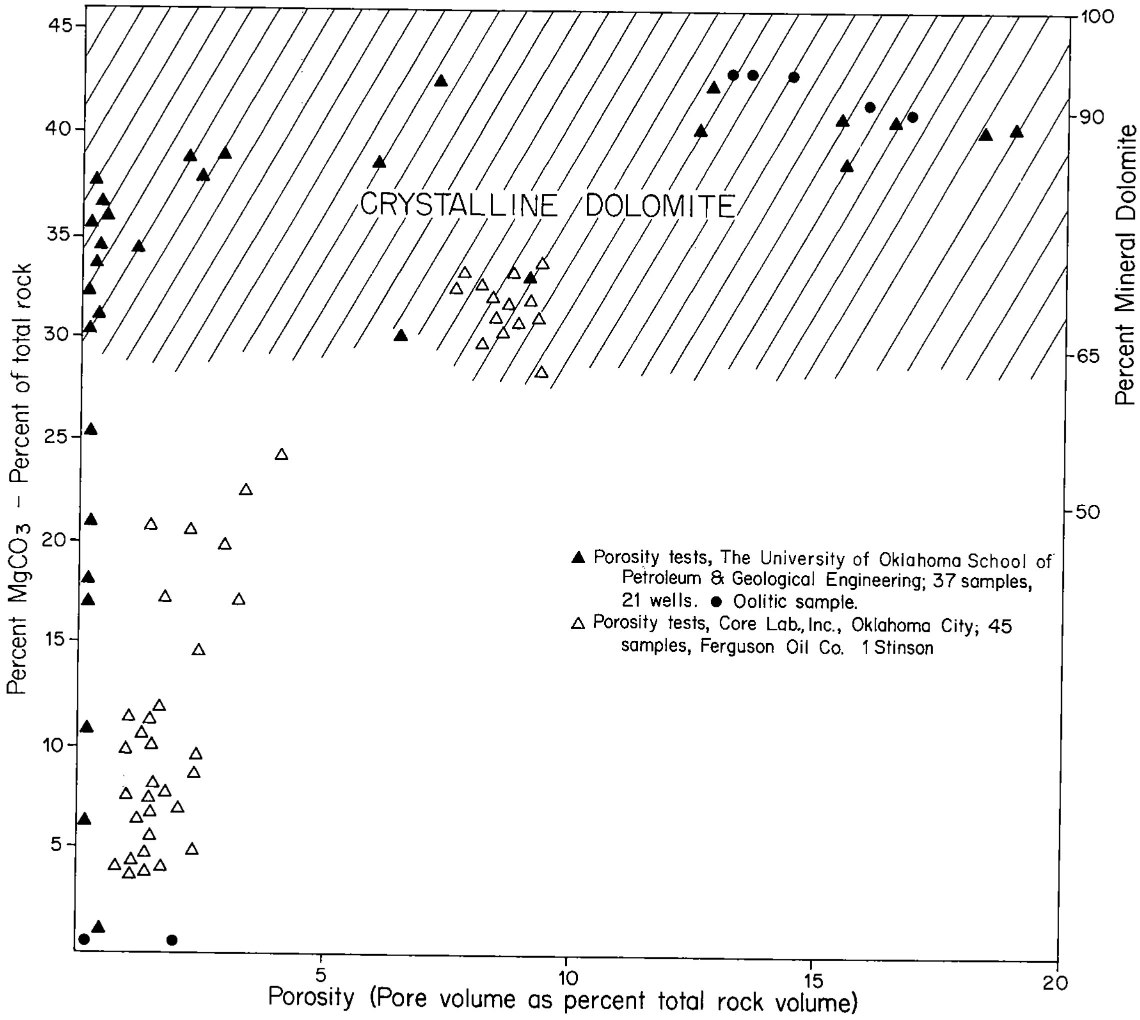
3. Most of the dolomitized oolites have excellent porosity, much of which is the result of cavities in the matrix surrounding the ooids, increased in many places by fossil molds (pl. 3, figs. *2-5*; pl. 4, figs. *2a-2b*; pl. 12, fig. *6*). The



Text-figure 31. Scatter diagram showing relationship of porosity to permeability in Ferguson 1 Stinson, tested by Core Laboratories, Inc., Dallas, Texas.

removal or partial removal of the matrix could be the result of incomplete cementation of the original sediment, but I think it is primarily due to dissolution because the undolomitized oolites have relatively low porosity (text-fig. 32; pl. 12, figs. *4*, *5*).

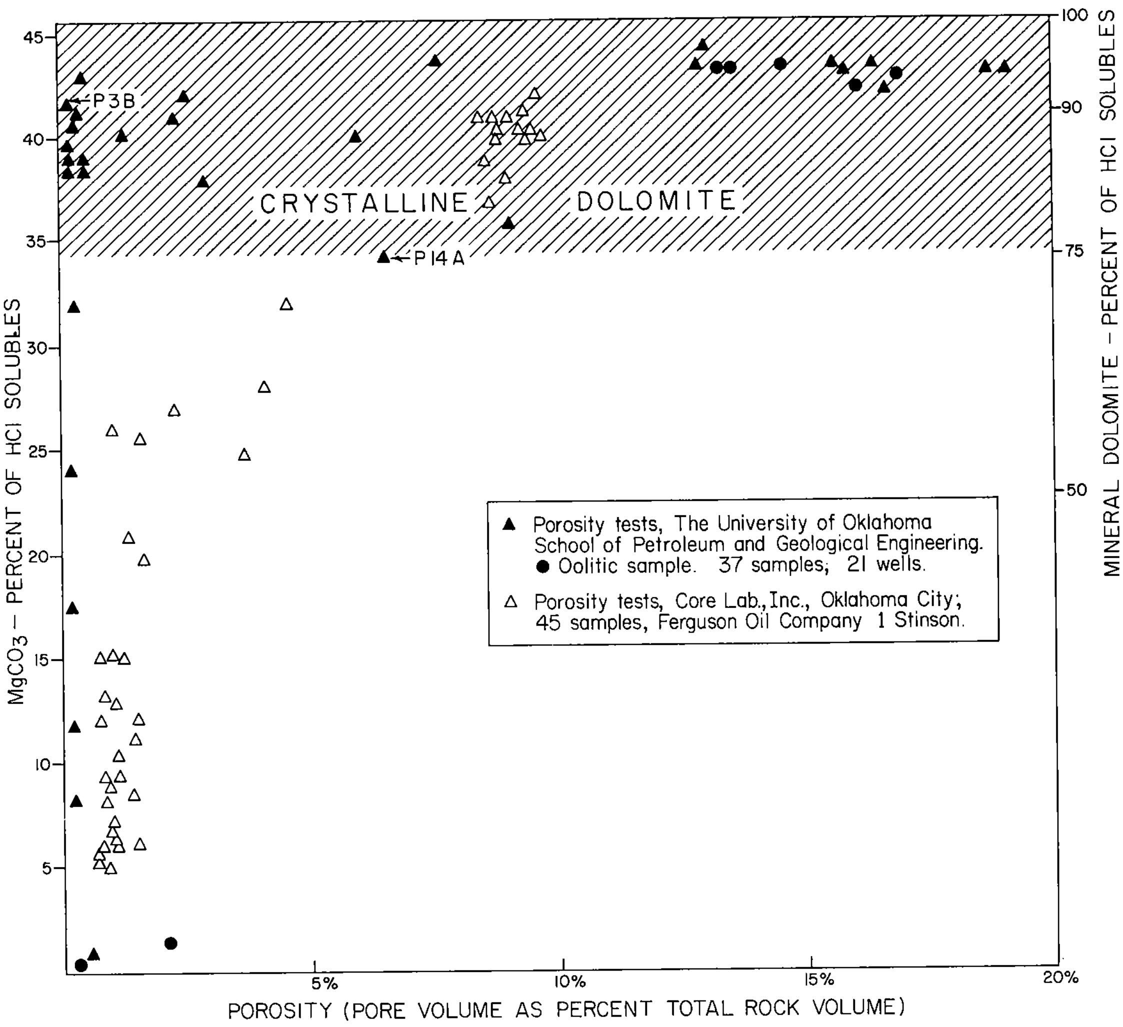
Undoubtedly, some of the dolomite porosity is associated with the development of the crystalline texture, and some is related to solution along irregular veins (pl. 13, fig. *4*), stylolite seams (pl. 13, fig. *6*), and fractures (pl. 13, fig. *5*). In fact, it would seem reasonable to suppose that under certain circumstances fractures might be an important source of porosity in both dolomites and limestones. However, the evidence cited previously seems to indicate quite clearly that, at least in the strata studied, significant porosity is in large part the result of dissolution of fossils and the matrix surrounding oolites. This solution appears to be clearly related to dolomitization; to be more specific, it is related to dolomitization that has progressed sufficiently to produce a crystalline dolomite texture having approximately 28 percent or more $MgCO_3$. Fossil molds are rare or absent in



Text-figure 32. Chart showing relationship of porosity to $MgCO_3$ content. $MgCO_3$ (and mineral dolomite) expressed as percentage of total rock volume. This also shows relationship of porosity to crystalline-dolomite texture.

the limestones, dolomitic limestones, and calcitic dolomites (approximately 26 percent $MgCO_3$ or less) observed by me. Perhaps some of the vuggy porosity developed in the low-magnesium Chimneyhill limestones may be associated with the dissolution of fossils, although judging from the Sunray DX 10-A Rentie most of this porosity is in the matrix surrounding the fossils.

Fossils replaced with spar are common in the crystalline-dolomite facies, where they are easily recognized by the size of the crystals as compared to those of the surrounding matrix (pl. 5, figs. *1-4*; pl. 9, figs. *2*, *3*). This type of preservation has not been observed in any of the limestone or dolomitic-limestone facies (rocks having 26 percent or less $MgCO_3$), whereas it is well represented in strata having 28 to 29 percent or more $MgCO_3$. This preservation could be interpreted as the result of direct replacement of the original shell by spar, but the evidence strongly suggests that it represents a later filling of molds and other cavities produced by dissolution. I have not observed any instances where the original shell, still retaining its microtexture, has been partly replaced by spar, whereas molds partly filled with spar are common (pl. 3, figs. *1*, *3*; pl. 4, figs. *1a*, *1b*; pl. 12, fig. *1*). Staining of thin sections and polished surfaces with Alizarin Red-S reveals both calcspar and dolospar, in some places separately and in other places together. In some *Kirkidium* shells the thicker, posterior part of the shell is filled with calcspar, and the thinner, anterior portion, with



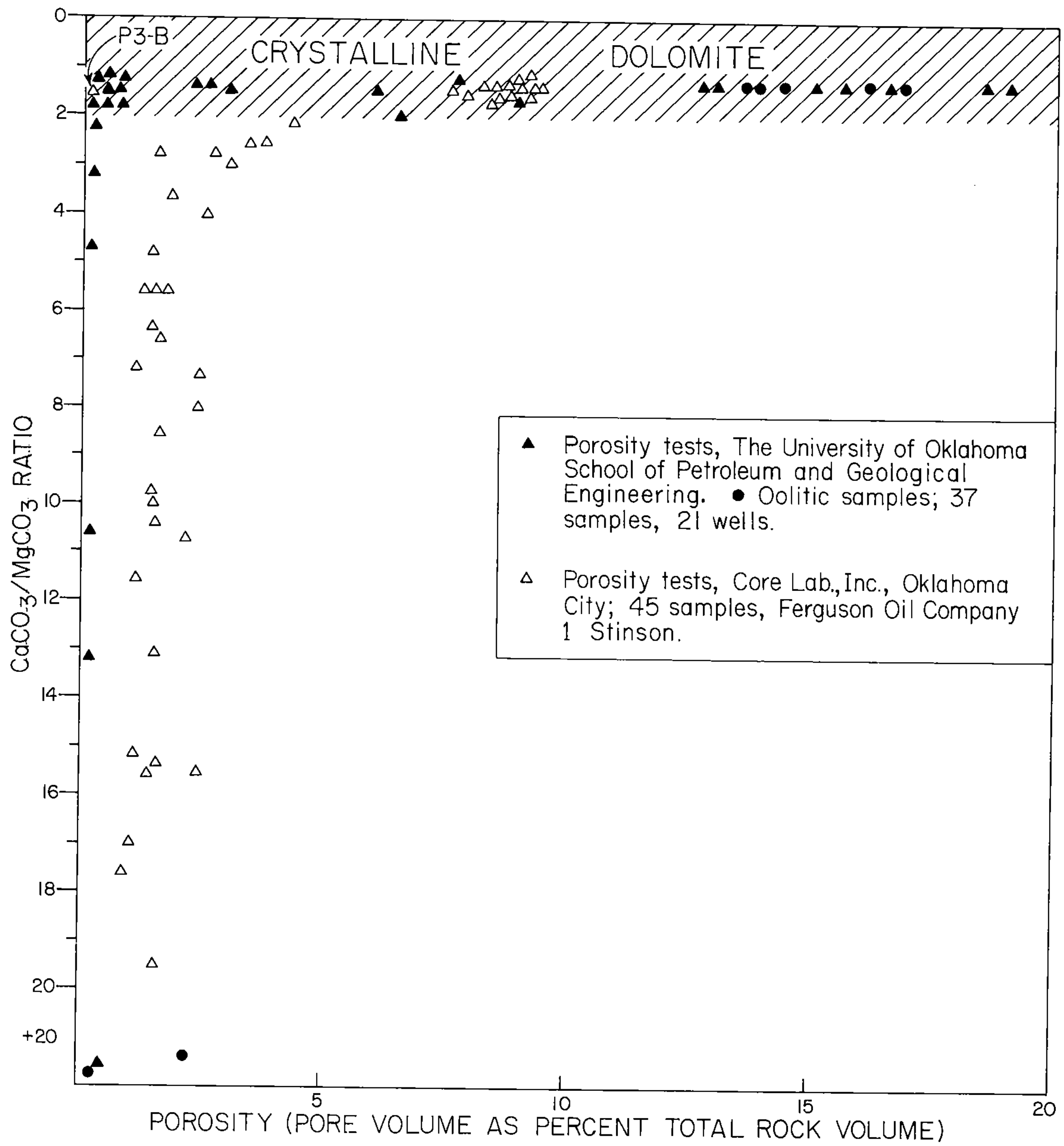
Text-figure 33. Chart showing relationship of porosity to $MgCO_3$, where the latter (and mineral dolomite) are expressed as percentage of acid-soluble parts only. This also shows relationship of porosity to crystalline-dolomite texture. Samples P3-B and P14-A do not have crystalline-dolomite texture because of their relatively high acid-insoluble content.

dolospar. Where the two occur together in the same cavity, the dolospar almost invariably forms the outer rim and the calcspar the inner part, indicating that the dolospar was deposited first, followed by calcspar (pl. 12, figs. *2*, *3*). Less commonly the fossils may be replaced by silica or pyrite. The crystalline dolomites with fossils replaced by spar or some other material have reduced porosity as compared with those having unfilled fossil molds, and there can be little doubt that the processes of dissolution and recementation significantly affect porosity.

Several investigators have noted the restricted or "pod"-shaped character of the porous zones in Hunton strata (Harvey, 1968, p. 194; Withrow, 1969, p. 86). My own study, although not specifically designed to delineate the local distribution of porosity, certainly suggests that Hunton porosity varies both laterally and vertically in relatively short distances. The primary factors controlling this porosity distribution are complex, but they seem to be closely related to the distribution of crystalline dolomite, modified by the effects of dissolution and recementation.

Origin of Porosity in Silurian Dolomites

The origin of carbonate porosity is a complex process, being dependent on original porosity



Text-figure 34. Graph showing relationship of porosity to $CaCO_3/MgCO_3$ ratio. This also shows relationship of porosity and $CaCO_3/MgCO_3$ ratio to crystalline-dolomite texture; sample P3-B does not have crystalline-dolomite texture (see Appendix, porosity and permeability tests).

affected by later solution and recrystallization (Choquette and Pray, 1970). Dolomitization may in itself increase the porosity (Al-Hashimi, 1972, p. 595-603), and the porosity also may be significantly affected by solution and recementation. In the Silurian strata under study, dolomitization and solution everywhere occur together, and it seems reasonable to infer that they are genetically related, the two events having taken place at about the same time, or with solution following dolomitization fairly closely. Thus the origin of the dolomite, especially the time of emplacement, is critical to any evaluation of the origin of the porosity. This problem is discussed in the section on Silurian Dolomite, the tentative conclusion being that the dolomite represents a penecontemporaneous replacement which took place at or near the depositional interface. Assuming this interpretation to be correct, then dissolution presumably occurred near the time of deposition, although of necessity it must have followed burial and induration. It is, of course, possible that the dissolution took place long after dolomitization, although the close association of leached fossils with the crystalline-dolomite texture seems to militate against this.

Subsequent to the leaching, carbonate-bearing solutions deposited calcspar and dolospar in the open pore space. Where the two occur together the dolospar appears to have been deposited first, indicating at least two episodes of carbonate mineralization. To a lesser extent, pyrite and silica also occur as cementing material, and it therefore seems reasonable to postulate several periods of mineralization.

It is tempting to associate some of these events with the long period of emergence and erosion that preceded deposition of the Woodford Shale. Murray (1960, p. 59) notes that limestone is more soluble than dolomite in weak acid and suggests that some of the dolomite porosity in the northeastern United States is due to leaching in association with unconformities. The present investigation offers some support for such an explanation, as it reveals a concentration of porous samples near the Woodford contact (text-fig. 29), although as noted elsewhere this is probably at least in part the result of sample bias. Moreover, strata with excellent porosity do occur far below the Woodford, sample P10-D with nearly 17-percent porosity coming from Chimneyhill strata approximately 300 feet beneath the top of the Silurian. Even more significant is the fact that in the Phillips 1-C Lee *Kirkidium*-bearing beds just beneath the Woodford are low-magnesium limestones with low porosity, and these strata are underlain by crystalline dolomites with good porosity (panel 10, section *B-B'*). One can, of course, postulate an erosional unconformity between the Chimneyhill and *Kirkidium*-bearing strata, during which time dolomitization and solution occurred. However, as noted before, there is almost no objective evidence for such an unconformity, and, in fact, the regional stratigraphic relations throughout most of the basin would seem to militate against it. The relationship of porosity to dolomitization seems well established, but the relationship of porosity to the pre-Woodford erosional surface is ambiguous. Quite possibly one or more of the episodes of mineralization that partly filled the cavities are related to the period of pre-Woodford uplift and erosion.

Geographic Distribution of Dolomite

The geographic distribution of Silurian dolomite in the western part of Oklahoma is shown on the lithofacies maps, panel 2, and is discussed at some length in the section on Silurian Dolomite. There is no need to repeat this information, but I do want to stress its economic importance. It should again be emphasized that not all Hunton porosity is associated with dolomite; nevertheless, much of the gas production from western Oklahoma does occur in dolomites, and thus the locus of strong dolomitization is of more than academic interest. Present information indicates that these dolomites have their maximum concentration in the central and northern parts of western Oklahoma, extending into the Texas Panhandle. Much of the deeper part of the Anadarko basin appears to be in the Arbuckle limestone facies, from which no production has been reported up to this time. However, it should be stressed that organo-detrital limestones are well developed in Hunton rocks of the deep basin, a type of carbonate that has developed significant porosity elsewhere in the State.

DEVONIAN STRATIGRAPHY

Devonian strata in Oklahoma are referrable to two distinct lithostratigraphic and biostratigraphic units: the Woodford Shale, locally including a basal conglomeratic sandstone (Misener and Sylamore Sandstones), of late Middle Devonian to Early Mississippian age, and an underlying sequence of carbonate strata of Early Devonian age (text-fig. 2). Conodonts are the principal invertebrate fossils in the Woodford-Misener-Sylamore sequence—although in places a few inarticulate brachiopods are present—whereas the Lower Devonian carbonate strata commonly have a rich shelly fauna.

Pre-Woodford Devonian strata in the Arbuckle Mountains-Criner Hills comprise two stratigraphic units: the Frisco Formation of middle Early Devonian age (Deerparkian-Siegenian) and the Haragan Formation of early Early Devonian age (Helderbergian-Gedinnian), which grades laterally into the Bois d'Arc Formation (text-fig. 2). South of the Arbuckle Mountains in a small inlier on Turkey Creek is a thin Devonian limestone (Turkey Creek limestone), which is underlain by the Sylvan Shale and overlain by strata here correlated with the Misener Sandstone (Amsden and others, 1968, p. 166). This limestone is of late

Early Devonian age and is thought to be slightly younger than the Frisco Formation and slightly older than the Sallisaw Formation of eastern Oklahoma (Amsden, 1961, p. 45-59). I have not identified this limestone in the subsurface of southern Oklahoma, but cores from the Kirkpatrick 1 Cronkite (Kingfisher County, Oklahoma), the Phillips 1-C Lina (Ochiltree County, Texas), and the Standard of Texas 1 Wheeler Unit (Wheeler County, Texas) carry a late Early Devonian brachiopod fauna with similarities to the Turkey Creek limestone and the Sallisaw Formation (panel 9).

Biostratigraphic information obtained from cores shows that Lower Devonian strata (notably the Frisco Formation) extend northward into northern Canadian and Oklahoma Counties (panel 9; panel 10, section *A-A'*). North and west of here the Lower Devonian is largely absent, allowing the Woodford Shale to rest directly on the Silurian, although Lower Devonian rocks are again present in parts of the Texas Panhandle. Lower Devonian strata are separated from the underlying strata by an erosional unconformity, and in places rocks of this age rest directly on the Ordovician (e.g., Phillips 1-C Lina, Ochiltree County, Texas; Tidewater 1 Johnson, Jackson County, Oklahoma; stratigraphic section Ma2, Marshall County, Oklahoma; see Appendix and Amsden and others, 1968). In the deep part of the Anadarko basin, where Hunton rocks are below −15,000 feet, no cores are available, and information on the age of the strata must be derived from lithostratigraphic comparisons. Studies of well samples in this part of the basin show a consistent and well-defined lithostratigraphic sequence consisting of upper organo-detrital limestones, middle marlstones, and lower organo-detrital limestones. This is similar to the section in the northern part of the Arbuckle Mountains region, where the Hunton comprises upper organo-detrital limestones (Frisco Formation and Fittstown Member of Bois d'Arc Formation), a group of middle marlstones (Cravatt Member of Bois d'Arc Formation, Haragan Formation, and Henryhouse Formation), and lower organo-detrital limestones (Chimneyhill Subgroup) (Amsden, 1960, panel II, pl. A; stratigraphic sections P1-P4, P8, P11). The lithostratigraphic similarity of the Hunton rocks in the two areas suggests that the deep basin has a fairly well-developed Lower Devonian section, possibly including representatives of the Frisco, Fittstown, and Haragan (panel 10, section *C-C'*; see also discussion following, on Haragan-Bois d'Arc Formations and Frisco Formation).

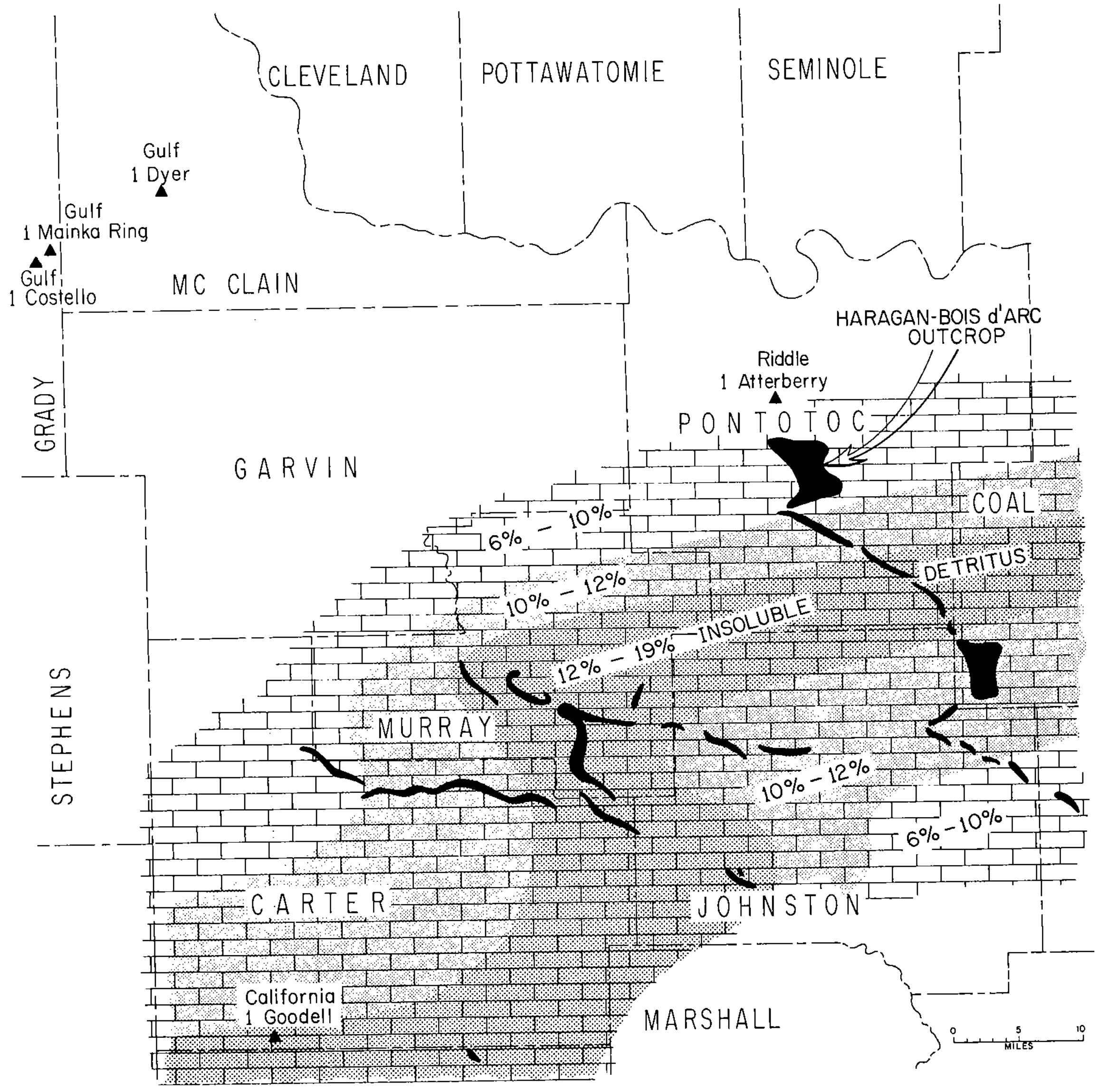
Haragan-Bois d'Arc Formations

The Haragan and Bois d'Arc Formations were named by Reeds (1911, p. 263, 265) for exposures in the Arbuckle Mountains. (A complete discussion of the nomenclatural history is given in Amsden, 1958b, p. 8; Amsden, 1960, p. 86, 99.) The Bois d'Arc Formation is divided into two members, the Cravatt Member and the Fittstown Member. The Fittstown generally overlies the Cravatt; however, the two members are believed to be facies of one another, intergrading vertically and laterally (Amsden, 1958b, p. 8-13). Both the Haragan and the Bois d'Arc crop out over much of the Arbuckle Mountains-Criner Hills region, where they have a maximum combined thickness of about 320 feet. No equivalent strata have been found in eastern Oklahoma, and present information suggests that strata of this age (Helderbergian) are largely, if not entirely, confined to central Oklahoma, probably including the deeper part of the Anadarko basin (pre-Woodford subcrop map, panel 9; panel 10, sections *A-A'*, *B-B'*).

The Haragan Formation in this outcrop area consists of a matrix of finely divided carbonate (calcilutite) and acid-insoluble detritus enclosing scattered fossils. The amount of fossil debris varies but is probably nowhere sufficiently concentrated to produce a grain-supported fabric. The quantity of insoluble material, much of which is in the form of silt-size quartz detritus, ranges up to about 45 percent, averaging 16 percent. The dolomite content is low, averaging 2.3 percent (Amsden, 1960, p. 68, 88-91).

The Cravatt Member of the Bois d'Arc Formation is a marlstone similar to the Haragan except for the presence of chert, and the Fittstown Member is an organo-detrital, grain-supported limestone, mostly with spar cement. The insoluble detritus is low in the latter member, averaging about 4.5 percent, and the $MgCO_3$ content of both members averages less than 3 percent (Amsden, 1960, p. 105-125).

The Haragan-Bois d'Arc lithofacies relationship has been discussed at some length in earlier papers and will only be summarized here (Amsden, 1960, p. 93-96; Amsden and Ventress, 1963, p. 17-22). The transition from typical Haragan marlstone to typical Fittstown calcarenite involves the following: (1) a reduction in insoluble detritus; (2) an increase in fossil debris, producing a change from a mud-supported to a grain-supported (fossil-clast) fabric; (3) a change from a micrite to a sparite cement; (4) a marked increase in disarticulation of brachiopod shells, from a marlstone texture in which most of the shells are articulated to an organo-detrital sparite in which over 90 percent of the brachiopods are disarticulated; (5) a change in the megafauna, mainly involving a substantial reduction in the number of taxa represented but not in the number of individuals. This transition appears to be primarily related to an increase in energy level, from the Haragan, which represents a quiet-water environment with a muddy bottom and presumably turbid water, to the Fittstown, which represents a more active-water environment with calcareous substrate and clear water. It is not possible, on the basis of present evidence, to fit these lithofacies and biofacies changes into any regional pattern. In the outcrop area the marlstone has its best development in a relatively narrow band extending roughly northeast-southwest through the Arbuckle Mountains-Criner Hills region, as shown in text-figure 35. Toward the north and west, in the areas where core data are relatively abundant, Helderbergian strata are trun-



Text-figure 35. Map showing distribution of HCl-insoluble detritus in combined Haragan-Bois d'Arc Formations. Based on chemical analyses of outcrop samples (Amsden, 1960, Appendix) plus analysis of core from California 1 Goodell et al. (Appendix). Map also shows locations of cores known to cut Haragan-Bois d'Arc, with exception of Pan American 1 Droke Unit (to north, in Kingfisher County).

cated by pre-Frisco and pre-Woodford erosion so that Haragan-Bois d'Arc strata extend only a short distance north of the outcrop area. As noted subsequently, these strata are believed to extend westward into the deep part of the Anadarko basin, but only well samples are available in this region and offer no evidence bearing on the critical biostratigraphic characteristics.

Cores

The following seven wells are known to have cored Haragan-Bois d'Arc strata.

Riddle et al. 1 Atterberry (Fee)
Gulf 1 Costello
Pan American 1 Droke Unit
Gulf 1 Dyer
California 1 Goodell et al.
Gulf 1 Mainka Ring
Gulf 1 Willis

All these cores have yielded Helderbergian brachiopods, indicating a correlation with the Haragan-Bois d'Arc strata in the outcrop area (Appendix). With the exception of the Pan American 1 Droke Unit, the wells are located in south-central Oklahoma, within a relatively short distance of the outcrop area (text-fig. 35). To the north and west, Haragan-Bois d'Arc strata are truncated by pre-Frisco and pre-Woodford erosion, the only known exception being the Pan American 1 Droke Unit, in Kingfisher County, which may represent a small erosional outlier. Elsewhere in north-central and northwestern Oklahoma, cores provide substantial biostratigraphic evidence that places Silurian strata either in contact with or in close stratigraphic proximity to the Woodford Shale, and it seems probable that pre-Woodford Devonian strata are largely absent from this region (Amsden, 1969, p. 965; Amsden and Rowland, 1971, p. 108-109). This does not, of course, preclude the possibility of local occurrences of Lower Devonian rocks; Lower Devonian strata are known to be present in the Texas Panhandle (Amsden and Rowland, 1971, p. 106; this report, Appendix, pre-Woodford subcrop map, panel 9), and it seems probable that small outliers such as the one found in the Pan American 1 Droke Unit are present in western Oklahoma.

Well Samples, Deep Anadarko Basin and Adjacent Shallow Fault Blocks

No cores are available for this region, but well samples show the presence of a well-developed marlstone lithofacies in the middle part of the Hunton Group. This lithofacies has been identified in the following 13 wells.

Howell, Holloway, and Howell 1 Anadarko Basin
Lone Star 1 Baden
Mobil 1-A Cement
Cities Service 1 Chalepah
Arkla 1-21 Clancy Estate (?)
Pure 1 Fuqua
Goff-Leeper 1 Giles
Stanolind 1 Groves Unit
Glover Heffner Kennedy 1-27 Hayes
Denver 1-A School Land
Carter 1 State Taylor
Texas 1 Rolls
Sunray DX (Phillips) 1-A Wesner

This lithofacies is well developed in the deep part of the basin, extending at least as far west as the Lone Star 1 Baden in Beckham County, Oklahoma. The thickness varies widely, ranging up to slightly over 1,000 feet in the Texas 1 Rolls, in Comanche County, Oklahoma.

The marlstones are overlain by light-colored organo-detrital limestones that range up to almost 600 feet in thickness (Stanolind 1 Groves Unit). Again, the stratigraphic position and geographic distribution suggest a correlation with the organo-detrital limestones of the Fittstown Member (Bois d'Arc Formation) and (or) the Frisco Formation. It should be stressed that the Fittstown is a part of, and genetically related to, the Haragan-Bois d'Arc depositional unit, which is separated from the overlying Frisco Formation by an unconformity of considerable magnitude. Thus some of the thickness variation in the upper limestones and underlying marlstones could be the result of truncation beneath this unconformity. On the other hand, Hunton rocks in the deep basin are unusually thick, perhaps indicating that this is a more complete section and lacks the unconformities present elsewhere. In the latter case, the variation in thickness could be in part the result of lateral facies gradation and perhaps variations in original deposition related to penecontemporaneous faulting (see Regional Structure).

Oil and Gas Production

I have not observed any porous zones in the Haragan Formation, and the marlstone lithology does not appear to be a rock fabric in which satisfactory porosity and permeability would commonly be developed. Oil and gas production have been widely reported from the Bois d'Arc Formation, although much of this now appears to be correctly assigned to either the Frisco Formation or to Silurian strata (Amsden and Rowland, 1971, p. 104, 106). The Gulf 1 Dyer and California 1 Goodell et al. report Bois d'Arc production, but other than this the present study provides no information bearing on Helderbergian porosity or production. However, the organo-detrital limestones of the Fittstown Member appear to be potentially capable of porosity development comparable to that of the Frisco Formation, thus making an excellent producing zone (see Frisco Formation, Oil and Gas Production; Amsden and Rowland, 1971, p. 108).

Frisco Formation

The Frisco Formation was first recognized by Reeds (1926), the name being taken from the town of Frisco in the northern part of the Arbuckle Mountains region, Pontotoc County. No type section was indicated, and in 1960 I (Amsden, 1960, p. 125) designated the exposures along Bois d'Arc Creek, NE¼ sec. 11, T. 2 N., R. 6 E., as the type section. The Frisco crops out only in the northeastern part of the Arbuckle Mountains region, having been removed by pre-Woodford erosion throughout the central and western areas; it also crops out in a small part of Sequoyah County in eastern Oklahoma (text-fig. 36). The Frisco in both areas is an organo-detrital limestone, mostly with spar cement, showing extensive fragmentation of the fossil debris. The HCl-insoluble residues and $MgCO_3$ content are everywhere low, averaging less than 2 percent (text-figs. 37-40). Locally, small chert nodules are present in the Arbuckle Mountains and Sequoyah outcrops; however, none has been observed in the cores. At the surface the Frisco attains a maximum thickness of about 60 feet, but in most places it is much thinner, commonly less than 20 feet. The Frisco Formation carries a substantial Early Devonian (Deerparkian, Siegenian) fauna, closely related to that of the Little Saline Limestone of Illinois and Missouri, the Harriman Novaculite of western Tennessee, and the Oriskany Sandstone of the Appalachian region. Detailed information on lithologic character, thickness, distribution, and fossils is given in my earlier publications (Amsden, 1960, p. 125-135; Amsden, 1961, p. 24-45; Amsden and Ventress, 1963, p. 9-59).

Cores

Until recently the Frisco was unrecognized in the subsurface, and any porous carbonate in the upper part of the Hunton Group was commonly assigned to the Bois d'Arc Formation (Amsden and Rowland, 1967b; 1971, p. 104-108). However, biostratigraphic and lithostratigraphic studies based on cores show that the Frisco Formation covers a relatively large area in the central part of Oklahoma and is also present in at least one place in the southwestern part of the State (text-fig. 36; panel 9, pre-Woodford subcrop map).

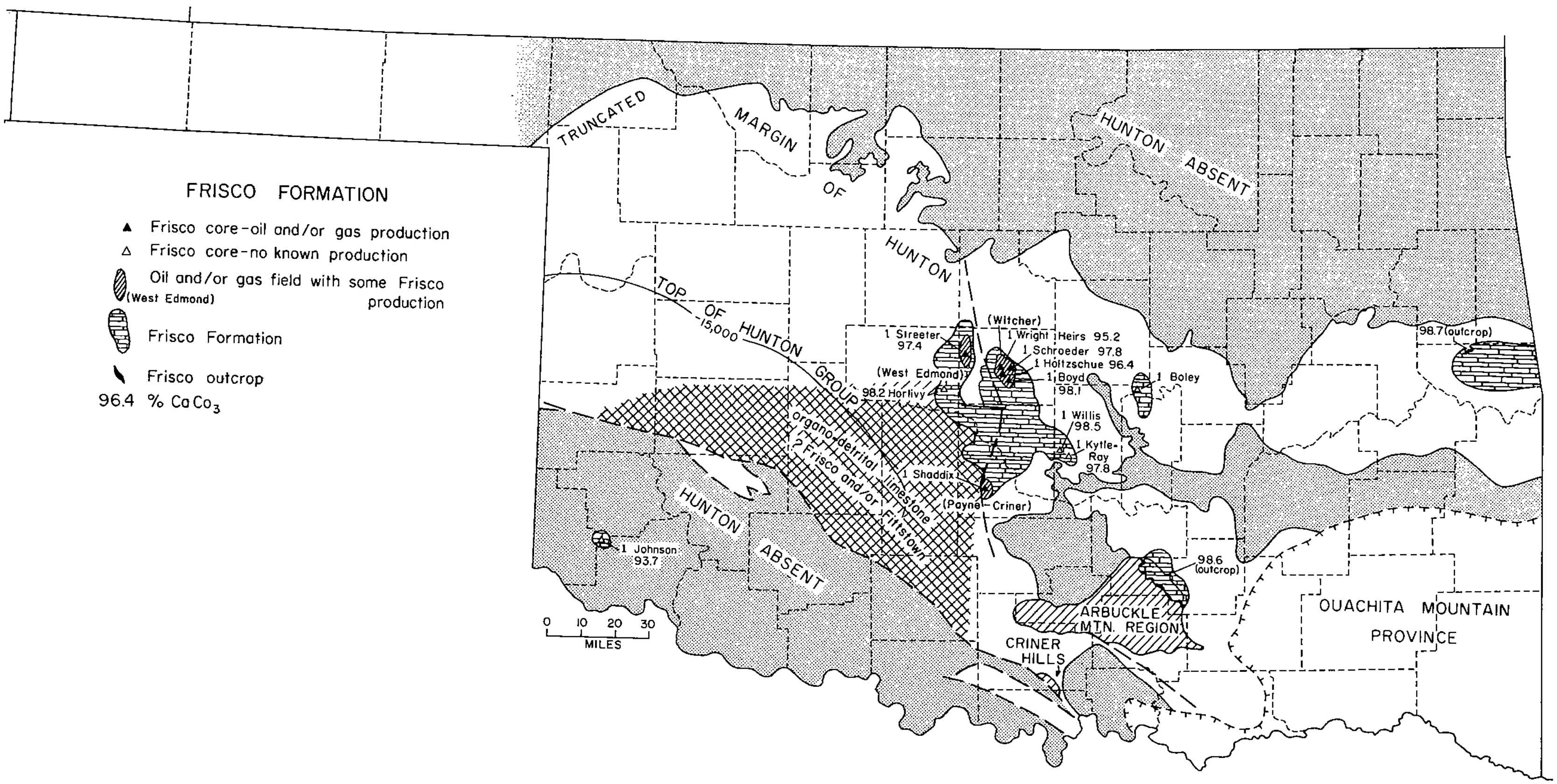
Cores from the following 11 wells are known to cut the Frisco Formation.

Shell 1 Boley
Jones and Pellow 1 Boyd
Gulf 1 Holtzschue
Sinclair 1 Horlivy
Tidewater 1 Johnson
Smith Bros. 1 Kytle-Ray
Gulf 1 Schroeder
Gulf 1 Shaddix
Gulf 1 Streeter
Gulf 1 Willis
Gulf 1 Wright Heirs

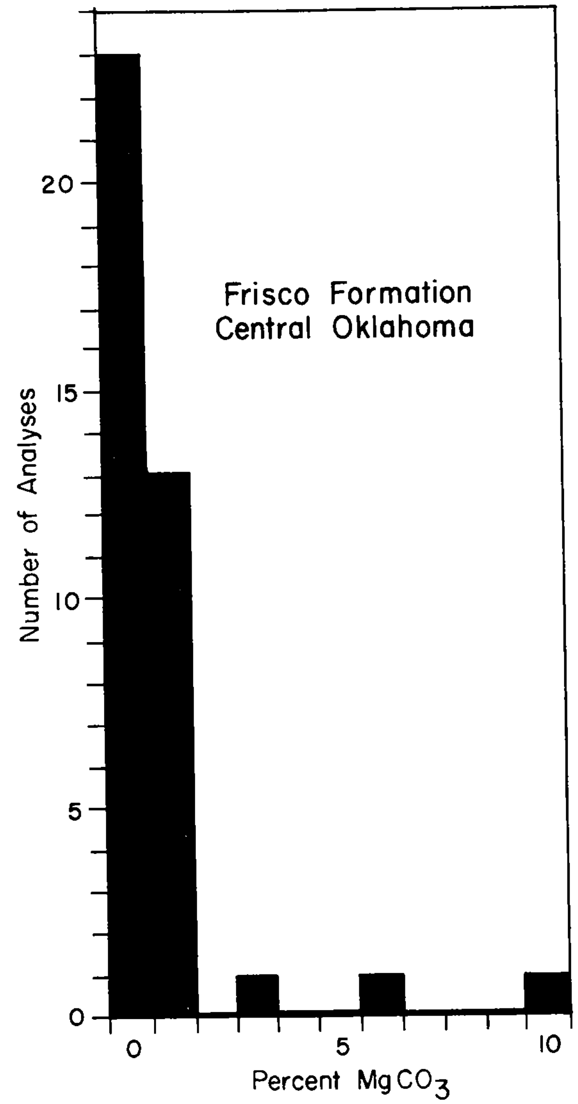
These cores yield substantial brachiopod faunas similar to those in the Frisco outcrops of south-central and eastern Oklahoma. The Frisco Formation in the 1 Johnson is overlain by questionable Mississippian strata and is underlain by Ordovician strata. In the other cores the Frisco is overlain by the Woodford Shale (the Misener Sandstone intervenes in the 1 Holtzschue and 1 Wright Heirs), although the actual contact was cored in only the 1 Boyd, 1 Holtzschue, 1 Schroeder, 1 Streeter, and 1 Wright Heirs. There is solid faunal evidence in the 1 Willis showing that the Frisco is underlain by Haragan-Bois d'Arc (Helderbergian) strata, and in the 1 Horlivy the Frisco is questionably underlain by the Bois d'Arc Formation. Silurian fossils are present in the strata directly beneath the 1 Holtzschue, 1 Schroeder, 1 Streeter (pl. 15, figs. *1*, *2*), and 1 Wright Heirs; the 1 Boley, 1 Boyd, 1 Shaddix, and 1 Kytle-Ray did not core the underlying strata. The locations of wells supplying these cores are given in text-figure 36 and on panel 1, map A, and they are described in the Appendix.

Lithostratigraphy

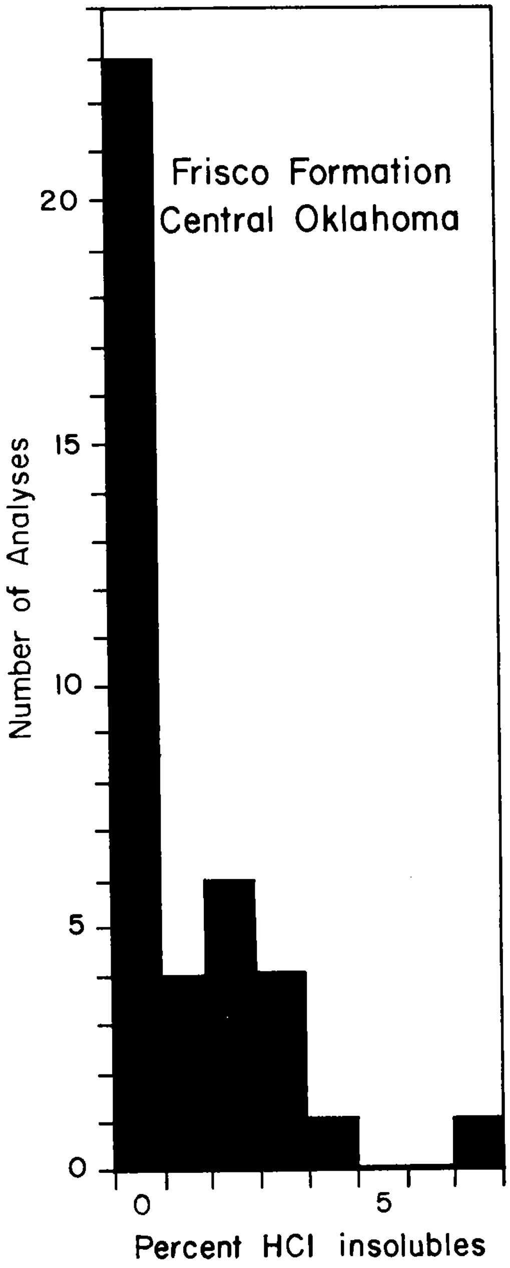
The Frisco Formation in the subsurface has essentially the same lithologic characters as it does in the outcrop areas. It is a light-gray to pinkish-gray organo-detrital limestone, mostly with spar cement. The fossil debris includes many pelmatozoan plates, usually with considerable shelly material (pl. 2, figs. *1-3*). Bryozoan and brachiopod shell fragments (pl. 2, figs. *1*, *3-5*) are especially abundant, although other groups such as the trilobites and snails are represented. The shelly debris was extensively fragmented (pl. 1, figs. *1*, *2*; pl. 2, figs. *3*, *4*) before and during deposition, and the brachiopod shells are almost entirely disarticulated (Amsden and Ventress, 1963, p. 20, 21). Oolitic beds are locally present (pl. 2, fig. *6*). The Frisco was subjected to much solution (pl. 2, figs.



Text-figure 36. Map showing known distribution of Frisco Formation in surface and subsurface and its possible extension into deep part of Anadarko basin. Map gives locations of oil and (or) gas fields believed to produce at least in part from Frisco. It also gives percentage of calcium carbonate (see Appendix, chemical analyses).

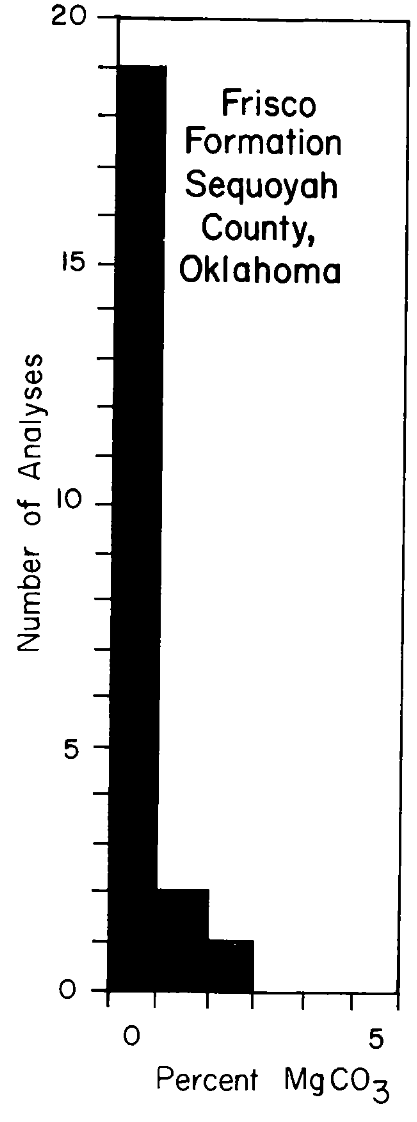


Text-figure 37. Frequency diagram showing distribution of $MgCO_3$ in Frisco Formation in outcrop area, Arbuckle Mountains (Amsden, 1960, Appendix), and in cores of Anadarko basin (Appendix, this report).

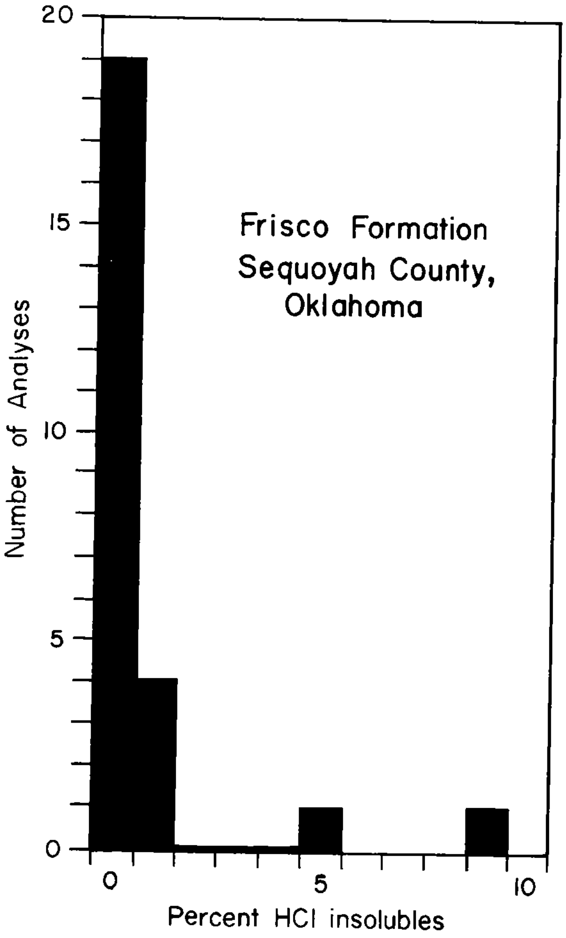


Text-figure 38. Frequency diagram showing distribution of HCl-insoluble residues in Frisco Formation of central Oklahoma. Based on analytical data from outcrop area, Arbuckle Mountains (Amsden, 1960, Appendix), and from cores in Anadarko basin (Appendix, this report).

2, 3), and in many beds the spar cement appears to have been at least partly altered to finely crystalline calcite (pl. 1, fig. *4a*). Much of this alteration presumably took place during the long period of erosion that preceded deposition of the Woodford Shale (see following section on Frisco porosity). Insoluble terrigenous detritus is everywhere low, averaging less than 2 percent (text-fig. 38). Amsden and Huffman (1958, p. 74) report 30-percent sand-size quartz detritus in the Smith Bros. 1 Kytle-Ray; however, a reexamination of the specimen yielding this detritus shows that the quartz sand is concentrated into well-defined "veins." The surrounding limestone is largely free of sand, and it seems reasonable to suppose that these "veins" developed as crevices in the Frisco limestone that were filled from above, probably during deposition of the Misener Sandstone. A



Text-figure 39. Frequency diagram showing distribution of $MgCO_3$ in Frisco Formation in outcrop area, Sequoyah County, eastern Oklahoma. Modified from Amsden (1961, text-fig. 9).



Text-figure 40. Frequency diagram showing distribution of HCl-insoluble residues from Frisco Formation in outcrop area, Sequoyah County, eastern Oklahoma. After Amsden (1961, text-fig. 8).

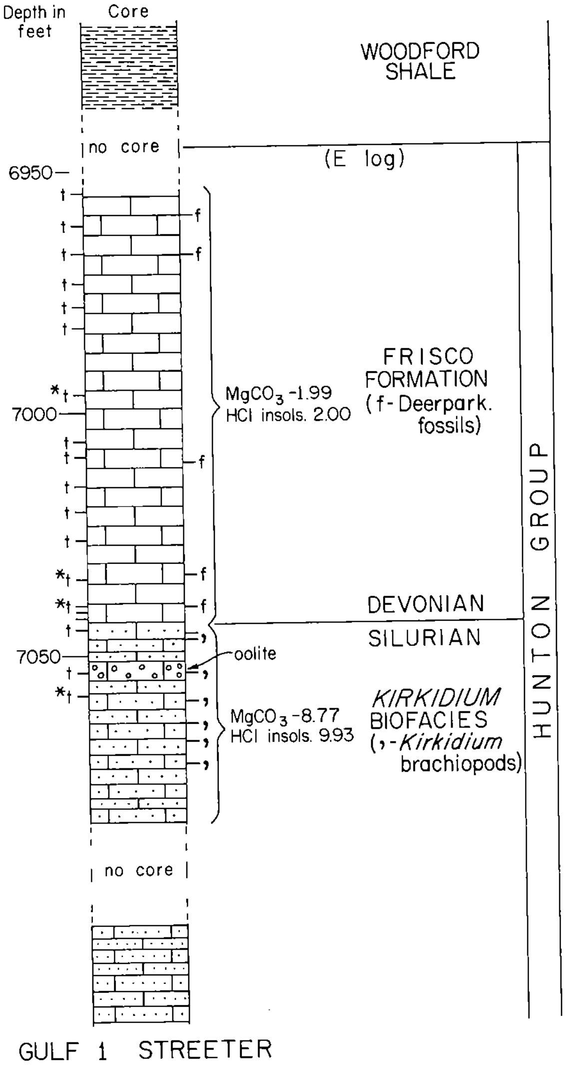
recent analysis of the 1 Kytle-Ray specimen, selected to exclude the "vein" material, gives 97.79 percent $CaCO_3$, 1.44 percent $MgCO_3$, and 1.09 percent HCl insolubles. The $MgCO_3$ is everywhere low, as shown in text-figures 37 and 39. Some glauconite is present, mostly in the form of steinkerns filling shells such as gastropods and in the hollow cores of pelmatozoan plates.

The thickest section of Frisco cored is 98 feet in the Gulf 1 Streeter. This core cuts the overlying Woodford Shale and underlying *Kirkidium* biofacies, and, assuming no abnormal structure, this is the thickest known section of Frisco in Oklahoma. Other wells that cored both the overlying and underlying formations are the Gulf 1 Holtzschue (33 feet), Gulf 1 Schroeder (39 feet), and Gulf 1 Wright Heirs (10 feet). A list of wells with thicknesses of Frisco cored is given below.

Shell 1 Boley	20 ft
Gulf 1 Willis	75 ft
Gulf 1 Wright Heirs	10 ft
Gulf 1 Schroeder	39 ft
Jones and Pellow 1 Boyd	45 ft
Gulf 1 Holtzschue	33 ft
Gulf 1 Streeter	98 ft
Sinclair 1 Horlivy	57 ft
Gulf 1 Shaddix	48 ft
Tidewater 1 Johnson	21 ft

Stratigraphic Relations

The Frisco Formation is unconformably overlain in most areas by the Woodford Shale (Chattanooga Shale in eastern Oklahoma), locally with the Misener Sandstone or Sylamore Sandstone at its base. It is separated from the underlying strata by an erosional unconformity of some magnitude, so that in places it rests on the Bois d'Arc Formation of Early Devonian (Helderbergian) age and in other places on Silurian or Ordovician strata. In its outcrop area it is a mappable unit that is easily distinguished lithologically from the overlying and underlying stratigraphic units (Amsden, 1960, p. 133; Amsden, 1961, p. 37-42), but in the subsurface its delineation is, of course, much more difficult. In cores such as the Gulf 1 Holtzschue, Gulf 1 Schroeder, and Gulf 1 Streeter (pl. 15, figs. *1*, *2*; text-fig. 41), where the Frisco can be demonstrated to rest on the *Kirkidium* zone by means of close biostratigraphic control, there is also a recognizable lithologic boundary between the two formations. The Frisco organo-detrital biosparite is distinct from the Henryhouse marlstone, which has increased insoluble detritus, micrite cement, and, in most beds, substantial quantities of crystalline dolomite. In a core such as the Gulf 1 Willis, where the Frisco appears to rest on the Bois d'Arc Formation, the lithologic distinction is less obvious; however, the latter formation has a greater quantity of insoluble detritus and lacks the abundant evidence of solution and recrystallization that is so common in the Frisco. It seems unlikely that the Frisco can be consistently and reliably separated from the underlying Hunton carbonate strata solely by means of mechanical logs, and in those areas well removed from biostratigraphic control based on cores, the Hunton stratigraphic divisions can only be inferred.



Text-figure 41. Stratigraphic section of lower Woodford and upper Hunton in Gulf 1 Streeter core. Silurian-Devonian boundary as here defined falls in basal Bois d'Arc Formation (just above "Bois d'Arc oolite") as defined by Swesnik (1948, p. 370). This core is described in Appendix. Illustrated thin sections (t*) on plate 1, figures *1a*, *1b*; plate 2, figure *3*; plate 7, figures *1a*, *1b*; plate 12, figure *4*. Frisco-*Kirkidium* boundary illustrated on plate 15, figures *1*, *2*.

Biostratigraphy

The Frisco is a bioclastic limestone with a large shelly fauna that is especially rich in brachiopods. Commonly the fossils are broken to some extent, but specifically identifiable brachiopods have been collected from all cores and include representatives of the following: *Costispirifer arenosus* (Conrad), *Acrospirifer murchisoni* (Castelnau), *Meristella*? *vascularia* Clarke, *Meristella carinata* Stewart, *Leptostrophia magnifica* (Hall), *Strophonella* sp., *Plethorhyncha* sp., *Anoplia nucleata* (Hall), *Rensselaeria* cf. *R. elongata* (Conrad); also, many large snails and the coral *Trachypora* sp. (Amsden, 1960, pl. 17, figs. *1-4*). These fossils are common in the Frisco of the outcrop area and are also present in the Oriskany Sandstone of the Appalachian region; in all respects, this appears to be a typical Deerparkian fauna.

This Deerparkian fauna can be readily traced from the Frisco of Oklahoma to the Little Saline Limestone of Missouri and Illinois, the Harriman Novaculite of Tennessee, the Oriskany Sandstone of the Appalachians, and the Grande Grève Limestone of Gaspé (Amsden and Ventress, 1963, p.

49-59), all of which presumably represent deposits laid down in a connected seaway. Although their lithologic characteristics vary, the Oriskany Sandstone being replaced in the continental interior by novaculites and limestones, all units appear to be clastic deposits representing similar environments of deposition. The deposits laid down in this seaway at one time almost certainly formed a much more extensive blanket of sediments which has been widely breached by post-Deerparkian (Siegenian) erosion. Present evidence demonstrates the presence of the Frisco along the eastern margin of the Anadarko basin (text-fig. 36); however, the Frisco is postulated to extend into the deep part of the basin (see a following section on Frisco porosity), and it seems reasonable to infer that originally it extended over most of the basin.

Oil and Gas Production

Much of the production from the upper part of the Hunton in central Oklahoma has been assigned to the Bois d'Arc Formation, but I have substantial biostratigraphic evidence indicating that much of it is from the Frisco (text-fig. 36; panel 10, section *A-A'*; Amsden and Rowland, 1971, p. 108). Six of the 11 cored wells in this area are believed to have Frisco production: Gulf 1 Wright Heirs, Gulf 1 Schroeder, Gulf 1 Holtzschue, Jones and Pellow 1 Boyd, all in the Witcher field; Gulf 1 Shaddix, in the Payne-Criner field; Gulf 1 Streeter, in the West Edmond field (field names and locations from Kunsman, 1967, p. 168-169; 176-197). West Edmond, which is one of the giant oil fields of the world, is described in detail by Swesnik, who assigned most of its production to the combined Frisco-Bois d'Arc Formations (Swesnik, 1948, p. 372-376, 378-380). In particular, this author illustrated an electric log of the Gulf 1 Streeter, assigning the Hunton strata to the Frisco, Bois d'Arc, Haragan, Henryhouse, and Chimneyhill Formations (Swesnik, 1948, p. 370). However, I believe that no Bois d'Arc or Haragan strata are present in this well, and that the Frisco Formation, bearing such characteristic Deerparkian fossils as *Leptostrophia magnifica*, *Acrospirifer* sp., and large terebratuloid brachiopods, rests directly on the Silurian *Rhipidium* biofacies (Amsden, 1969, p. 965; Appendix, this report). Moreover, in this general area the Frisco has been identified in several cores (text-fig. 36; Appendix), but in only the Sinclair 1 Horlivy has any Bois d'Arc been even tentatively identified (and this lacks confirming biostratigraphic data). However, it should be noted that in the Kirkpatrick 1 Cronkite, some 15 miles north of the Streeter, the upper part of the Hunton is of late Early Devonian (?Emsian) age. These strata have some porosity (sample P19-A tested 2.15-percent porosity), and the reported Hunton production is believed to be from this zone.

Porosity

Swesnik (1948, p. 378-380) has a lengthy discussion on Hunton porosity in the West Edmond field, which he thinks is developed mainly in the Bois d'Arc Formation (=Frisco Formation and uppermost *Kirkidium* beds of this report; see text-fig. 41). He believes that the porosity, which is unusually low as compared to most oil-producing zones, results mainly from solution-enlarged fractures. This solution followed joint planes developed in Hunton rocks that were exposed to erosion during post-Hunton, pre-Woodford and post-Mississippian, pre-Cherokee (Pennsylvanian) times. Some dolomite-related porosity is reported, but Swesnik emphasizes that production in the West Edmond field is mainly from a limestone reservoir.

My information on Hunton porosity in the West Edmond field is derived entirely from a study of the Gulf 1 Streeter core (text-fig. 41; Appendix). Twenty-five thin sections were prepared, most of these from the Frisco and uppermost *Kirkidium* biofacies including the oolite which Swesnik referred to the basal Bois d'Arc Formation. In addition, the entire core was chemically analyzed for $CaCO_3$, $MgCO_3$, and HCl-insoluble residues (Appendix). These data fully support Swesnik's observation that production is primarily from a limestone reservoir. The Frisco Formation in the 1 Streeter—and in fact in all surface and subsurface sections known to me—is extremely low in $MgCO_3$, and I do not think there is any dolomite-related porosity in this formation. In the Gulf 1 Streeter, Frisco porosity, as determined by thin sections, appears to be clearly related to (1) the matrix surrounding fossils, or the hollow interior parts of fossils, and (2) solution channels. These types of porosity are described more fully in the following two paragraphs.

1. The hollow parts of fossils such as bryozoans are in many cases free of matrix, existing as voids in the rock (pl. 7, figs. *1a*, *1b*). These interstices surrounding the fossils may also be unfilled, or only partially filled, thus leaving a void in the rock (pl. 7, figs. *2a*, *2b*). The Frisco is an organo-detrital limestone, in places with a micrite matrix (which may be in part recrystallized sparite) but more commonly with a sparite matrix, and it is in the latter occurrence that porosity has its best development.

2. In addition to the interstitial porosity, there are solution channels that cut across the fossils and the matrix. Some of these are secondarily filled with calcite, but many are not and exist as voids (pl. 7, figs. *3a*, *3b*; pl. 14, fig. *1*). The possible relationship of these to preexisting fractures is not entirely clear in the thin sections under study, but some have a linear distribution, suggesting a relationship to fractures (pl. 14, fig. *1*). I find no place where solution has removed individual fossils, leaving a mold surrounded by matrix, as is commonly the case in the western Silurian dolomites (see Porosity and Permeability in Late Ordovician and Silurian Strata). Porosity in the Gulf 1 Streeter thus appears to be in large part an interstitial porosity, probably caused by the incomplete cementation of the original fossil debris, increased by later solution. Some "pressure-type" solution, possibly associated with compaction, is also present, and this seems to have the effect of reducing porosity (pl. 1, figs. *2a*, *2b*). According to this explanation, some Frisco porosity developed at the time of deposition, and this was affected by later solution (some of which followed fractures), which probably occurred during the time of pre-Woodford and pre-Pennsylvanian uplift and erosion, as postulated by Swesnik (1948).

Other than the Frisco Formation in the 1 Streeter and the Chimneyhill Subgroup in the Sunray DX 10-A Rentie (see Chimneyhill Subgroup, Porosity and Permeability; text-fig. 28), I have not investigated limestone porosity in Hunton strata. However, it seems reasonable to postulate that almost any organo-detrital sparite could develop significant porous zones through incomplete cementation, especially if increased by later solution. This is an important consideration in the case of the deep Anadarko basin, where most wells reveal thick sections of an upper (?Frisco and/or Fittstown) and a lower (Chimneyhill) sequence of organo-detrital limestones, mainly with spar cement (panel 10, section *C-C'*). No oil or gas production is presently known to me from the limestone lithofacies of the deep basin and adjoining fault blocks (the latter have been drilled in a number of places), but it would certainly seem possible to have at least local development of porous zones similar to that found in the Frisco in the 1 Streeter and in the Chimneyhill in the 10-A Rentie. Mud-supported marlstones and organo-detrital limestones cemented with lime mud would appear less likely to develop porosity, and I would think the Henryhouse and (or) Haragan marlstones would be less likely to have satisfactory producing zones.

Late Early Devonian Strata

The Sallisaw Formation (text-fig. 2), which crops out in eastern Oklahoma, yields a brachiopod fauna of late Early Devonian (Emsian, Esopusian) age (Amsden, 1963a, p. 143-154). This fauna includes the following species.

Protoleptostrophia blainvillei
Leptaena sp.
Eodevonaria intermedia
Chonostrophia complanata?
Anoplia nucleata
Schellwienella? sp.
Leptocoelia flabellites?
Atrypa sp.
Fimbrispirifer cf. *F. divaricatus*
Hysterolites (*A.*) *worthenanus*?
Amphigenia curta

No equivalent strata have been recognized in the Arbuckle Mountains-Criner Hills region, and the Frisco (Siegenian, Deerparkian) is the youngest Early Devonian formation present. However, a thin limestone (Turkey Creek limestone) of late Early Devonian age was formerly exposed in a small inlier on Turkey Creek in Marshall County (panel 11). Conodonts and trilobites from this unit suggest that it is slightly younger than the Sallisaw Formation and slightly older than the Frisco Formation (Amsden, Klapper, and Ormiston, 1968, p. 165, 166; Ormiston, 1968, p. 1187-1188). This limestone rests directly on the Sylvan Shale.

Three wells are known to have cored strata carrying brachiopod faunas similar to that of the Sallisaw Formation: the Kirkpatrick 1 Cronkite in Kingfisher County, Oklahoma; and the Standard of Texas 1 Wheeler Unit and Phillips 1-C Lina, both in the Texas Panhandle. These cores are widely spaced and appear to represent erosional remnants isolated from one another by post-Early Devonian erosion. Present faunal information is inadequate to demonstrate the exact time relationship of these units to one another, or to the Sallisaw and Turkey Creek strata. However, all units appear to represent a late Early Devonian age, and suggest that carbonate deposition, locally with much chert in the eastern region, extended over most of this general region.

The Kirkpatrick 1 Cronkite core yields specimens of *Amphigenia*? sp., *Leptocoelia* sp., *Eodevonaria* sp., *Protoleptostrophia*? cf. *P. blainvillei*, *Anoplia* cf. *A. nucleata*, *Schellwienella*? sp., and *Atrypa* sp. The quantity and preservation of these fossils are not sufficient to permit exact identification, but the fossils are sufficiently similar to the Sallisaw fauna to suggest a reasonably close relationship. The age of the underlying beds is uncertain, although the thick Hunton section indicates that Silurian strata are present, possibly with some intervening Frisco. This well produces from the Hunton, at least some of which appears to be these late Early Devonian rocks.

The Phillips 1-C Lina core yields specimens of *Amphigenia* sp., *Eodevonaria* sp., *Hysterolites* cf. *H. worthenanus*?, and a leptostrophid brachiopod, probably *Protoleptostrophia*. These brachiopod-bearing strata either directly overlie, or are in close proximity to, the Sylvan Shale.

The Standard of Texas 1 Wheeler Unit furnishes a spondylium-bearing terebratuloid brachiopod, probably *Amphigenia*. The age of the underlying strata is unknown, but this fossil is from a bed 50 feet below the Woodford; and since the Hunton is reported to be more than 700 feet thick, Silurian rocks are certainly present, possibly with some intervening Lower Devonian rocks.

In the outcrop area of eastern Oklahoma, the Sallisaw is separated from the underlying strata by an erosional unconformity, and this formation may rest on the Frisco Formation or directly on the Silurian. The present study shows that the western late Early Devonian rocks are also separated from the underlying beds by an erosional unconformity of sufficient magnitude to locally remove all the Lower Devonian and Silurian strata, allowing them to rest directly on the Ordovician.

Lower Devonian strata in the 1 Cronkite are interesting because they are lithologically similar to the *Kirkidium*-rich beds of the Jones and Pellow 1 Farrell (Appendix), and thus illustrate the danger in lithologic correlation. Both include well-developed beds of oolite, and in both the dolomitic limestones are similar in $MgCO_3$ content and HCl-insoluble content. A somewhat similar situation is present farther north in the Pan American 1 Droke Unit, where a specimen of *Rensselaerina*? sp. was obtained from a strongly dolomitized oolite, lithologically resembling those from nearby wells, where dolomitized oolites yield many specimens of *Kirkidium*. The generic identity of the brachiopod from the 1 Droke Unit is not certain, but it is definitely a terebratuloid brachiopod and represents a group of shells that have never been found in pre-Devonian strata. Possibly this brachiopod represents an Esopusian rather than a Helderbergian age and would therefore be approximately correlative with the Lower Devonian strata in the 1 Cronkite.

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APPENDIX

The Appendix includes the following sections: part I, Core Descriptions; part II, Sample Descriptions; part III, Chemical Analyses; part IV, Porosity and Permeability Tests. All wells cited are alphabetized by farm name, and all are located on panel 1, map A, and panels 5 and 6.

Part I—Core Descriptions

Cores from 125 wells are described in this section. Almost all of these wells cored some part of the Hunton Group, although a few are included which cut only the Misener Sandstone. Most wells are on the shallow, peripheral margin of the basin (panel 1, map A; panels 5, 6). The deepest cored wells are in Custer County, with the Hunton cores generally at a depth of −12,000 feet to −14,000 feet; no cores are known below −15,000 feet (panel 5). With only a few exceptions, the cores were chemically analyzed in the chemical laboratory of the Oklahoma Geological Survey; these data are given in the section on Chemical Analyses (part III), and only summary information is included here. A number of porosity-permeability tests were made (see part IV of Appendix), and many thin sections were prepared, some of which are illustrated on plates 1-15. The repository is given for each core; unless otherwise stated, all thin sections and fossils are in the collections of the Oklahoma Geological Survey.

For each well the basic data include location, elevation, total depth (TD), and production information (Hunton only). The depth of formation tops is generally cited for the Woodford Shale, Hunton Group, and Sylvan Shale, and the source is given as follows: well-completion cards (CC), mechanical logs (GR logs), and cores (core).

The Hunton Group is divided into formations (wherever possible), and a brief lithologic and biostratigraphic description is given for each stratigraphic division recognized.

COX 1-A ANNIS--C NW¼NW¼ sec. 3, T. 26 N., R. 21 W., Harper County, Oklahoma; elev. 1791'; TD 7365' (Hunton); compl. 9/1/67, D&A. Tops: Hunton 7296' (-5505') (core). Cored 7269'-7365' (Hunton 7296'-7365'); 3 thin sections; chemical analyses; OU Core Library.

Woodford Shale

Hunton Group 7296'-7365' (TD)

?Silurian; ?Chimneyhill Subgroup. No diagnostic fossils observed; tentatively assigned to Chimneyhill on basis of lithology and stratigraphic position (near truncated margin of Hunton; see panel 6).

7269'-7304' Gray crystalline dolomite with much chert. Very little detrital quartz; no fossils observed. Some visible porosity.

7304'-7322' Gray crystalline dolomite with very little detrital quartz; no fossils observed; some visible porosity. 7269'-7322' averages 25.36% $MgCO_3$.

7322'-7365' (TD) Pinkish-gray organo-detrital limestone; minor shelly debris, mostly crinoidal material. Very little detrital quartz. Patches of crystalline dolomite, but this interval is mostly low-magnesium limestone (average $MgCO_3$ 2.30%).

RIDDLE ET AL. 1 ATTERBERRY (FEE)--sec. 11, T. 3 N., R. 5 E., Pontotoc County, Oklahoma. Cored 3932'-3937' (all Hunton); chemical analysis (no other information available); OU Core Library.

Hunton Group

Lower Devonian; Haragan Formation.

3932'-3937' Gray fossiliferous marlstone. Brachiopods: *Coelospira virgiana*, *Atrypina hami*, *Levenea* sp., *Atrypa* sp.

JONES 1 BARTOW--C SW¼NE¼SW¼ sec. 23, T. 23 N., R. 18 W., Woodward County, Oklahoma; elev. 1999'; TD 9155' (Sylvan); compl. 10/11/68, D&A. Tops: Woodford (CC) 8818' (-6819'), Hunton (CC) 8844' (-6845'), Sylvan (CC) 9128' (-7129'); Hunton thickness 284'. Cored 8852'-8907' (all Hunton); 2 thin sections, chemical analyses; OU Core Library.

Woodford Shale 8818'-8844'

Hunton Group 8844'-9128'

?Silurian; ?*Kirkidium* biofacies. No diagnostic fossils observed; tentatively assigned to *Kirkidium* biofacies on basis of lithologic character, stratigraphic position, and thickness with respect to other wells in this area; see panel 10, section A-A'.

8852'-8907' Gray crystalline dolomite with nodules of vitreous chert. Minor insoluble detritus. Poorly preserved brachiopod (?pentamerid) at 8868'.

8907'-9128' No core.

Sylvan Shale 9128'

AMERICAN 4-A BAYNE--C SE¼SW¼ sec. 16, T. 5 N., R. 6 E., Pontotoc County, Oklahoma; elev. 962'; TD 2808' (Sylvan); compl. 8/10/70, Hunton production (perforated 2720'-2745', 2785'-2795'). Tops: Woodford (CC) 2379' (-1417'), Hunton (CC) 2606' (-1640'), Sylvan (CC) 2795' (-1833'); Hunton thickness 193'. Cored 2687'-2745.5' (all Hunton); 2 thin sections; chemical analysis; OU Core Library.

Woodford Shale 2379'-2602'

Hunton Group 2602'-2795'

Silurian; Henryhouse Formation. Fossils,

trilobites: Dalmanites rutellum at 2688'
2712' (identified by K. S. W. Campbell).
2686'-2737' Greenish-gray marlstone with scattered fossils. Silt-size subangular quartz detritus (average insolubles 23.60%) and minor scattered dolomite crystals (average $MgCO_3$ 8.95%).
?Chimneyhill Subgroup. No diagnostic fossils observed, assigned on basis of lithology and stratigraphic position.
2737'-2745' Pinkish-gray organo-detrital limestone with micrite and sparite cement. Very little detrital quartz (average insolubles 6.20%) and a few irregular bodies of dolomite (average $MgCO_3$ 5.20%).
2745'-2795' No core; samples not studied.
Sylvan Shale 2795'

KAHAN ET AL. 6 BEAN--N½N½NW¼ sec. 11, T. 8 N., R. 5 E., Seminole County, Oklahoma; elev. 969'; TD 4345' (Wilcox); compl. 3/11/65, Hunton production (perforated 4013'-4056'). Tops: Woodford (CC) 3893' (-2924'), Hunton (CC) 4006' (-3037'), Sylvan (CC) 4053' (-3084'), Viola 4136' (-3167'); Hunton thickness 47'. Cored 4011'-4052' (all Hunton); 6 thin sections; chemical analyses; OU Core Library.
Woodford Shale 3893'-4006'
Hunton Group 4006'-4053'
Silurian; Chimneyhill Subgroup, ?Cochrane Formation. No diagnostic fossils observed, assigned on basis of lithology and stratigraphic position.
4011'-4028' Glauconitic and dolomitic limestone with very little quartz detritus; fossiliferous (average $MgCO_3$ 18.34%, average insolubles 8.68%).
4028'-4052' Glauconitic, organo-detrital limestone (average $MgCO_3$ 6.9%, average insolubles 1.80%).
4052'-4053' No core, samples not examined.
Sylvan Shale 4053'-4136'

CALVERT 1 BERTIE--C SE¼NW¼ sec. 35, T. 19 N., R. 9 W., Kingfisher County, Oklahoma; elev. 1115'; TD 8675' (Viola); compl. 5/9/63, Hunton production (perforated 8578'-8592', 8604'-8626'). Tops: Woodford (CC) 8318' (-7203'), Hunton (core) 8333' (-7218'), Sylvan (CC) 8639' (-7524'); Hunton thickness 306'. Cored 8296'-8398', 8515'-8616' (Woodford-Hunton); 11 thin sections; chemical analyses (Hunton portion only); OU Core Library. Porosity-permeability tests P10-A, P10-B, P10-C, P10-D.
Woodford Shale 8318'-8333'
Hunton Group 8333'-8639'
8333'-8398' Silurian; Kirkidium biofacies. Upper 10 feet is gray crystalline dolomite (35.58% $MgCO_3$, 5.04% HCl insolubles); remainder of interval is fossiliferous dolomitic limestone with considerable insoluble detritus. Entire interval averages 22.83% $MgCO_3$ and 16.05% HCl insolubles. Thin section illustrated, pl. 10, fig. 1; pl. 11, fig. 2a (depth 8351'). Specimens of Kirkidium sp. common, observed from 8339' to 8390'; Strophonella loeblichi Amsden 8352'-8355'; Halysites sp. and favositid corals at 8379'-8383'.
8398'-8515' No core.
8515'-8558' ?Chimneyhill Subgroup. Dolomitic biomicrite with some shelly debris and much crinoidal material, some plates being pink; considerable insoluble detritus (average $MgCO_3$ 13.89%, HCl insolubles 12.30%). No diagnostic fossils observed; assigned to Chimneyhill on basis of lithology and stratigraphic position.
8558'-8616' ?Chimneyhill Subgroup. Gray crystalline dolomite with fossils preserved as molds or in spar (average $MgCO_3$ 38.38%, HCl insolubles 3.41%). Good porosity: P10-B, 6.08%; P10-C, 7.6%; P10-D, 16.66%. No diagnostic fossils observed; assigned to Chimneyhill on basis of stratigraphic position.
8616'-8639' No core.
Sylvan Shale 8639'

JONES & PELLOW 1 BEST--C NE¼NE¼ sec. 15, T. 15 N., R. 6 W., Kingfisher County, Oklahoma; elev. 1185'; TD 8139' (Sylvan); compl. 5/9/69; no Hunton production reported (perforated 7990'-7994'). Tops: Woodford (CC) 7762' (-6577'), Hunton (CC) 7826' (-6641'), Sylvan (CC) 8120' (-6935'); Hunton thickness 294'. Cored 7960'-8015' (all Hunton); 4 thin sections; chemical analyses; OU Core Library.
Woodford Shale 7762'-7826'
Hunton Group 7826'-8120'
7826'-7960' No core.
7960'-8015' ?Silurian. Dolomitic, fossiliferous limestone with much crinoidal material; mostly micrite cement; some sparite. Dolomite content variable, averaging 23.16% $MgCO_3$; HCl insolubles variable, averaging 9.15%. A few beds grade into crystalline dolomite, but mostly rock is dolomitic limestone with euhedral crystals of dolomite scattered through matrix and retaining microstructure of shelly and pelmatozoan debris. A few incomplete brachiopods collected at 8012', but no diagnostic fossils observed; cored interval, and in fact the entire Hunton, is tentatively referred to Silurian on basis of thickness and stratigraphic position. Compare this section to Jones & Pellow 1 Farrell, Gulf 1 Triplett, and Kirkpatrick 1 Cronkite, which did yield identifiable Silurian fossils.
8015'-8120' No core.
Sylvan Shale 8120'

KIRKPATRICK 1 BLEVINS UNIT--C NE¼SW¼ sec. 7, T. 17 N., R. 4 W., Logan County, Oklahoma; elev. 1152'; TD 7090' (Sylvan); compl. 2/21/67, no Hunton production reported (perforated 6989'-7008', 7032'-7039'). Tops: no Woodford top reported, Hunton (CC) 6987' (-5835'), Sylvan (core) 7039' (-5887'); Hunton thickness 53'. Cored 6993'-7043' (Hunton-Sylvan); 6 thin sections; chemical analyses; OU Core Library.

This well located near truncated margin of Hunton, and only Chimneyhill Subgroup is preserved, upper Kirkidium beds having been removed by pre-Woodford erosion.

Woodford Shale ?
Hunton Group 6987'-7039'
6987'-6993' No core.
6993'-7022' Silurian; Chimneyhill Subgroup,

Clarita Formation. Gray to pinkish-gray biomicrite with many pink crinoid plates; minor spar cement. Insoluble detritus is low (average HCl insolubles 3.90%), and only minor euhedral crystals of dolomite scattered through matrix (average $MgCO_3$ 3.03%). This is typical Clarita lithology, and trilobites from 6094' and 6010' are reported by K. S. W. Campbell to be Clarita types (personal communication). Also a few brachiopods at 6095', including a strophodontid. Contact with underlying unit is not well defined.

7022'-7039' Cochrane Formation. Light-gray organo-detrital limestone with glauconite. Mainly spar matrix, some micrite. Scattered euhedral crystals of dolomite (10.47% $MgCO_3$) and considerable insoluble detritus (HCl insolubles 12.65%). Some recrystallization. Lower few inches with scattered oolites (?Keel Formation); Hunton-Sylvan contact cored and well shown. This interval is assigned to Cochrane on basis of lithology and stratigraphic position.

Sylvan Shale 7039'

CALVERT MID-AMERICA 2 BLOYD--W½NW¼ sec. 21, T. 27 N., R. 15 W., Woods County, Oklahoma; elev. 1570'; TD 6290' (Sylvan); compl. 3/29/68, Hunton production (perforated 6237'-6241'). Tops: Woodford (CC) 6156' (-4586'), Hunton (core) 6208' (-4638'), Sylvan 6240' (-4670'); Hunton thickness 32'. Cored 6189'-6244' (Woodford, Hunton, Sylvan); 4 thin sections; chemical analyses; OU Core Library. Porosity-permeability test P11-A at 6211', 8.9% porosity, 13.37% permeability.

This well is located in western dolomite facies, very near truncated margin of Hunton; only Chimneyhill strata preserved, the Kirkidium biofacies having been removed by pre-Woodford erosion.

Woodford Shale 6156'-6208'

Hunton Group 6208'-6240'

6208'-6232' Silurian; Chimneyhill Subgroup, Cochrane Formation. Gray crystalline dolomite with numerous fossils, especially crinoids ($MgCO_3$ 33.58%). Considerable visible porosity, both in hand specimen and thin section; much appears to be result of fossil dissolution (P11-A, 8.9% porosity). Specimen of Triplesia alata? at 6211'; interval assigned to Cochrane Formation on basis of this fossil and its stratigraphic position.

6232'-6238' Cochrane Formation. Pink crinoidal biosparite with only minor dolomite ($MgCO_3$ 9.57%; HCl insolubles 7.58%).

6238'-6240' ?Keel Formation. Gray crystalline dolomite with 40.42% $MgCO_3$ and 0.26% insolubles. This may be dolomitized oolite, but dolomitization has obscured texture.

Sylvan Shale 6240'

SHELL 1 BOLEY--SE¼SE¼SW¼ sec. 8, T. 11 N., R. 6 E., Pottawatomie County, Oklahoma; elev. 995'; TD 4748' (Ordovician); compl. 5/17/38, D&A. Tops: ?Misener (CC) 4347' (-3352'), Hunton (CC) 4353' (-3358'), Sylvan (core) 4508' (-3513'); Hunton thickness 155'. Cored 4353'-4373' (Hunton), 4495'-4508' (Hunton-Sylvan); 11 thin sections; no chemical analysis.

This well, which cored 18' of Frisco, is located on what appears to be an outlier of Frisco, separated from main body of Lower Devonian by pre-Woodford erosion (see panel 9). Frisco is almost totally devoid of dolomite, but Silurian is moderately to completely dolomitized.

?Misener Sandstone 4347'-4353'

Hunton Group 4353'-4508'

4353'-4373' Lower Devonian; Frisco Formation. Light-gray biosparite with very little dolomite and very little quartz detritus. Much crinoidal material and fragmented shelly debris, including considerable quantity of bryozoan material. Some visible porosity in thin section, mostly occupying center of hollow fossils and matrix surrounding fossils. Brachiopods from this interval include Rensselaeria sp., R. elongata, ?Costispirifer sp., Anoplia nucleata. Assigned to Frisco on basis of these fossils, stratigraphic position, and lithology (typical Frisco lithology). Rau and Ackley (1939, p. 230) illustrate a brachiopod from 1 Boley core which they assign to Misener but which I believe represents Frisco; core preserved at OU Core Library includes no Misener, and illustrated fossil is suggestive of a Frisco spiriferid brachiopod (see also Amsden and Klapper, 1972, p. 2325-2326).

4443'-4459' Silurian; ?Chimneyhill Subgroup. Pink crinoidal limestone, heavily dolomitized in places. Limestone is crinoid-rich biosparite and micrite and also includes much shelly debris. Strongly dolomitized areas have been replaced by light-gray crystalline dolomite. Parts resemble laminated carbonate in sediment-filled cavities present in Tenkiller Formation of eastern Oklahoma (Amsden and Rowland, 1965, p. 37, pls. 8-11). Very little detrital quartz. No diagnostic fossils observed, and this unit assigned to Chimneyhill on basis of lithologic character and stratigraphic position.

4495'-4505' Chimneyhill Subgroup. Strongly dolomitized, fossiliferous limestone. Only minor quartz detritus.

4505'-4508' Keel Formation. Dolomitized oolite; almost entirely crystalline dolomite. Contact with Sylvan exposed. Some visible solution cavities.

Sylvan Shale 4508'

JONES & PELLOW 1 BOYD--SW¼NE¼NW¼ sec. 28, T. 12 N., R. 2 W., Oklahoma County, Oklahoma; elev. 1175'; TD 6582' (Hunton); compl. 4/11/69, Hunton production reported (perforated 6500'-6524'). Tops: Woodford (CC) 6468' (-5293'); Hunton (core) 6487' (-5312'); 95' Hunton drilled to TD. Cored 6475'-6533' (Woodford-Hunton); 4 thin sections; chemical analyses; OU Core Library.

This core penetrates 46' of Frisco; see panel 10, section A-A'.

Woodford Shale 6468'-6487'

Hunton Group 6487'-6582' (TD)

6487'-6533' Lower Devonian; Frisco Formation. Light-gray to pinkish-gray organo-detrital limestone. Much crinoidal debris along with shelly material including many bryozoan fragments. Very low in insolubles and dolomite (averages 0.77% MgCO$_3$ and 1.09% HCl insolubles). Some glauconite present as fillings of fossils and along seams. Some visible porosity in thin sections (pl. 7, figs. 3a, 3b; see also pl. 1, figs. 2a, 2b, and pl. 2, fig. 4, for other illustrations of Frisco from 1 Boyd). Frisco brachiopods throughout interval, including large terebratuloids, Costispirifer arenosus, Acrospirifer sp. Assigned to Frisco on basis of these fossils; also, this is typical Frisco lithology.

6533'-6582' (TD) No core.

AMERADA 1 BRECKENRIDGE--C NW¼SE¼ sec. 33, T. 25 N., R. 6 W., Grant County, Oklahoma; elev. 1081'; TD 6313' (Viola); compl. 6/26/64, Misener production. Tops: Woodford (CC) 6220' (-5139'), Misener (core) 6250' (-5169'), Sylvan 6271' (-5190'). Cored 6250'-6274' (Misener-Sylvan); 3 thin sections; chemical analyses; OU Core Library.

This well is a short distance north of Hunton zero isopach. It is described and illustrated in Amsden and Klapper (1972, p. 2327-2330), and early Late Devonian (Frasnian) conodonts are listed.

Woodford Shale 6220'-6250'

Misener Sandstone 6250'-6271'

6250'-6271' Upper Devonian. Dolomitic quartz sandstone with linguloid brachiopods and conodonts. HCl insolubles, mainly silt and sand-size quartz detritus, range from 65% to 90%; quantity of dolomite varies greatly, and in places rock probably grades into sandy crystalline dolomite. Conodonts indicate a Late Devonian (Frasnian) age.

MOBIL 1 CARTER--SE¼NW¼ sec. 15, T. 15 N., R. 16 W., Custer County, Oklahoma; elev. 1802'; TD 15,165' (Hunton); compl. 2/25/60, Hunton production (perforated 14,690'-14,771', 14,792'-14,880', 14,900'-14,980'). Tops: Woodford (CC) 14,572' (-12,770'), Hunton (CC) 14,682' (-12,880'); 483' of Hunton rocks penetrated to TD. Core chips 14,696'-14,749'; no thin sections or chemical analyses; OU Core Library.

Woodford Shale 14,572'-14,682'

Hunton Group 14,682'-15,165' (TD)

14,682'-14,696' ?Silurian. No core. Assigned to Silurian on basis of stratigraphic position and relationship to nearby wells supplying Silurian fossils. (See Sunray DX 1 Frans; Mobil 1 Horton, Mobil 1 Sharp-Hunt Unit; panel 1, map A; panel 10, section B-B'.)

14,696'-14,749' Gray calcitic dolomite and dolomitic limestone.

14,749'-15,165 (TD) No core.

HUBER 1 CHEROKEE METHODIST CHURCH--C S½NE¼ sec. 21, T. 26 N., R. 11 W., Alfalfa County, Oklahoma; elev. 1198'; TD 6280' (Wilcox); compl. 9/20/68, D&A. Tops: Woodford 6049' (-4851'), Hunton (core; only 2" thick) 6088' (-4890'), Sylvan 6088½' (-4890½'). Cored 6081'-6115' (Woodford-Hunton-Sylvan); 1 thin section; no chemical analyses; OU Core Library.

Woodford Shale 6049'-6088'

Hunton Group 6088'

6088' Silurian; Chimneyhill Subgroup; Keel Formation. Approximately 2" of core between Woodford Shale and Sylvan Shale. Silicified, fossiliferous oolite.

Sylvan Shale 6088½'

ATLANTIC 1 CHOATE--C SE¼SW¼ sec. 26, T. 19 N., R. 9 W., Kingfisher County, Oklahoma; elev. 1110'; TD 8660' (Sylvan); compl. 6/15/49, D&A. Tops: Woodford (CC) 8304' (-7194'), Hunton (CC) 8315' (-7205'), Sylvan (CC) 8630' (-7520'); Hunton thickness 315'. Cored 8316'-8389' (Hunton); 2 thin sections; chemical analyses; OU Core Library.

Woodford Shale 8304'-8315'

Hunton Group 8315'-8630'

8316'-8389' Silurian; Kirkidium biofacies (no Woodford in top of core). Medium-gray dolomitic and fossiliferous marlstone; upper part (8316'-8368') averages 21.90% MgCO$_3$ and 18.66% HCl insolubles, and lower part (8368'-8389') averages 6.48% MgCO$_3$ and 17.13% insolubles. Much subangular to angular silt-size detrital quartz and euhedral dolomite crystals of about same size. Thin section (6347'), pl. 6, fig. 3. Specimens of Kirkidium sp. at 8321', 8347', 8365'; Halysites at 8347'.

8389'-8630' No core.

Sylvan Shale 8630'

GETTY 1-B COFFMAN--C SW¼NE¼ sec. 4, T. 22 N., R. 24 W., Ellis County, Oklahoma; elev. 2324'; TD 11,586' (Viola); compl. 12/1/67, D&A. Tops: Woodford (CC) 11,186' (-8862'), Hunton 11,192' (-8868'), Sylvan 11,370' (-9046'); Hunton thickness 178'. Cored 11,122'-11,172', 11,201'-11,251' (latter all Hunton); 5 thin sections; chemical analyses; porosity-permeability test (P13-A); OU Core Library.

Woodford Shale 11,186'-11,192'

Hunton Group 11,192'-11,370'

11,192'-11,201' ?Silurian; ?Kirkidium biofacies. No core.

11,201'-11,210' Silurian; ?Kirkidium biofacies. Pale-gray organo-detrital limestone; many corals, all fossils much broken up. Very little dolomite (1.84% MgCO$_3$) and very little insoluble detritus (2.08%). No Kirkidium observed in this interval; mostly corals, solitary and colonial, including Halysites sp. in lower 2'.

11,210'-11,251' Silurian; ?Kirkidium biofacies. Pale-gray organo-detrital limestone like above. Averages 1.56% MgCO$_3$ and 3.76% insolubles. Sample P13-A, 11,236', 0.30% porosity, 0.00 permeability. Thin section illustrated, pl. 10, figs. 2a, 2b, 2c. This interval includes numerous specimens of large pentamerid brachiopods; probably two genera, Kirkidium and Pentameroides (specimens much fragmented). Also corals, including Entelophyllum sp.

(identified by Dr. P. K. Sutherland). Crinoidal debris common.

11,251'-11,370' No core.

Sylvan Shale 11,370'

GULF 1 COSTELLO--C NE¼SE¼ sec. 14, T. 5 N., R. 5 W., Grady County, Oklahoma; elev. 1029'; TD 12,775' (Simpson); completed 10/21/54, no Hunton production reported. Tops: Woodford (CC) 10,180' (-9151'), Hunton (CC) 10,415' (-9386'), Sylvan (CC) 10,800' (-9771'); Hunton thickness 385'. Cored 10,433'-10,558' (all Hunton); no thin sections; chemical analyses; OU Core Library.

Woodford Shale 10,180'-10,415'

Hunton Group 10,415'-10,800'

10,415'-10,433' No core. Probably all Lower Devonian.

10,433'-10,558' Lower Devonian; Haragan-Bois d'Arc Formations. Medium-gray fossiliferous marlstone; $MgCO_3$ averages 7.56%, HCl insolubles average 15.49%. This core furnished a few pelecypods, bryozoans, and trilobites, and following brachiopods: Obturamentella sp., Strophonella sp., Leptostrophia sp., Levenea subcarinata pumilis?, Dalejina sp., Meristella atoka?, Gypidula sp., Sphaerirhynchia sp. This brachiopod fauna is similar to that of Haragan-Bois d'Arc at outcrop.

10,558'-10,800' No core.

Sylvan Shale 10,800'

KIRKPATRICK 1 CRONKITE--C N½NW¼ sec. 14, T. 15 N., R. 5 W., Kingfisher County, Oklahoma; elev. 1102'; TD 7900' (Simpson); compl. 8/5/70, Hunton production (perforated 7108'-7114', 7094'-7097'). Tops: Woodford (CC) 7043' (-5941'), Hunton (CC) 7097' (-5995'), Sylvan (CC) 7370' (-6268'); Hunton thickness 273'. Cored 7098'-7136' (all Hunton); 4 thin sections; chemical analyses; OU Core Library; 1 porosity-permeability test, P19-A.

This well drilled by Pickens to 7146' (2/24/67), deepened by Kirkpatrick to 7900'.

Woodford Shale 7043'-7907'

Hunton Group 7097'-7370'

7097'-7098' No core.

7098'-7108' Lower Devonian; ?Emsian (?=Sallisaw Formation). Fossiliferous, dolomitic limestone; 19.51% $MgCO_3$ and 9.43% HCl insolubles. Few if any oolites. At 7099' numerous specimens of a spondylium-bearing terebratuloid, probably Amphigenia sp.; also specimens of Amphigenia? sp. and Leptocoelia sp. at 7102'.

7109'-7118' Fossiliferous, oolitic limestone; very little dolomite (1.69% $MgCO_3$, 6.42% HCl insolubles). Oolitic matrix mostly spar; parts with much crystalline quartz, probably largely silicification. Sample P19-A at 7109' tested 2.15% porosity. Brachiopods from 7110'-7114', 7118' include Eodevonaria sp., Protoleptostrophia? cf. P. blainvillei, Leptocoelia sp., Anoplia cf. A. nucleata, Schellwienella? sp., and Atrypa sp. On basis of these fossils, this interval and overlying unit are assigned to late Early Devonian (?Emsian).

7118'-7120' Like unit below, but yielding a few specimens of Leptocoelia sp. Assigned to late Early Devonian on basis of these brachiopods.

7120'-7136' Fossiliferous dolomitic limestone with substantial insoluble detritus; average $MgCO_3$ 25.90%, HCl insolubles 18.38%. No diagnostic fossils observed, and age of this interval is uncertain; tentatively assigned to Lower Devonian.

7136'-7370' No core.

Sylvan Shale 7370'

SUNRAY DX 1 DAVIS--NW¼SE¼NW¼ sec. 17, T. 5. N., R. 8 E., Hughes County, Oklahoma; elev. 772'; TD 4120' (Simpson); compl. 11/22/62, no Hunton production reported. Tops: Woodford (CC) 3660' (-2888'), Hunton (CC) 3817' (-3045'), Sylvan (CC) 3844' (-3072'); Hunton thickness 27'. Cored 3818'-3842' (all Hunton); 6 thin sections; chemical analyses; OU Core Library.

Woodford Shale 3660'-3817'

Hunton Group 3817'-3844'

3817'-3818' No core.

3818'-3830½' Silurian; Cochrane Formation. Cherty, organo-detrital limestone, parts with substantial glauconite. Dolomite content variable, averaging 6.36% $MgCO_3$. Insoluble content is high (average HCl insolubles 25.52%, but part of this is silicification and part is glauconite. Stromatolite at 3824'. Assigned to Cochrane on basis of lithology and stratigraphic position.

3830½'-3842' Keel Formation. Oolitic and fossiliferous limestone with minor dolomite; $MgCO_3$ averages 6.05%, HCl insolubles 4.46%. Some of oolites appear deformed. Numerous specimens of Brevilamnulella thebesensis (Savage) at 3835'. Assigned to Keel on basis of these fossils, lithology, and stratigraphic position.

3842'-3844' No core.

Sylvan Shale 3844'

SHELL 1-15 DILL--SE¼SW¼NE¼ sec. 15, T. 19 N., R. 10 W., Blaine County, Oklahoma; elev. 1213'; TD 8960' (Hunton); compl. 5/6/65, D&A. Tops: Woodford (CC) 8512' (-7299'), Hunton (core) 8531' (-7318'); Hunton thickness 429' to TD. Cored 8517'-8577' (Woodford-Hunton); 17 thin sections; chemical analyses; 3 porosity-permeability tests (P21-A, B, C); OU Core Library.

Woodford Shale 8512'-8531'

Black shale with 3" of sandstone just above Woodford-Hunton contact (Misener Sandstone).

Hunton Group 8531'-8960' (TD)

8531'-8542' Silurian; Kirkidium biofacies. Strongly dolomitized oolite; individual ooids preserved in crystalline dolomite, much of matrix is void. Excellent porosity: P21-A 16.07%, P21-B 16.87%. Insoluble residues low, mostly about 1.46%; $MgCO_3$ averages 39.20%. This interval fossiliferous with specimens of Kirkidium common;

mostly preserved as internal and external molds.

8542'-8569' *Kirkidium* biofacies. Light-gray crystalline dolomite; MgCO$_3$ averages 36.53%, HCl insolubles 8.76%. Much of this rock is *Kirkidium* coquina (some recognizable pelmatozoan plates) with fossils preserved mostly in spar, a few as molds (pl. 3, fig. 6). Spar may be either calcspar or dolospar, with calcspar commonly filling posterior, thicker part of shale and dolospar thinner parts. *Kirkidium* sp. throughout interval. Porosity generally low; P21-C 0.45% porosity.

8569'-8577' Crystalline dolomite like above; no *Kirkidium* observed.

8577'-8960' (TD) No core.

PAN AMERICAN 1 DROKE UNIT--C NE¼NE¼ sec. 4, T. 18 N., R. 9 W., Kingfisher County, Oklahoma; elev. 1124'; TD 8940' (Sylvan); compl. 6/26/64, no Hunton production reported. Tops: Woodford ?, Hunton (core) 8473' (-7349'), Sylvan (CC) 8916' (-7792'); Hunton thickness 443'. Cored 8177'-8611'; this well obviously cored deeper, as I have examined fossils from a piece of core at 8878'. No thin sections or chemical analyses; core presumably at Pan American.

I have examined only a few fossils from this core, most of my information being supplied by Prof. Gilbert Klapper (letter, 8/21/67).

Woodford Shale Top not reported.

Hunton Group 8473'-8916' (Gilbert Klapper, letter, 8/21/67).

8474' Lower Devonian. Specimen of terebratuloid brachiopod, possibly representative of *Rensselaerina*. I have examined this shell but no other part of core. Since *Kirkidium* specimens are reported to start at 8484', Devonian cannot exceed 11'.

8484'-8574' Silurian; *Kirkidium* biofacies. Klapper (letter, 8/21/67) reported *Kirkidium* as ranging through this interval. I have examined a specimen of core at 8566'-8569' which has *Coelospira saffordi*, a common species in Henryhouse Formation (see Amsden, 1958a, p. 113, text-fig. 28).

8874'-8878' No information available.

8878' Chimneyhill Subgroup, Cochrane Formation. Glauconitic limestone with specimens of *Microcardinalia protriplesiana* (Amsden, 1966, p. 1010).

No information to Sylvan Shale.

Sylvan Shale 8916'

TEXACO 1 DURSCHER--C NW¼SW¼ sec. 2, T. 16 N., R. 8 W., Kingfisher County, Oklahoma; elev. 1171'; TD 9086' (Hunton); compl. 8/23/56, no Hunton production reported. Tops: Woodford (CC) 8788' (-7617'), Hunton (CC) 8830' (-7659'), 256' of Hunton penetrated to TD; cored 8993'-9004' (all Hunton); 1 thin section; no chemical analyses; OU Core Library.

Woodford Shale 8788'-8830'

Hunton Group 8830'-9086' (TD)

8830'-8993' No core.

8993'-9004' ?Silurian; ?Chimneyhill Subgroup. Greenish-gray strongly dolomitized, fossiliferous limestone. No crystalline dolomite texture, but matrix with substantial euhedral crystals of dolomite which corrode fossil boundaries; fossils, mainly pelmatozoan plates, retain their original microtexture. Assigned to Chimneyhill on basis of lithology and stratigraphic position.

9004'-9086' (TD) No core.

GULF 1 DYER--SE¼SW¼NE¼ sec. 20, T. 6 N., R. 3 W., McClain County, Oklahoma; elev. 1194'; TD 11,134' (Oil Creek); compl. 6/14/56, Hunton and Bromide production (perforated 8905'-8907', 8955'-8997'). Tops: Hunton (CC) 8969'? (-7775'?), Sylvan (core) 9334' (-8140'), Viola (CC) 9453' (-8259'); Hunton thickness 363'; cored 8996'-9061', 9220'-9335'; 4 thin sections; no chemical analyses; OU Core Library.

This core was studied by Amsden and Rowland in 1967; subsequently it was re-boxed and core sequence mixed. Data given below taken from 1967 examination, plus electric-log data given on completion card.

Woodford Shale? (Woodford-Hunton contact placed at 8969' on basis of electric-log data supplied in completion card; see discussion above).

Hunton Group 8969'?-9332'

8969'-8996' No core (this is certainly Devonian; presumably all carbonate strata including Bois d'Arc and possibly some Frisco; see discussion above).

8996'-9037' Lower Devonian; Bois d'Arc Formation, Fittstown Member. Medium-gray to pinkish-gray biosparite grading downward into fossiliferous marlstone. Biosparite is low in insoluble detritus and dolomite, whereas marlstone has much detrital quartz and considerable euhedral crystals of dolomite. Some chert present. Upper 10' carries Helderbergian conodonts (Gilbert Klapper, letter, 8/21/67); brachiopods include *Howellella cycloptera*, *Orthostrophia*? sp., *Leptaena acuticuspidata*?, *Dalejina oblata*?. Assigned to Fittstown Member of Bois d'Arc Formation on basis of lithology and fossils.

9037'-9042' No core.

9042'-9061' Lower Devonian; Haragan Formation. Gray fossiliferous marlstone with substantial euhedral crystals of dolomite; much silt-size angular quartz detritus. *Levenea* sp. at 9057'-9058'. Assigned to Haragan Formation on basis of brachiopods and lithologic character.

9061'-9220' No core.

9220'-9290' Lower Devonian and (or) Silurian; Haragan and (or) Henryhouse. Gray fossiliferous and dolomitic marlstone. No fossils observed; lithology and stratigraphic position indicate part of Henryhouse-Haragan sequence.

9290'-9334' Silurian; Chimneyhill Subgroup. Light-gray to pinkish-gray biomicrite, becoming glauconitic downward. Clarita-type conodonts reported by Gilbert Klapper at 9305'; assigned to Chimneyhill on basis of fossils, lithology, and stratigraphic position.

Sylvan Shale 9334'

JONES & PELLOW 1 FARRELL--C NE¼NE¼ sec. 14, T. 15 N., R. 6 W., Kingfisher County, Oklahoma; elev. 1188'; TD 7798' (Hunton); compl. 9/27/66, Hunton production reported (perforated 7755'-7785', 7907'-7918'). Tops: Woodford (CC) 7691' (-6503'), Hunton (CC) 7752' (-6564'); 46' of Hunton to TD; cored 7770'-7823' (Hunton); 5 thin sections; chemical analyses; two porosity tests, P14-A, P14-B.

Woodford Shale 7691'-7752'

Hunton Group 7752'-7798' (TD)

7752'-7770' No core. This interval may include some Lower Devonian.

7770'-7778' Silurian; *Kirkidium* biofacies. Gray dolomitic and fossiliferous limestone with considerable silt-size subangular quartz detritus. Specimen tested for porosity analyzed 30.48% $MgCO_3$ and 10.04% HCl insolubles; this is strongly dolomitized rock, although it is not crystalline dolomite and at least some of fossils retain their original microtexture.

7780'-7794' *Kirkidium* biofacies. Mostly fossiliferous oolite with spar matrix; very low in dolomite and in insolubles ($MgCO_3$ averages 1.74%, insolubles 0.98%). One porosity test, P14-B, 0.35% (bed of organo-detrital limestone). Specimens of *Kirkidium* collected from overlying and underlying units, none from this interval.

7794'-7823' *Kirkidium* biofacies. Gray dolomitic and fossiliferous limestone with considerable detrital quartz ($MgCO_3$ averages 14.70%, insolubles 13.83%). Parts of this rock have substantial organic debris and grade into organic-detrital limestone; in part it appears to have mud-supported fabric of marlstone. Numerous specimens of *Kirkidium* from this interval, deepest from bed at 7812'. Illustration of *Kirkidium*, pl. 10, fig. 4; photomicrographs pl. 11, figs. 3a, 3b.

7823'-7798' (TD) No core.

ASPEN 1-A FEDERAL--N½S½SW¼NE¼ sec. 14, T. 22 N., R. 15 W., Major County, Oklahoma; elev. 1588'; TD 8818' (Sylvan); compl. 3/29/68, D&A. Tops: Woodford (CC) 8368' (-6780'), Hunton (core) 8454' (-6866'), Sylvan (CC) 8809' (-7221'); Hunton thickness 335'. Cored 8445'-8537' (basal Woodford-Hunton); 3 thin sections; chemical analyses; OU Core Library.

Nearest cored well yielding *Kirkidium* is 1-A Jordan Unit, about 8 miles to southeast (see panel 10, section A-A').

Woodford Shale 8368'-8454'

Cored 8445'-8454'

Hunton Group 8454'-8809'

8454'-8537' ?Silurian; ?*Kirkidium* biofacies. Gray crystalline dolomite with nodules of light-colored vitreous chert. Few fossils present, mostly poorly preserved in spar; silicified tetracoral fragment at 8462'. Low in detrital quartz; probably much of insolubles represent silicification (chert). Average $MgCO_3$ 36.80%, insolubles 5.54%. Tentatively assigned to Silurian, *Kirkidium* biofacies, on basis of lithology and stratigraphic position.

TENNECO 1-11 FISHER UNIT--C S½NW¼ sec. 11, T. 20 N., R. 10 W., Major County, Oklahoma; elev. 1154'; TD 8364' (Sylvan); compl. 7/8/70, Hunton production reported (perforated 8172'-8177'). Tops: Woodford (core) 8079' (-6925'), Misener (core) 8127' (-6973'), Hunton (core) 8129' (-6975'), Sylvan (CC) 8315' (-7161'); Hunton thickness 186'. Cored 8124'-8177' (Woodford, ?Misener, Hunton); 4 thin sections; chemical analyses; 3 porosity tests (P3-A, P3-B, P3-C); OU Core Library.

This well is located about 3 miles southeast of Midwest 1 Hughes Unit, which cored *Kirkidium* biofacies.

Woodford Shale 8079'-8127'

Misener Sandstone 8127'-8129'

Dolomitic limestone with much silt-size angular to subangular quartz detritus; 42.62% insoluble detritus and 22.62% $MgCO_3$.

Hunton Group 8129'-8315'

8129'-8177' ?Silurian; ?*Kirkidium* biofacies. Upper 30 feet of this interval is dolomitic, fossiliferous marlstone with about 20% to 30% insoluble detritus and 12% to 18% $MgCO_3$. Lower 18 feet is crystalline dolomite (33% to 40% $MgCO_3$) with much reduced insoluble detritus (2% to 7% insolubles); this interval is porous, with most of pores being produced by dissolution of fossils, mainly crinoid plates. Three porosity tests: P3-A (8136'), P3-B (8157'), and P3-C (8174'); first two are in marlstone lithology and have very low porosity (0.10%), whereas last one is in crystalline dolomite and shows excellent porosity (12.9%). No diagnostic fossils observed, and this interval assigned to Silurian on basis of lithology and stratigraphic position (cf. Midwest 1 Hughes Unit).

Sylvan Shale 8139'-8315'

TENNECO 1 LUCY FISHER--NE¼NE¼ sec. 21. T. 20 N., R. 9 W., Major County, Oklahoma; elev. 1232'; TD 8290' (Sylvan); compl. 1/31/67, D&A. Tops: Woodford (CC) 192'; cored 8088'-8131' (Hunton); 3 thin sections; chemical analyses; OU Core Library.

Woodford Shale 8025'-8080'

Hunton Group 8080'-8272'

8080'-8088' No core.

8088'-8116' Silurian; ?*Kirkidium* biofacies. Gray moderately dolomitic marlstone with chert nodules. Silt-size subangular quartz detritus and mica common (HCl insolubles average 23.15%; some of these insolubles probably represent chert). Dolomite present as euhedral crystals scattered through matrix ($MgCO_3$ averages 13.02%). Fossils common, including shelly debris as well as crinoidal material; fair number of ostracodes and bryozoans. *Halysites* present at 8100'; assigned to Silurian on basis of *Halysites*, lithology, and stratigraphic position.

8116'-8131' Silurian. Medium-gray organo-detrital limestone, partly with micrite, partly with spar cement. Insoluble detritus and dolomite low (HCl insolubles average 8.40%, $MgCO_3$ 4.20%). Fairly sharp break between this unit and overlying one; this could represent Chimneyhill Subgroup, although it would make that subgroup unusually thick (over 150'). No diagnostic fossils observed.

8131'-8272' No core.

Sylvan Shale 8272'

PHILLIPS 1-D FRANKLIN--1050' FSL & 1000' FWL sec. 53, Blk. A-6, H&GN Survey, Gray County, Texas; elev. 2838'; TD 13,594' (Ordovician); compl. 8/12/72, D&A? Tops: Hunton 11,350' (-8512') (no Woodford present; Hunton overlain by Pennsylvanian); Sylvan 12,110' (-9272'); Hunton thickness 760'; cored 11,457'-12,036' (all Hunton); 10 thin sections; no chemical analyses; Phillips Petroleum Company, Bartlesville, Oklahoma (probably to be discarded).

On March 27, 1974, I examined this core at the Phillips core-storage plant in Bartlesville. Mr. Don Dalyrimple, Phillips' carbonate petrologist, was with me and provided information based on thin sections which he had prepared and studied; I also had 10 thin sections prepared in addition to numerous peels of the Microcardinalia protriplesiana. Mr. Dalyrimple also provided me with a drilling-company record of this well, including the porosity tests made about every foot (apparently no chemical analyses are available). Based on my own observations, and including the data from Dalyrimple, this entire core is a low-magnesium, organo-detrital limestone with very little insolubles. I am sure the entire core would average well under 5% $MgCO_3$, and, although there are a few shaly partings, on the whole it probably has less than 5% insoluble detritus. It has a uniformly low porosity, with almost all the tests showing less than 1% porosity.

The only diagnostic fossils observed are in a well-developed bed of brachiopods at a depth of 11,930'-11,932'. These shells show some disarticulation and breakage but also include several well-preserved articulated shells (the anterior end is generally absent owing to solution along a stylolite seam). Two sets of serial sections show excellent internal structure, and these shells can be reliably referred to Microcardinalia protriplesiana Amsden. Stricklandids with this internal structure are confined to late Llandoverian strata insofar as known, and these strata would appear to be reasonably correlated with the Cochrane Formation of the Arbuckle Mountains region and the Blackgum Formation of eastern Oklahoma (Amsden, 1966, p. 1010; 1971b, p. 145). This clearly shows that the Cochrane Formation, and a considerable part of the Chimneyhill strata, are represented by a limestone lithofacies in the 1-D Franklin.

I also borrowed the well samples from the Amarillo Sample Cut and Library. These show that the Hunton strata above the cored interval are in a low-magnesium-limestone lithofacies and that Hunton rocks are overlain by the cherts and clastics here referred to the Pennsylvanian. The lower 50 feet of the Hunton strata just above the Sylvan Shale include considerable dolomite including crystalline dolomite, this being the only bed with any appreciable dolomite in the entire group.

Pennsylvanian strata?

Well samples examined from 11,200'-11,350'. Basal samples include some conglomeratic sandstone with white, chalky chert; most of this interval is a white, chalky chert.

Hunton Group 11,350'-12,110'

11,350'-11,457' ?Silurian; ?Devonian. Well samples. Light-gray to pinkish-gray low-magnesium limestone with some chert.

11,457'-11,930' Core. Light-gray to pinkish-gray organo-detrital limestone with some chert. Thin sections in upper part (3 sections, 11,460'-11,466') show a limestone rich in pelmatozoan plates and bryozoan debris. Largely spar cement; some beds have irregular areas of spar, suggesting solution and filling. This interval, as well as underlying cored interval, is rich in bryozoans and pelmatozoans, and in this respect resembles Quarry Mountain biofacies of eastern Oklahoma. Moreover, there are substantial areas with irregular bodies of spar, again similar to spar-filled cavities of Quarry Mountain and Tenkiller Formations (Amsden and Rowland, 1965, p. 36-37, 50, pls. 8, 9, 10, 11, 15). I am presently making a more detailed study of lithofacies and biofacies of Silurian rocks in Oklahoma and adjacent states and will include 1-D Franklin in this investigation.

11,930'-12,036' Silurian; Chimneyhill Subgroup; Cochrane Formation. Cored interval. Light-gray to pinkish-gray organo-detrital limestone, as above; much shelly debris in upper few feet. Upper 2 feet includes specimens of Microcardinalia protiplesiana Amsden, and on basis of this brachiopod entire interval is referred to Cochrane Formation.

12,036'-12,050' Well samples. Dolomitic limestone and calcareous dolomite with light-colored chert (1 thin section).

12,050'-12,110' Well samples. Gray crystalline dolomite with much white chert; 12,100' to 12,110' may include dolomitized oolites (4 thin sections).

Sylvan Shale 12,110'

SUNRAY DX 1 FRANS--C SW¼NE¼ sec. 3, T. 15 N., R. 16 W., Custer County, Oklahoma; elev. 1846'; TD 14,950' (Sylvan); compl. 1/31/69, D&A. Tops: Woodford (CC) 14,400' (-12,554'), Hunton (CC) 14,504' (-12,658'), Sylvan (CC) 14,947' (-13,101'); Hunton thickness 435'. Cored 14,504'-14,720' (all Hunton); 11 thin sections; chemical analyses; one porosity test (P15-A); OU Core Library. See panel 10, section B-B'.

This is an interesting and significant core because it includes numerous examples of fossils replaced with dolospar and calcspar; see photomicrographs, pl. 5, figs. 1-4; pl. 3, fig. 3; pl. 12, fig. 2.

Woodford Shale 14,400'-14,504'

Hunton Group 14,504'-14,947'

14,504'-14,524' ?Silurian; ?*Kirkidium* biofacies. Crystalline dolomite as below. No diagnostic fossils observed; this could include some Devonian.

14,524'-14,560' Silurian; *Kirkidium* biofacies. Gray crystalline dolomite with numerous specimens of *Kirkidium* sp. (Porosity test P15-A; 0.14% porosity, 0.00 md permeability.)

14,560'-14,720' Silurian; ?*Kirkidium* biofacies. Gray crystalline dolomite; no diagnostic fossils observed.

Entire cored interval (14,504'-14,720') is relatively uniform crystalline dolomite which is low in insoluble detritus; averages 34.64% $MgCO_3$ and 6.56% insolubles (see Chemical Analyses, part III of Appendix). Most of rock shows little visible porosity (P15-A has 0.14% porosity), and fossils, which are abundant in some beds, appear to have been largely filled with spar. However, some visible porosity in hand specimen and thin section is present from 14,622' to 14,648'. Also, small nodules of chert are present throughout, although they are most abundant from 14,650' to 14,722'.

Entire interval is tentatively assigned to *Kirkidium* biofacies, although upper 16' could include some Devonian and part below lowest observed *Kirkidium* specimen (14,560') could include some Chimneyhill.

14,720'-14,947' No core.

Sylvan Shale 14,947'

CLEARY 1-21 GILBERT--SW¼NE¼ sec. 21, T. 17 N., R. 6 W., Kingfisher County, Oklahoma; elev. 1012'; TD 7873' (Sylvan); compl. 2/9/68, no Hunton production reported. Tops: Woodford (CC) 7496' (-6484'), Misener (core) 7545' (-6533'), Hunton (core) 7560' (-6548'), Sylvan (CC) 7816' (-6804'); Hunton thickness 256'. Cored 7542'-7576' (lower Woodford, Misener, and upper Hunton); 2 thin sections; chemical analyses; OU Core Library.

Woodford Shale 7496'-7545'

Misener Sandstone 7545'-7560'

Dark-gray dolomite with much silt-size angular quartz detritus including considerable mica. No fossils observed.

Hunton Group 7560'-7816'

7560'-7576' Silurian; *Kirkidium* biofacies. Gray dolomitic marlstone; $MgCO_3$ averages 23.90%, insolubles 23.64%. Fossils common, including shelly debris and pelmatozoan plates. Specimens of *Kirkidium* sp. at 7560'.

7576'-7816' No core.

Sylvan Shale 7816'

TEXACO 1 GIPSON--NE¼NE¼NW¼ sec. 11, T. 6 S., R. 6 E., Marshall County, Oklahoma; elev. 707'; TD 4190' (Sylvan); compl. 5/31/57, Woodford-Misener production reported. Tops: Woodford (CC) 3565' (-2858'), Misener (CC) 4077' (-3370'), Sylvan (CC) 4125' (-3418'), no Hunton present. Cored 4095'-4117' (Misener); 3 thin sections; no chemical analyses; OU Core Library.

Woodford Shale 3565'-4077'

Misener Sandstone 4077'-4125'

4077'-4095' No core.

4095'-4117' Dark-gray to brown fine-grained dolomitic and glauconitic siltstone. This core described by Walters (1958, p. 19), Maxwell (1959, p. 121), and Amsden, Klapper, and Ormiston (1968, p. 164).

4117'-4125' No core.

Sylvan Shale 4125'

CALIFORNIA 1 GOODELL ET AL.--NW¼NE¼ sec. 33, T. 5 S., R. 2 W., Carter County, Oklahoma; elev. 932'; TD 9975' (Sylvan); compl. 9/27/62, Hunton production reported (perforated 9462'-9464', 9505'-9513'). Tops: Woodford (CC) 9234' (-8302'), Hunton (core) 9462' (-8530'), Sylvan (CC) 9905' (-8973'); Hunton thickness 443'. Cored 9456'-9506' (lower Woodford-upper Hunton); 3 thin sections; chemical analyses; OU Core Library.

Woodford Shale 9234'-9462'

Hunton Group 9462'-9905'

9462'-9480'(?) ?Lower Devonian; ?Haragan Formation. Gray fossiliferous marlstone with moderate detritus and dolomite; HCl insolubles average 10.86%, $MgCO_3$ 7.82%. This interval yields some poorly preserved brachiopods including ?*Sphaerirhynchia lindenensis* and *Atrypa* sp. (9472', 9475', 9480'). The lithology is a typical marlstone texture similar to that of the Haragan-Henryhouse, but the faunal control for assigning it to the Haragan is modest.

9480'-9506' ?Silurian, ?Henryhouse Formation. Gray fossiliferous marlstone similar to above; HCl insolubles average 15.05%, $MgCO_3$ 7.79%. This interval yields a few poorly preserved brachiopods including a brachiopod tentatively identified as *Merista* sp. (9465'). Again, lithology is typical Henryhouse-Haragan marlstone texture, but faunal evidence for assigning it to Henryhouse is modest.

9506'-9905' No core.

Sylvan Shale 9905'

LONE STAR 1 HANNAN UNIT--NE¼ sec. 6, T. 19 N., R. 24 W., Ellis County, Oklahoma; elev. 2498'; TD 14,640' (Viola); compl. 1/21/69, D&A. Tops: Woodford (CC) 14,296' (-11,798'), Hunton (core) 14,342' (-11,844'), Sylvan (CC) 14,522' (-12,024'); Hunton thickness 180'. Cored 14,322'-14,389' (lower Woodford, upper Hunton); 7 thin sections; chemical analyses; 3 porosity tests (P12-A, P12-B, P12-C); OU Core Library.

I tried to locate samples for this well, but apparently they have been lost. Note the presence of relatively large, rounded quartz grains.

Woodford Shale 14,296'-14,342'

Hunton Group 14,342'-14,522'

14,342'-14,384' ?Silurian; ?*Kirkidium* biofacies. Gray crystalline dolomite with nodules of vitreous chert. $MgCO_3$ averages 35.23%. This interval has some subrounded to well-rounded quartz grains up to 0.5 mm (average HCl insolubles 10.92%). Some fracturing (mostly healed) and some brecciation of chert; sample P12-A tested 0.36% porosity. A few specimens of pentamerid, probably *Kirkidium*, at 14,361'; on basis of these

shells, interval assigned to Silurian, although upper 20 feet could be Devonian.
14,384'-14,389' ?Kirkidium biofacies. Fossiliferous, dolomitic limestone with nodules of chert; $MgCO_3$ averages 16.60%, HCl insolubles 13.95%. Some fracturing, mostly healed with spar. Fossils abundant, with shelly debris including trilobites and ostracodes and crinoidal material. Porosity tests P12-B, P12-C, 0.20% and 0.10% porosity. No diagnostic fossils observed; assigned to Kirkidium biofacies on basis of stratigraphic position.
14,389'-14,522' No core.
Sylvan Shale 14,522'

ANADARKO 1-A HAWKINS--SE¼SW¼NE¼ sec. 26, T. 26 N., R. 11 W., Alfalfa County, Oklahoma; elev. 1190'; TD 6200' (Sylvan); compl. 4/14/66, D&A (formerly Ambassador Oil Co.). Tops: Woodford 6110' (-4920'), Hunton 6143' (-4953'), Sylvan 6155' (-4965'); Hunton thickness 12'. Cored 6135'-6160' (Woodford-Hunton-Sylvan); 2 thin sections; chemical analyses; OU Core Library.

This well is located very near northern truncated margin of Hunton.

Woodford Shale 6110'-6143'
About 1 inch of Misener Sandstone at base of Woodford.
Hunton Group 6143'-6155'
6143'-6155' Silurian-Chimneyhill Subgroup-?Cochrane Formation. Glauconitic organo-detrital dolomitic limestone with some pink crinoidal beds ($MgCO_3$ averages 18.79%, insoluble detritus 1.31%). Referred to Cochrane Formation, Chimneyhill Subgroup, on basis of lithologic character and stratigraphic position.
Sylvan Shale 6155'
Upper foot or so is green dolomitic siltstone.

PARKER 1 HENSLEY--C NE¼SW¼ sec. 21, T. 23 N., R. 18 W., Woodward County, Oklahoma; elev. 1968'; TD 9266' (Sylvan); compl. 10/20/60, D&A. Tops: Woodford (CC) 8958' (-6990'), Hunton (CC) 8959' (-6991'), Sylvan (CC) 9219' (-7251'); Hunton thickness 260'. Cored 8966'-9000', 9009'-9040' (all Hunton); no thin sections; chemical analyses; OU Core Library.

No diagnostic fossils obtained from this core, but these strata are tentatively correlated with Kirkidium biofacies on basis of their stratigraphic position; cf. to Getty 1-B Coffman and Tenneco 1-A Jordan Unit.

Woodford Shale 8958'
Hunton Group 8959'-9219'
8959'-8966' No core.
8966'-9000' ?Silurian. Gray crystalline dolomite with some fossils; chert in upper 10' ($MgCO_3$ averages 35.62%, HCl insolubles 7.59%). No diagnostic fossils observed; assigned to Silurian on basis of stratigraphic position.
9000'-9009' No core.
9009'-9040' Light-gray dolomitic limestone with a few small chert nodules ($MgCO_3$ averages 12.83%, HCl insolubles 3.35%).
9040'-9219' No core.
Sylvan Shale 9219'

CARTER 1 HESTER--SW¼SE¼ sec. 27, T. 5 N., R. 3 W., McClain County, Oklahoma; elev. 1036'; TD 7799' (Sylvan); compl. 7/28/60, no Hunton production reported. Tops: Hunton (CC) 7451' (-6415'), Sylvan (CC) 7784'(-6748'); Hunton thickness 333'. Cored 7770'-7783.3' (all Hunton); 4 thin sections; chemical analyses; OU Core Library.

Lithology and lithostratigraphic sequence is typical for Clarita-Cochrane section of Chimneyhill (no Keel observed); Cochrane fossil Triplesia alata Ulrich and Cooper collected at 7777'.

Woodford Shale Top not determined.
Hunton Group 7451'-7784'
7451'-7770' No core.
7770'-7775' Silurian; Chimneyhill Subgroup; Clarita Formation. Gray organo-detrital limestone with micrite cement; numerous pink crinoid plates. Formic residues with inarticulate brachiopods and conodonts. Assigned to Clarita Formation on basis of lithologic character and stratigraphic position.
7775'-7783.3' Chimneyhill Subgroup; Cochrane Formation. Pale-gray organo-detrital limestone, mainly spar cement; much glauconite. Triplesia alata at 7777'. Assigned to Cochrane on basis of fossils, lithologic character, and stratigraphic position.

Note: all of cored interval is low-magnesium limestone; $MgCO_3$ averages 2.54%, HCl insolubles 6.51%. Core did not cut Sylvan, but reported tops indicate that it must have been very near.

Sylvan Shale 7784'

ANADARKO 1 HILPERT--C SE¼SW¼ sec. 2, T. 14 N., R. 4 W., Oklahoma County, Oklahoma; elev. 1071'; TD 6700' (Sylvan); compl. 9/6/66, Hunton production reported (perforated 6782'-6790', 6795'-6800'). Tops: Woodford (CC) 6366' (-5295'), Hunton (CC) 6387' (-5316'), Sylvan (CC) 6661' (-5590'); Hunton thickness 274'. Cored 6581'-6587.8', 6595'-6601', 6641.3'-6646', 6650'-6656' (all Hunton); 2 thin sections; chemical analyses; OU Core Library.

Cored portion of this well is low-magnesium limestone showing substantial solution and some visual porosity.

Woodford Shale 6366'-6387'
Hunton Group 6387'-6661'
6387'-6581' No core. This interval may include some Lower Devonian in upper part (see pre-Woodford subcrop map, panel 9).
6581'-6587.8' Silurian; Chimneyhill Subgroup. Gray to pinkish-gray organo-detrital limestone with numerous pink crinoid plates; mostly micrite cement. Formic residues with conodonts. No diagnostic fossils observed; referred to Chimneyhill on basis of lithologic character and stratigraphic position (it has typical Clarita lithology).
6587.8'-6596' No core.
6595'-6601' Organo-detrital limestone like above.

6601'-6641.3' No core.
6641.3'-6646' Organo-detrital limestone with pink crinoid plates; similar to overlying cored strata.
6646'-6650' No core.
6650'-6656' Gray to pinkish-gray organo-detrital limestone; micrite cement, numerous pink crinoids. Similar to overlying cored strata.

Note: All of above cored strata are organo-detrital micrites with very little dolomite or HCl insolubles ($MgCO_3$ averages 2.58%, HCl insolubles 3.225%); it is typical Clarita lithology with very little glauconite.

6656'-6661' No core.
Sylvan Shale 6661'

GLOVER HEFNER KENNEDY 1-1 HOFFMAN--NE¼NE¼NE¼ sec. 1, T. 14 N., R. 16 W., Custer County, Oklahoma; elev. 1711'; TD 14,880' (Viola); compl. 2/27/69, D&A. Tops: Hunton (core) 14,267' (-12,556'), Sylvan (CC) 14,824' (-13,113'); Hunton thickness 557'. Cored 14,250'-14,349' (Woodford-Hunton); 2 thin sections; chemical analyses; porosity-permeability test (P16-A); OU Core Library.

No specimens of Kirkidium recovered from upper 14' of Hunton, and this interval could include some Lower Devonian; however, it is tentatively referred to Kirkidium biofacies because of its lithologic similarity to underlying strata, which bear Kirkidium. Cored strata have a relatively high insoluble content (average 16.52%), possibly reflecting proximity of this well to basinal marlstone lithofacies (see panel 2). Kirkidium sp. ranges through at least 70' of this core.

Woodford Shale Top not available.
Hunton Group 14,267'-14,824'
14,267'-14,281' ?Silurian; ?Kirkidium biofacies. Gray crystalline dolomite. No diagnostic fossils observed, and this interval assigned to Kirkidium biofacies on basis of stratigraphic position and lithologic character (immediately underlain by crystalline dolomites with Kirkidium sp. This interval has 35%-36% $MgCO_3$ and 9% HCl insolubles. One porosity test (P16-A) shows 0.32% porosity and 0.00 md permeability.
14,281'-14,319' Silurian; Kirkidium biofacies. Photomicrograph, pl. 13, fig. 5. Gray crystalline dolomite; $MgCO_3$ averages 33.01%, HCl insolubles 15.37%. Specimens of Kirkidium at 14,281' and 14,293'.
14,319'-14,349' Gray calcareous dolomite and dolomitic limestone with many specimens of Kirkidium sp. This interval averages 21.24% $MgCO_3$ and 18.25% HCl-insoluble residues.
14,349'-14,824' No core.
Sylvan Shale 14,824'

GULF 1 HOLTZSCHUE--NW¼NW¼SW¼ sec. 8, T. 12 N., R. 2 W., Oklahoma County, Oklahoma; elev. 1143'; TD 6505' (Hunton); compl. 11/6/49, Hunton production reported (perforated 6442'-6478'). Tops: Misener (core) 6431' (-5288'), Hunton 6447' (-5304') (TD in Hunton). Cored 5687'-5746', 6342'-6506' (latter Woodford-Misener-Hunton); 7 thin sections; chemical analyses; OU Core Library.

Silurian-Devonian boundary can be precisely located in this well; specimens of Kirkidium are present within 3' of strata with Frisco brachiopods. Undoubtedly some, if not all, Hunton production is from Lower Devonian Frisco Formation (probably some also from overlying Misener Sandstone).

Woodford Shale Top not available.

Misener Sandstone 6431'-6447'
Light-colored sandstone with some shaly beds.
Hunton Group 6447'-6505' (TD)
6447'-6479' Lower Devonian; Frisco Formation. Light-gray organo-detrital limestone, mostly with spar cement; very low in dolomite and insoluble residues ($MgCO_3$ averages 0.91%; HCl insolubles 2.10%). Oolitic beds in lower part (photomicrograph, pl. 2, fig. 6). This interval fossiliferous, yielding specimens of Costispirifer arenosus, Leptostrophia magnifica, Rensselaeria cf. R. elongata, Meristella vascularia?, Strophonella sp., Trachypora sp. (fossils at 6455', 6462', 6468', 6470', 6474', 6479'). Assigned to Frisco Formation on basis of these fossils. Sharp lithologic break between low-magnesium, low-insoluble limestones of Frisco and underlying Kirkidium biofacies with substantially increased dolomite and insoluble detritus (see text-fig. 20).
6479'-6505' Silurian; Kirkidium biofacies. Gray organo-detrital limestone with much subangular silt-size quartz detritus (HCl insolubles average 15.48%). Micrite cement with euhedral crystals of dolomite ($MgCO_3$ averages 14.12%). Probably largely a grain-supported (fossil-clast) texture. Specimens of Kirkidium recovered at 6482'-6486', 6496'.
TD 6505'

SINCLAIR 1 HORLIVY--C SW¼SW¼ sec. 19, T. 11 N., R. 5 W., Canadian County, Oklahoma; elev. 1387'; TD 9792' (Simpson Group); compl. 4/1/65, D&A. Tops: Woodford (CC) 8680' (-7293'), Hunton (CC) 8764' (-7377'), Sylvan 9171' (-7784'); Hunton thickness 407'. Cored 8780'-8839' (all Hunton); 4 thin sections; chemical analyses; OU Core Library.

Well-defined lithostratigraphic contact at 8837' between low-magnesium, low-insoluble organo-detrital limestones of Frisco Formation and an underlying unit with substantially increased insoluble detritus (7.06%) and some increase in $MgCO_3$ (3.33%). Lower strata are tentatively assigned to Fittstown Member of the Bois d'Arc Formation, but there are no faunal data to support this; quite possibly this lower unit represents Kirkidium biofacies or even silty bed in Frisco, although all of known Frisco Limestone in this region has 95% or more $CaCO_3$ (text-fig. 32).

Woodford Shale 8680'-8764'

Hunton Group 8764'-9171'

8764'-8780' No core.

8780'-8837' Lower Devonian; Frisco Formation. Light-gray organo-detrital limestone with spar and micrite cement; very low in dolomite and insolubles ($MgCO_3$ averages 1.13%, HCl insolubles 0.70%). Photomicrographs, pl. 1, fig. 4a, pl. 2, fig. 2. Fossils at 8781', 8802', 8813', 8820', 8828'; include *Costispirifer arenosus* and *Rensselaeria* sp. Sharp lithologic break with underlying unit.

8837'-8839' ?Lower Devonian; ?Fittstown Member, Bois d'Arc Formation. Silty, organo-detrital limestone with micrite cement; 7.06% HCl insolubles, 3.33% $MgCO_3$. No diagnostic fossils observed, and reference of these strata to Bois d'Arc is uncertain (see remarks above).

8839'-9171' No core.

Sylvan Shale 9171'

MOBIL 1 HORTON--C SE¼NW¼ sec. 14, T. 15 N., R. 15 W., Custer County, Oklahoma; elev. 1783'; TD 14,869' (Ord.); compl. 5/18/61, no Hunton production reported. Tops: Woodford (CC) 14,143' (-12,360'), Hunton (CC) 14,242' (-12,459'), Sylvan (CC) 14,769' (-12,986'); Hunton thickness 527'. Cored 14,262'-14,280', 14,290'-14,358', 14,370'-14,592', 14,599'-14,610', 14,629'-14,642', 14,660'-14,672', 14,682'-14,753' (all Hunton); 15 thin sections; 2 porosity tests (P1-A, P1-B); chemical analyses; OU Core Library.

Upper 280' of Hunton, including *Kirkidium*-bearing strata, is high in insoluble detritus (averaging about 17%), probably reflecting proximity of this well to marlstone lithofacies in deep basin (see panels 2, 10). Hunton strata in 1 Horton presumably include some Chimneyhill equivalents; however, there is no biostratigraphic information bearing on this. There is a fairly sharp reduction in insoluble detritus at 14,530', and possibly this represents *Kirkidium* biofacies-Chimneyhill boundary.

Woodford Shale 14,143'-14,242'

Hunton Group 14,242'-14,769'

14,242'-14,262' No core.

14,262'-14,280' Silurian; *Kirkidium* biofacies. Dark-gray fossiliferous limestone with much silt-size subangular quartz detritus (HCl insolubles range up to 18%). This interval is dolomitized, $MgCO_3$ averaging about 17%; dolomite is present as euhedral crystals in matrix which impinge on and corrode fossil boundaries in some places. Fossils retain their original microtexture. *Kirkidium* sp. observed from 14,267'-14,280'; this interval also has numerous corals, including *Heliolites* sp. and *Enterolasma waynense* (identified by P. K. Sutherland). Pelmatozoan plates are abundant. Porosity test P1-A at 14,265'; 0.00% porosity, 0.00 md permeability.

14,280'-14,290' No core.

14,290'-14,358' *Kirkidium* biofacies. Dark-gray fossiliferous, dolomitized limestone. Much silt-size subangular quartz detritus; insolubles average 12.36%. This ranges from dolomitized limestone into calcitic dolomite (photomicrograph, pl. 6, fig. 1), locally grading into crystalline dolomite (14,310'-14,320') with fossils replaced by spar (photomicrograph, pl. 4, figs. 3a, 3b). Porosity test P1-B at 14,315'; 0.00% porosity, 0.00 md permeability (this is crystalline-dolomite facies, but fossils are replaced by spar). Specimens of *Kirkidium* collected from 14,290' to 14,340'. Also specimens of *Halysites* sp. at 14,344' and 14,352'. This is brachiopod-crinoid-coral biofacies similar to unit above.

14,358'-14,370' No core.

14,370'-14,530' *Kirkidium* biofacies. Dark-gray fossiliferous, dolomitic limestone with much silt-size subangular quartz detritus; HCl insolubles average about 20%. This interval is primarily dolomitized limestone averaging about 10% $MgCO_3$; dolomite is represented largely by euhedral crystals scattered through matrix, in places abundant enough to impinge against and corrode fossils. This interval and overlying beds are mainly fossiliferous marlstone, at some places grading into grain-supported (fossil-clast) texture. Fossils include shelly debris, brachiopods, bryozoans, ostracodes, corals, and much pelmatozoan debris. Specimens of *Kirkidium* observed only at 14,375', remainder of this interval being referred to this biofacies on basis of lithologic similarity and stratigraphic position.

14,530'-14,642' ?Chimneyhill Subgroup. Gray organo-detrital limestone, low in insoluble detritus and low in in dolomite; averages 6.29% $MgCO_3$, 7.34% HCl insolubles. No diagnostic fossils observed, and age of these strata uncertain. (Note two core skips; 14,592'-14,599'; 14,610'-14,629'.)

14,642'-14,682' 8' of core recovered; no analysis.

14,682'-14,753' ?Chimneyhill Subgroup. Dark-gray fossiliferous, cherty limestone, probably mostly grain supported. Insoluble residues are high (24.61%), but this interval includes much chert and in all probability insolubles, in large part, represent silicification. Dolomite is relatively low, averaging 10.45% $MgCO_3$. No diagnostic fossils observed, and this interval is assigned to Chimneyhill on basis of its stratigraphic position.

14,753'-14,769' No core.

Sylvan Shale 14,769'

PAYNE 1 HOUCK--SE¼NE¼ sec. 36, T. 17 N., R. 5 W., Kingfisher County, Oklahoma; elev. 1069'; TD 7150' (?Sylvan); compl. 4/28/66, no Hunton production reported (perforated Woodford-Hunton 6900'-7020'). Tops: Woodford (CC) 6868' (-5799'), Hunton (CC) 6941' (-5872'), Sylvan (CC) 7100' (-6031'); Hunton thickness 159. Cored 7000'-7040', 7050'-7099' (all Hunton).

Entire cored interval is tentatively referred to Chimneyhill, although diagnostic fossils have not been observed in upper 40 feet. This upper core has considerable insoluble detritus, averaging 9.40% with some beds ranging up to 16.36%; it could represent intermediate marlstone lithofacies of Kirkidium-Henryhouse strata, although general lithologic characteristics and thickness suggest Chimneyhill Subgroup.

Woodford Shale 6868'-6941'
Hunton Group 6941'-7100'
6941'-7000' No core.
7000'-7040' Silurian; ?Chimneyhill Subgroup. Light-gray biomicrite with irregular bands that are, at least in part, shale-silt partings. Fossils include much shelly debris, including brachiopods, ostracodes, bryozoans, and many pelmatozoan plates, some of which are pink. Matrix is almost entirely micrite with only a few euhedral crystals of dolomite ($MgCO_3$ ranges from 1.82% to 4.17%); a fair amount of silt-size subangular to angular quartz detritus (insoluble ranges from 4.82% to 16.35%). This interval tentatively referred to Chimneyhill on basis of its lithology and stratigraphic position.
7040'-7050' No core.
7050'-7099' Silurian; Chimneyhill Subgroup. Light-gray biomicrite with many pink crinoid plates. In addition to crinoidal material there is much shelly debris, including substantial number of ostracodes. This interval has some silt-size quartz detritus like above, HCl insolubles ranging from 2.84% to 10.72%; dolomite content is low, all analyses testing less than 7%, and generally present as irregular bodies of moderately concentrated dolomite crystals. Brachiopod tentatively identified as Kozlowskiellina vaningeni (Thomas) was found at 7057'; this is Clarita-type series, and at least upper part of interval is considered correlative with that formation. Lower part of cored interval may include Cochrane correlatives.

Entire cored interval averages 3.65% $MgCO_3$ and 7.85% HCl-insoluble residues.

MIDWEST 1 HUGHES UNIT--C SW¼NE¼ sec. 4, T. 20 N., R. 10 W., Major County, Oklahoma; elev. 1158'; TD 8272' (Sylvan); compl. 7/12/68, no Hunton production reported. Tops: Woodford (CC) 7982' (-6824'), Hunton (CC) 8020' (-6862'), Sylvan (CC) 8261' (-7103'); Hunton thickness 241'. Cored 8062'-8158' (all Hunton); 4 thin sections; chemical analyses; porosity-permeability test P18-A; OU Core Library.

This is interesting core because it is only one studied by me which includes both Kirkidium and Chimneyhill fossils (Eospirifer acutolineatus acutolineatus Amsden=Clarita Formation; see discussion in text of Chimneyhill Subgroup). Kirkidium brachiopods occur at 8073', and Chimneyhill brachiopods at 8142' and 8153'; thus they are separated by 69' of strata with no diagnostic fossils. There is no really well-defined lithostratigraphic boundary in interval separating these fossils, although there is break between upper marlstones and underlying light-colored organo-detrital limestones. This break is tentatively used as Kirkidium-Chimneyhill boundary, but it should be noted that lower 10' of marlstone sequence has reduced insoluble detritus, becoming increasingly fossiliferous and grading toward underlying limestones. Moreover, lower part of Chimneyhill becomes marly and resembles upper marlstones.

Woodford Shale 7982'-8020'
Hunton Group 8020'-8261'
8020'-8262' No core.
8062'-8092½' Silurian; Kirkidium biofacies. Gray fossiliferous marlstone, probably largely if not entirely mud supported; considerable silt-size quartz detritus and euhedral dolomite crystals. Lower part of this interval has reduced insolubles and is increasingly fossiliferous; upper 20' with 19.82% HCl insolubles, lower part with 11.18%; $MgCO_3$ averages about 8%. Specimens of Kirkidium at 8073'. Entire interval assigned to Silurian on basis of these fossils, although upper part could include some Devonian and lower part some Chimneyhill.
8092½'-8112' ?Chimneyhill Subgroup. Light-colored organo-detrital limestone. Boundary with underlying unit is not sharply defined, being marked mainly by increase in dolomite, from about 6% $MgCO_3$ to about 14%. No diagnostic fossils observed, and this interval assigned to Chimneyhill on basis of lithologic character and stratigraphic position.
8112'-8122' Similar to above, but with increased dolomite. No diagnostic fossils observed.
8122'-8158' Similar to above in dolomite content, but becoming more marly; probably in large part mud-supported fabric similar to 8062'-8092½' interval above. Specimens of Eospirifer acutolineatus acutolineatus Amsden at 8142' and 8151', and Resserella sp. at 8151' (similar to Resserella sp., Amsden, 1968, pl. 3, figs. 5a-5h).
8158'-8261' No core.
Sylvan Shale 8261'

TENNECO 1 HUNTZINGER--C NE¼ sec. 24, T. 27 N., R. 21 W., Harper County, Oklahoma; elev. 1840'; TD 7500' (Viola); compl. 7/5/68, D&A. Tops: Hunton (CC) 7335' (-5495'), Sylvan (core) 7337' (-5497'); Hunton thickness 2'. Cored 7335'-7360' (Hunton-Sylvan); 1 thin section; no analyses; OU Core Library.

Well located very near truncated margin of Hunton Group.

Woodford Shale Top not available.
Hunton Group 7335'-7337'
7335'-7337' Silurian; Chimneyhill Subgroup. Light-gray to pinkish-gray organo-detrital sparite; mostly pelmatozoan limestone. Low in dolomite and insoluble detritus. Appears to have considerable solution and some recrystallization. Assigned to Chimneyhill on basis of stratigraphic position and lithology.
Sylvan Shale 7337'
7337'-7360' Cored; green shale.

TIDEWATER 1 JOHNSON--NE¼NE¼SE¼ sec. 19, T. 3 N., R. 23 W., Jackson County, Oklahoma; elev. 1487'; compl. 1/31/50, D&A; TD 8032' (Arbuckle). Tops: Hunton (?core) 7514' (-6027'), Ordovician (core) 7534'? (-6037'), Hunton thickness 20'?. Cored 7514'-7565' (Hunton-Ordovician); chemical analyses; OU Core Library.

This well, located in the Hollis basin, is the only well in this area known to me in which Hunton rocks have been positively identified. A description of this well is given by Jordan (1965, p. 20-27), including a lithologic description of Hunton rocks by W. E. Ham. The Hunton is believed to be overlain by Mississippian strata, no Woodford being recognized in this area. The upper 20' of the cored portion yields Lower Devonian, Frisco, brachiopods, and these strata are believed to rest directly on Late Ordovician limestone, possibly the "Fernvale" (Jordan, 1965, p. 22). The Frisco here, as elsewhere in Oklahoma, is a low-magnesium limestone (text-fig. 32).

Mississippian?

Hunton Group 7514'?-7534'

7514'-7534' Lower Devonian; Frisco Formation. Light-gray organo-detrital limestone; mostly spar cement, but includes some micrite. Fossils include much shelly debris, brachiopods, bryozoans, trilobites, and corals as well as considerable crinoidal material. Insoluble detritus and dolomite low, 5.16% $MgCO_3$ and 0.54% HCl insolubles. Fossils from this interval include *Rensselaeria* cf. *R. elongata* (Conrad) (similar to Frisco specimens), *Costellirostra* sp., *Meristella* sp., *Atrypa* sp. Earlier G. Arthur Cooper, U.S. National Museum, examined this fauna and assigned it an Oriskanian (Deerparkian) age, a correlation with which I agree.

Ordovician 7534'?

Organo-detrital micrite with many crinoid plates and including brachiopods, trilobites, and other shelly debris. On basis of a strongly biconvex rafinesquinoid brachiopod, G. Arthur Cooper suggested this represents Late Ordovician age ("Fernvale") (Jordan, 1965, p. 22).

MOBIL 1 JONES UNIT--200' S C NE¼ sec. 21, T. 15 N., R. 16 W., Custer County, Oklahoma; elev. 1873'; TD 15,003' (Sylvan); compl. 8/29/63, Hunton production (perforations through most of interval 14,490'-14,930'). Tops: Woodford (CC) 14,384' (-12,511'), Hunton (CC) 14,481' (-12,608'), Sylvan (CC) 14,947' (-13,074'); Hunton thickness 466'. Cored 14,503'-14,613' (all Hunton); chemical analyses; OU Core Library.

Specimens of *Kirkidium* were observed at 14,521', 40' below Woodford. All of upper Hunton strata are referred to Silurian; however, this upper 40' could include some Lower Devonian. This well, like most of others in area, has substantial insolubles, undoubtedly reflecting proximity to marlstone lithofacies in deep basin.

Woodford Shale 14,384'-14,481'

Hunton Group 14,481'-14,947'

14,481'-14,503' No core.

14,503'-14,613' Silurian; *Kirkidium* biofacies. Gray crystalline dolomite with substantial insoluble material; $MgCO_3$ averages 33.85%, HCl insolubles 16.02%. Specimens of *Kirkidium* at 14,521' and questionably at 14,584'. All of interval referred to *Kirkidium* biofacies on basis of these shells, plus stratigraphic position and lithologic character.

14,613'-14,947' No core.

Sylvan Shale 14,947'

TENNECO 1-A JORDAN UNIT--SW¼NE¼ sec. 3 ("twin"), T. 21 N., R. 14 W., Major County, Oklahoma; elev. 1489'; TD 8927' (Sylvan); compl. 9/1/67, Hunton production reported (perforated 8499'-8504'). Tops: Woodford (CC) 8424' (-6935'), Hunton (core) 8489' (-7000'), Sylvan (CC) 8910' (-7421'); Hunton thickness 421'. Cored 8471'-8614' (lower Woodford, Hunton); 2 thin sections; chemical analyses; 2 porosity tests, P2-A (8501') and P2-B (8523').

Upper part of Hunton is represented by crystalline dolomite lithofacies and has excellent porosity.

Woodford Shale 8424'-8489'

Hunton Group 8489'-8910'

8489'-8509' ?Silurian; ?*Kirkidium* biofacies. Gray porous crystalline dolomite with little or no chert; $MgCO_3$ averages 40.01%, HCl insolubles 8.73%. No diagnostic fossils observed, and this interval referred to *Kirkidium* biofacies because of its lithologic similarity to underlying strata; may include some Lower Devonian. Porosity test P2-A at 8501'; 18.49% porosity, 154.31 md permeability.

8509'-8551' Silurian; *Kirkidium* biofacies. Gray cherty, porous crystalline dolomite; $MgCO_3$ averages 39.94%, HCl insolubles 9.67%. Specimens of *Kirkidium* at 8522'; entire interval referred to this biofacies on basis of these fossils, plus lithologic similarity and stratigraphic position. Porosity test P2-B at 8523'; 15.63% porosity, 7.27 md permeability.

8551'-8581' Cherty crystalline dolomite like above; $MgCO_3$ averages 34.31%, HCl insolubles 11.96%. No diagnostic fossil observed.

8581'-8614' Cherty, fossiliferous, dolomitic limestone; $MgCO_3$ averages 14.53%, HCl insolubles 6.53%. Corals *Tryplasma* cf. *T. radiculum* and *Enterolasma* sp. at 8593' (identified by P. K. Sutherland); *Halysites* sp. at 8594'.

8614'-8910' No core.

Sylvan Shale 8910'

TENNECO 1-34 JORDAN--NW¼SW¼SE¼ sec. 34, T. 22 N., R. 14 W., Major County, Oklahoma; elev. 1452'; TD 8930'; compl. 10/18/68, Hunton production reported. Tops: No electric-log tops available. Cored 8454'-8466'; no analyses or thin sections; OU Core Library.

Compare to 1-A Jordan Unit.

Hunton Group

8454'-8466' Gray crystalline dolomite with nodules of vitreous chert.

TENNECO 2-34 JORDAN UNIT--SE¼NE¼SW¼ sec. 34, T. 22 N., R. 14 W., Major County, Oklahoma; elev. 1480'; compl. 10/18/68, Hunton production reported. Tops: no electric-log tops available. Cored 8464'-8570'; two thin sections; chemical analyses; two porosity tests (P4-A, P4-B); OU Core Library.

This core probably, at least in part, in *Kirkidium* biofacies; cf. to 1-A Jordan Unit, located a short distance south of 2-34 Jordan Unit.

Hunton Group

8464'-8514' ?Silurian. Gray crystalline dolomite with many nodules of vitreous chert; $MgCO_3$ averages 34.26%, HCl insolubles 13.44%. Chert probably accounts for at least part of relatively high insolubles. Porosity test P4-A at 8477'; 2.5% porosity, 0.00 md permeability.

8514'-8540' Gray crystalline dolomite with less vitreous chert than overlying unit; $MgCO_3$ averages 35.75%, HCl insolubles 7.85%.

8540'-8570' Gray porous, crystalline dolomite with very little chert; $MgCO_3$ averages 41.20%, HCl insolubles 4.14%. Porosity test P4-B at 8562'; 19.0% porosity, 70.24% md permeability.

CLEARY 1-20 KINNEY--SW¼NE¼ sec. 20, T. 25 N., R. 21 W., Harper County, Oklahoma; elev. 2139'; compl. 4/5/68, D&A. Tops: Hunton (CC) 8720' (-6581'), Sylvan (CC) 8802' (-6663'); Hunton thickness 82'. Cored 8721'-8760' (all Hunton); 3 thin sections; chemical analyses; OU Core Library.

Well is located near truncated northwestern margin of Hunton Group.

Woodford Shale

Hunton Group 8720'-8802'

8720'-8721' No core.

8721'-8730' Silurian; Chimneyhill Subgroup. Pale-gray organo-detrital limestone, which appears brecciated. Angular "fragments" appear to be mostly dolomitic; this texture may be result of solution near Woodford contact. $MgCO_3$ averages 7.36%, HCl insolubles 7.92%. No diagnostic fossils observed; referred to Chimneyhill on basis of lithology and stratigraphic position.

8730'-8760' Chimneyhill Subgroup. Upper part of this interval is pale-gray organo-detrital micrite with much glauconite; some shelly debris, but mostly pelmatozoan plates. Lower part is pinkish-gray crinoidal limestone; mostly pelmatozoan plates set in a spar matrix. Some irregular patches of dolomite, but most of rock is very low-magnesium limestone; $MgCO_3$ averages 1.09%, HCl insolubles 1.19%. No diagnostic fossils observed, and this unit referred to Chimneyhill on basis of lithology and stratigraphic position.

8760'-8802' No core.

Sylvan Shale 8802'

CLEARY 1-24 KRAMP-COBB--C W½NW¼NW¼ sec. 24, T. 19 N., R. 10 W., Blaine County, Oklahoma; elev. 1191'; TD 8570' (Hunton); compl. 5/17/66, Hunton production reported. Tops: Woodford (CC) 8464' (-7273'), Hunton (CC) 8488' (-7297'); 82' of Hunton to TD. Cored 8495'-8532' (all Hunton); 6 thin sections; chemical analyses; 2 porosity tests (P9-A, P9-B); OU Core Library.

Excellent example of fossiliferous, strongly dolomitized oolite (pl. 3, fig. 3; pl. 4, figs. 2a, 2b).

Woodford Shale 8464'-8488'

Hunton Group 8488'-8570' (TD)

8488'-8495' No core.

8495'-8512' Silurian; *Kirkidium* biofacies. Gray fossiliferous, porous dolomitized oolite (pl. 3, fig. 3; pl. 4, figs. 2a, 2b); $MgCO_3$ averages 44.35%, HCl insolubles 0.92%. Porosity test P9-A at 8512'; porosity 13.6%, permeability 174.89 md. Specimens of *Kirkidium* 8505'-8508'.

8512'-8515' No core.

8515'-8532' *Kirkidium* biofacies. Gray fossiliferous, crystalline dolomite; $MgCO_3$ averages 37.14%, HCl insolubles 8.08%. Porosity test P9-B, 8515'; porosity 0.16%, 0.00 md permeability. Numerous specimens of *Kirkidium* from 8515' to 8528'.

8532'-8570' No core.

TD 8570'

SMITH BROTHERS 1 KYTLE-RAY--SW½NE¼NW¼ sec. 36, T. 8 N., R. 2 E., Pottawatomie County, Oklahoma; elev. 971'; TD 5490'; compl. 11/9/47, D&A. Top: Hunton (CC) 4830' (-3859'). Cored interval unknown, only one piece of fossiliferous core examined (4930'); chemical analyses; OU collections.

This fragment of Frisco core yields an excellent specimen of *Rensselaeria* sp. (Amsden and Huffman, 1958, p. 74; Amsden and Ventress, 1963, pl. 7, figs. 19-20).

Woodford Shale

Hunton Group 4830'

4930' Lower Devonian; Frisco Formation. Organo-detrital sparite, most of fossil debris being crinoidal material; $MgCO_3$ 1.44%, HCl insolubles 1.09% (insolubles incorrectly reported by Amsden and Huffman, 1958, p. 74, as 30%). This includes large specimen of *Rensselaeria* mentioned above, a characteristic Frisco brachiopod.

PHILLIPS 1-C LEE--1980' F S & EL, sec. 80, Blk. M-1, H&GN Survey, Wheeler County, Texas; elev. 2773'; TD 17,098'; compl. 9/14/64; Woodford-Hunton contact 14,973' (-12,200') (samples), Hunton-Sylvan contact 15,330' (-12,557') (samples); Hunton thickness 357'. Core from this well (14,980' to 15,100') was examined by T. L. Rowland and me at Phillips warehouse, Bartlesville, Oklahoma, in 1967. Several samples were taken, and 4 oversize thin sections were prepared; 5 specimens were chemically analyzed in interval from 14,993' to 15,100' (average HCl-insoluble residue, 1.54%; average $MgCO_3$ content, 2.61%; see part III of Appendix). In 1973 I borrowed 1-C Lee samples from Phillips, examining these from 15,100' to 15,350'; these consist of core chips from 15,100' to 15,240', a skip from 15,240' to 15,260', and well cuttings below this point; sample quality good. Thirteen thin sections were prepared from core chips (15,100' to 15,240'), and 6 from samples (15,260' to 15,330'). See panel 10, section B-B'.

Woodford Shale
Hunton Group
14,975'-15,101' Silurian; Kirkidium biofacies. Light-gray organo-detrital biosparite. This limestone is very low in insolubles and in dolomite. Numerous specimens of Kirkidium sp. are present throughout interval, also corals and other groups. Considerable recrystallization and solution, but little evidence of porosity.
15,102'-15,330' (photomicrographs, pl. 2, figs. 1a, 1b) ?Chimneyhill Subgroup. Crystalline dolomite with some angular quartz detritus up to 0.30 mm. Chert is present, and thin sections commonly show minor evidence of silicification. Rock appears to have good porosity. Basal samples, from 15,300' to 15,330', are dolomitized oolite, showing porosity around oolites; ?Keel Formation (photomicrographs, pl. 12, fig. 6). Interval appears to include some Chimneyhill correlatives, but position of Kirkidium-Chimneyhill contact is uncertain.
Sylvan Shale 15,300'

APCO 1 LEON--NE¼SW¼SW¼ sec. 9, T. 8 N., R. 2 W., Cleveland County, Oklahoma; elev. 1168'; TD 8807' (Arbuckle); compl. 10/22/59, no Hunton production reported. Tops: Woodford (CC) 7280' (-6112'), Hunton (CC) 7289' (-6121'), Sylvan (CC) 7541' (-6373'); Hunton thickness 252'. Core; cored interval unknown; one fragment of fossiliferous core (Kirkidium biofacies) examined, depth unknown; chemical analysis; no thin section; Oklahoma Geological Survey collections.

A piece of core from this well has excellent specimen of Kirkidium pingue pingue (Amsden); well is important because it represents most southeasterly extent of Kirkidium biofacies presently known (see panel 9).

Woodford Shale 7280'-7289'
Hunton Group 7289'-7541'
Nothing is known concerning stratigraphic distribution of Kirkidium biofacies in this well, as only a single piece of Kirkidium-bearing core is known but depth is not known. This is dolomitic, fossiliferous limestone with substantial insoluble detritus; $MgCO_3$ 10.24%, HCl insolubles 17.45%.
Sylvan Shale 7541'

PHILLIPS 1-C LINA--sec. 570, Blk. 43, H&TC Survey, Ochiltree County, Texas; elev. 2879'; TD 11,906'; compl. 2/27/68. Tops (from Phillips): Kinderhook (no Woodford recognized) 10,960' (-8081'), Hunton 11,060' (-8181'), Sylvan (core) 11,078' (-8199'); Hunton thickness 18'. Cored 11,070'-11,138' (Hunton-Sylvan); no chemical analyses; Phillips, Bartlesville, Oklahoma.

This core is interesting because Hunton limestone, with late Early Devonian (Emsian) fossils, rests directly on Sylvan Shale. Sylvan in this area is quite calcareous, and, in fact, upper part of strata here referred to Sylvan is argillaceous limestone.

Kinderhook 10,960'-11,060'
Hunton Group 11,060'-11,078'
11,060'-11,070' No core.
11,070'-11,078' Lower Devonian (?Sallisaw Formation, ?Turkey Creek Limestone). Gray organo-detrital limestone with numerous euhedral crystals of dolomite and scattered subrounded quartz grains. Numerous megafossils including Amphigenia sp., Eodevonaria? sp., Acrospirifer cf. A. worthenanus, Leptocoelia? sp., and several large leptostrophid brachiopods representing either Leptostrophia or Protoleptostrophia. These brachiopods indicate a late Early Devonian age (Emsian) with similarities to faunas from Kirkpatrick 1 Cronkite in Kingfisher County, Oklahoma, and Sallisaw Formation in eastern Oklahoma (Amsden, 1963a, p. 148); Turkey Creek limestone, Marshall County, Oklahoma, is also late Early Devonian unit of about same age (Amsden, Klapper, and Ormiston, 1968, p. 166).
Sylvan Shale 11,078'
11,078'-11,138' Upper 4 feet of this interval is dark-gray fine-grained organo-detrital limestone with clay bands; this is underlain by 6 feet of argillaceous limestone with thin sandstone bands and chert nodules. Remainder of core is dark-gray calcareous clay with some thin shelly bands. Upper 10 feet of core is limestone and could represent Hunton, but shale and sandstone bands suggest that it is calcareous facies of Sylvan; in fact, entire Sylvan in this area is strongly calcareous.

GETTY 1 LUETKEMEYER UNIT--C SE¼NW¼ sec. 24, T. 19 N., R. 11 W., Blaine County, Oklahoma; elev. 1222'; TD 9254' (Sylvan); compl. 12/9/67, D&A. Tops: Hunton (CC) 8820' (-7598'), Sylvan (core) 9248' (-8026'); Hunton thickness 428'. Cored 8827'-8852', 9192'-9253.5' (Hunton-upper Sylvan); chemical analyses; 5 thin sections; porosity test (P8-A); OU Core Library.

Silurian in this well includes strongly dolomitized beds of oolite in Kirkidium biofacies (pl. 3, fig. 4) and very weakly dolomitic oolites in basal Keel Formation (pl. 12, fig. 5). Dolomitized oolite in Kirkidium beds has 14.3% porosity (P8-A).

Woodford Shale
Hunton Group 8820'-9248'
8820'-8827' No core.
8827'-8852' Silurian; Kirkidium biofacies. Gray crystalline dolomite. Upper part is strongly porous, dolomitized, fossiliferous oolite (photomicrograph, pl. 3, fig. 4), and lower part fossiliferous crystalline dolomite; insolubles low throughout. $MgCO_3$

averages 42.13%, HCl insolubles 2.65%. Porosity test P8-A at 8842' in oolite with 14.3% porosity, 211.28 md permeability. Specimens of Kirkidium common from 8835' to 8852'; all of cored interval referred to Kirkidium biofacies, although upper 8' (and overlying uncored interval) may include some Lower Devonian.

8852'-9192' No core.

9192'-9245' Chimneyhill Subgroup. Light-gray fossiliferous limestone with nodules of vitreous chert. This rock includes high percentage of HCl insolubles, but undoubtedly this largely represents silicification rather than detritus; there is some silt-size angular to subangular quartz detritus, but not in quantity indicated by analyses. Dolomite content is relatively low, averaging 7.34% $MgCO_3$. No diagnostic fossils observed, and this interval is referred to Chimneyhill on basis of stratigraphic position and lithology.

9245'-9248' Chimneyhill Subgroup; Keel Formation. Pale-gray fossiliferous oolite with spar matrix (photomicrograph, pl. 12, fig. 5). $MgCO_3$ 11.90%, HCl insolubles 3.62%. Referred to Keel on basis of lithology and stratigraphic position.

Sylvan Shale 9248'

9248'-9253.5' Core; greenish-gray shale.

GULF 1 MAINKA RING--SE¼NE¼ sec. 12, T. 5 N., R. 5 W., Grady County, Oklahoma; elev. 1160'; TD 13,631' (McLish); compl. 12/6/66, D&A. Tops: Woodford (CC) 11,521' (-10,361'), Hunton (core) 11,746' (-10,586'), Sylvan (CC) 12,210' (-11,050'); Hunton thickness 464'. Cored 11,714'-11,765', 12,158'-12,208' (lower Woodford-Hunton); 3 thin sections; no chemical analyses; OU Core Library.

This is one of few wells with good biostratigraphic control on Haragan-Bois d'Arc strata. It also cored Cochrane?-Keel oolite strata.

Woodford Shale 11,521'-11,746'

11,714'-11,746' Core; black shale.

Hunton Group 11,746'-12,210'

11,746'-11,765' Lower Devonian; Haragan-Bois d'Arc Formations. Dark-gray fossiliferous marlstone; parts with considerable amount of euhedral dolomite crystals and with subangular silt-size quartz detritus. Fossil debris includes trilobites, brachiopods, bryozoans, and pelmatozoan plates; in places fossils are scattered, and in other places they are more concentrated; locally it probably grades into a grain-supported (fossil-clast) rock. Upper part (11,748'-11,750') with Howellella cycloptera (Hall), Dalejina oblata (Hall)?, Strophonella bransoni Amsden?, phacopid trilobites. On basis of these fossils, interval is referred to Helderbergian, although lower part below these fossils could include some Silurian.

11,765'-12,158' No core.

12,158'-12,206' Silurian; Chimneyhill Subgroup. Light-gray organo-detrital limestone with relatively little dolomite. Referred to Chimneyhill on basis of lithology and stratigraphic position.

12,206'-12,208' Chimneyhill Subgroup; Keel Formation. Closely packed oolites with spar cement; oolites with radial and concentric structure. Low in dolomite and HCl insolubles. Referred to Keel on basis of lithology and stratigraphic position.

12,208'-12,210' No core.

Sylvan Shale 12,210'

GULF 1 MAY--SE¼NE¼SW¼ sec. 17, T. 19 N., R. 9 W., Kingfisher County, Oklahoma; elev. 1131'; TD 8749' (Sylvan); compl. 11/1/62, ?Hunton production. Tops: Woodford (CC) 8302' (-7171'), Hunton (CC) 8324' (-7193'), Sylvan (core) 8725' (-7594'); Hunton thickness 401'. Cored 8723'-8749' (Hunton-Sylvan); 1 thin section; chemical analyses; OU Core Library.

Hunton-Sylvan contact was cored; no recognizable Keel oolite present.

Woodford Shale 8302'-8324'

Hunton Group 8324'-8725'

8324'-8723' No core.

8723'-8725' Silurian; Chimneyhill Subgroup. Dark-gray cherty, organo-detrital limestone with only minor dolomite and HCl-insoluble detritus; $MgCO_3$ averages 6.39%, HCl insolubles 12.43% (latter probably includes some silicified material). No diagnostic fossils observed; assigned to Chimneyhill on basis of lithology and stratigraphic position.

Sylvan Shale 8725'

8725'-8749' Core; dark-greenish shale.

YINGER 1 MAYES--S½N½NE¼NW¼ sec. 1, T. 17 N., R. 7 W., Kingfisher County, Oklahoma; elev. 1081'; TD 8107' (Sylvan); compl. 1/9/70, no Hunton production reported. Tops: Woodford (CC) 7750' (-6669'), Hunton (CC) 7780' (-6699'), Sylvan (CC) 8079' (-6998'); Hunton thickness 299'. Cored 7780'-7809' (all Hunton); 1 thin section; chemical analyses; OU Core Library.

Woodford Shale 7750'-7780'

Hunton Group 7780'-8079'

7780'-7789' Silurian; Kirkidium biofacies. Dark-gray fossiliferous, crystalline dolomite with some insoluble detritus; $MgCO_3$ averages 36.13%, HCl insolubles 10.89%. Specimens of Kirkidium at 7780'-7781'.

7789'-7796' Kirkidium biofacies. Dark-gray fossiliferous, dolomitic limestone; $MgCO_3$ averages 22.86%, HCl-insoluble residues 8.64%. Excellent specimens of Kirkidium at 7791'-7792'.

7796'-7809' Dark-gray cherty, fossiliferous marlstone; $MgCO_3$ averages 10.29%, HCl insolubles 13.84%. Specimens of Halysites at 7809'.

7809'-8079' No core.

Sylvan Shale 8079'

CALIFORNIA 1 MULLEN ET AL.--C SE¼SE¼ sec. 29, T. 5 S., R. 2 W., Carter County, Oklahoma; elev. 943'; TD 9613' (Sylvan); compl. 4/5/62, Hunton production reported. Tops: Woodford (CC) 8970' (-8027'), Hunton (core) 9187' (-8244'), Sylvan (CC) 9606' (-8663'); Hunton thickness 419'. Cored 9019'-9332' (Woodford-Hunton); chemical analyses; OU Core Library.

This well cored upper 145' of Hunton, all of which is low-magnesium marlstone. This undoubtedly represents some part of Henryhouse-Haragan marlstone sequence (it is located only a short distance west of Criner Hills outcrops); presence of a calymenid trilobite at 9265' suggests that this part is Henryhouse, but contact with overlying Haragan (if it is present) cannot be determined on basis of present evidence.

Woodford Shale 8970'-9187'
Hunton Group 9187'-9606'
9187'-9258' ?Lower Devonian; ?Haragan Formation. Gray fossiliferous marlstone with only minor dolomite; $MgCO_3$ averages 5.42%, HCl insolubles 12.03%. Some fragmentary brachiopods at 9208' and 9217', and corals at 9253', but no diagnostic fossils identified; this marlstone interval referred with question to Haragan on basis of stratigraphic position.
9258'-9332' ?Silurian; ?Henryhouse Formation. Gray fossiliferous marlstone similar to overlying unit; $MgCO_3$ averages 4.72%, HCl insolubles 13.68%. Calymenid trilobite at 9265', this being basis for referring this unit to Silurian.
9332'-9606' No core.
Sylvan Shale 9606'

KIRKPATRICK & NATOL 1 NICKEL UNIT--C NW¼ sec. 34, T. 22 N., R. 12 W., Major County, Oklahoma; elev. 1283'; TD 8147' (Sylvan); compl. 8/16/66, no Hunton production reported. Tops: Hunton (CC) 7871', (-6588'), Sylvan (CC) 8119' (-6836'); Hunton thickness 248'. Cored 7880'-7907' (Hunton); chemical analyses; OU Core Library.

Woodford Shale
Hunton Group 7871'-8119'
7871'-7880' No core.
7880'-7907' ?Silurian. Gray fossiliferous, porous, crystalline dolomite with relatively little insoluble debris; $MgCO_3$ averages 41.83%, HCl insolubles 6.95%. This rock shows much visible porosity, much of which is result of leaching of fossils. Much crinoidal debris along with bryozoans, trilobites, and brachiopods. Pentameracid brachiopod at 7882'; this is internal mold of brachial valve, probably with smooth shell. No diagnostic fossils observed, and this interval referred to Silurian on basis of stratigraphic position and lithology.
7907'-8119' No core.
Sylvan Shale 8119'

PAN AMERICAN 1 POST UNIT--C NW¼SE¼ sec. 34, T. 16 N., R. 7 W., Kingfisher County, Oklahoma; elev. 1086'; TD 9274' (Simpson Group); compl. 1/30/64, D&A. Tops: Woodford (CC) 8147' (-7061'), Hunton (CC) 8214' (-7128'), Sylvan (CC) 8554' (-7468'); Hunton thickness 340'. Cored 8307'-8327' (Hunton); no thin sections or chemical analyses; Pan American (now Amoco), Tulsa, Oklahoma.

I have not examined this core, but Gilbert Klapper (The University of Iowa, personal communication) identified *Polygnathoides siluricus* at a depth of 8325', indicating Late Silurian age. Lower Devonian strata may be represented in upper part of Hunton.

COLUMBIA FUEL 2 RAINY MOUNTAIN (STRATIGRAPHIC TEST)--sec. 14, T. 6 N., R. 15 W., Kiowa County, Oklahoma; elev. ?; TD ?; compl. ?. Tops: no tops available. Cored 623'-633' (possibly Hunton); chemical analyses; OU Core Library.

Correspondence with Oklahoma Corporation Commission and with Cities Service fails to produce any information on this well. Columbia Fuel (subsidiary of Cities Service) does have record of 1 Doyle Hancock, SE¼SW¼SW¼ sec. 14, T. 6 N., R. 15 W., which bottomed at 620' and penetrated Hunton at 610' (813' above sea level); driller's log indicates that 1 Hancock ran 13' high to adjacent 2 Rainy Mountain. Cored portion of 1 Rainy Mountain is pale-gray low-magnesium calcilutite.

COLUMBIA FUEL 3 RAINY MOUNTAIN (STRATIGRAPHIC TEST)--sec. 22, T. 6 N., R. 15 W., Kiowa County, Oklahoma; elev. ?; TD ?; compl. ? Tops: Hunton 595' (?), Sylvan 767 (?); depths from information accompanying core. Cored 757'-761' (all Hunton?); OU Core Library.

No information is available to me concerning this well; see remarks under 2 RAINY MOUNTAIN. Cored portion is dark-gray low-magnesium limestone.

JONES & PELLOW 1 REHERMAN--C NE¼SE¼ sec. 25, T. 15 N., R. 6 W., Kingfisher County, Oklahoma; elev. 1174'; TD 7989' (Hunton); compl. 3/22/68, no Hunton production reported. Tops: Woodford (CC) 7658' (-6484'), Hunton (CC) 7720' (-6546'). Cored 7867'-7923' (all Hunton); 2 thin sections; chemical analyses; OU Core Library.

This core yields small brachiopod fauna at 7911'-7912' with similarities to Clarita fauna (Amsden, 1968, p. 18).

Woodford Shale 7658'-7720'
Hunton Group 7720'-7989' (TD)
7720'-7867' No core.
7867'-7909' Silurian; ?Chimneyhill Subgroup. Light-gray organo-detrital limestone, partly micrite cement, partly spar cement. Low in dolomite and in insoluble detritus; $MgCO_3$ averages 7.48%, HCl insolubles 3.68%. Reference of this unit to Chimneyhill Subgroup is uncertain, as no diagnostic fossils were observed; it is lithologically somewhat like underlying beds, which do yield fossils
7909'-7923' Chimneyhill Subgroup, Clarita Formation. Light-gray to greenish-gray argillaceous, organo-detrital limestone, mostly micrite cement. Relatively low dolomite content; $MgCO_3$ averages 13.07%, HCl insolubles 12.33%. Small brachiopod fauna collected at 7911'-7912'; *Plicocyrtia arkansana*? Amsden, *Resserella* sp. (cf. to *Resserella* sp. Amsden, 1968, pl. 3, figs. 5a-5h), ?*Leangella* sp. (cf. to *L*. (*O*.) *dissiticostella* Amsden, 1968, pl. 16, figs. 1a-1e), ?*Howellella splendens* (Thomas), *Atrypa* sp.; calymenid trilobite at 7919'. Assigned to Clarita Formation on basis of this fauna.
7923'-7989' (TD) No core.

SUNRAY DX 10-A RENTIE--NE¼NW¼SE¼ sec. 14, T. 9 N., R. 6 E., Seminole County, Oklahoma; elev. 976'; TD 4413' (Simpson); compl. 10/4/66, Hunton oil production reported. Tops: Woodford (CC) 3956' (-2980'), Hunton (CC) 4029' (-3053'), Sylvan (core) 4104' (-3128'); Hunton thickness 75'. Cored 4030'-4110' (Hunton-upper Sylvan); 8 thin sections; chemical analyses; porosity tests (Earlougher Engineering Co., Tulsa, Oklahoma); OU Core Library.

Cored portion of Hunton is a low-magnesium limestone which appears to be assigned to Chimneyhill Subgroup with reasonable certainty. Mr. L. A. Brandon, Sun Oil Company, provided porosity data showing reasonably good porosity throughout most of core, and this well is therefore a good example of low-magnesium limestone with satisfactory porosity (see discussion in text, Porosity and Permeability in Late Ordovician and Silurian Strata, and part IV of Appendix).

Woodford Shale 3956'-4029'
Hunton Group 4029'-4104'
4029'-4030' No core.
4030'-4104' Silurian; Chimneyhill Subgroup. Mostly pelmatozoan limestone with some shelly debris. It is low-magnesium limestone with very little insoluble detritus; $MgCO_3$ averages 7.9%, HCl-insoluble debris 2.07%. This rock has considerable visual vuggy porosity, most of which appears to be concentrated in matrix; solution producing this may extend into and corrode fossils, but its primary locus appears to be in matrix. Also some recrystallization in rock, although original fossil texture is largely preserved. Porosity averages 6.32%, permeability 1.36 md. Entire cored interval assigned to Chimneyhill Subgroup on basis of lithology and stratigraphic position.
Sylvan Shale 4104'
4104'-4110' Core; calcareous shale; 15.11% $MgCO_3$, 57.20% HCl insolubles.

AMERADA 1 RICHEY--C N½SW¼NW¼ sec. 33, T. 25 N., R. 6 W., Grant County, Oklahoma; elev. 1082'; TD 6332' (Viola); compl. 1/21/65, Misener production reported. No tops reported. Cored 6235'-6266' (all Misener); 3 thin sections; chemical analyses; OU Core Library.

This well is situated north of Hunton zero isopach (panel 1, map A; panel 9), in an area where Misener presumably rests directly on Sylvan Shale. Conodonts from this core indicate an early Late Devonian (early Frasnian) age (Amsden and Klapper, 1972, p. 2328-2330). Misener in this area is believed to be overlain by Woodford Shale and underlain by Sylvan Shale (Amsden and Klapper, 1972, p. 2325). It is dolomitic quartz sandstone grading into sandy dolomite; insolubles, most of which are detrital quartz, range from 26.6% to 62.8%, and $MgCO_3$ from 30.6% to 13.0%. Quartz grains are generally subrounded, and many have quartz overgrowths giving them an angular external shape (Amsden and Klapper, 1972, fig. 4).

SAMEDAN 2 RIO BRAVO--1980' FSL & 1980' FEL sec. 23, Blk. 42, H&TC Survey, Hemphill County, Texas; elev. 2521'; TD 15,680' (Ordovician); compl. 3/22/68. Tops: Woodford 15,210' (GR log) (-12,689'), Hunton 15,234' (GR log) (-12,713'), Sylvan (GR log) 15,374' (-12,853'); Hunton thickness 140'. Cored 15,250'-15,283' (all Hunton); Chevron Oil Co., Oklahoma City, Oklahoma.

No fossils observed in upper 17' of core; specimens of Halysites sp. observed at 15,267', 15,273', and 15,278', and on basis of these fossils entire core interval is tentatively assigned to Silurian, ?Kirkidium biofacies.

Woodford Shale 15,210'-15,234' (GR log)
Hunton Group 15,234'-15,250' No core.
15,250'-15,267' Silurian; ?Kirkidium biofacies. Gray fossiliferous limestone with oolitic beds 15,255'-15,260'. No identifiable fossils observed.
15,267'-15,283' Gray limestone with much broken fossil debris. Specimens of Halysites sp. observed at 15,267', 15,273', and 15,278'.
15,283'-15,374' No core.
Sylvan Shale 15,374' (GR log)

PAN AMERICAN 1 ROETZAL UNIT--C NE¼SW¼ sec. 18, T. 19 N., R. 9 W., Kingfisher County, Oklahoma; elev. 1152'; TD 8825'? (Hunton); compl. 1/23/64, Hunton production reported. Tops: Woodford 8332' (-7180'), Hunton 8370' (-7218'). Cored 8056'-8106', 8293'-8444'; no thin sections or chemical analyses; Pan American (now Amoco), Tulsa, Oklahoma.

I have not examined this core except for study of specimen of Kirkidium sp. from 8428', loaned by Pan American; also, A. R. Ormiston (Amoco Production Company, Tulsa, Oklahoma, personal communication) reports Kirkidium at 8400'. This well could include some Lower Devonian strata in the upper 30' of Hunton.

PAN AMERICAN 1-B ROETZAL UNIT--NW¼SE¼ sec. 13, T. 19 N., R. 10 W., Blaine County, Oklahoma; elev. 1170'; TD 8500' (Hunton); compl. 1/14/65, D&A. Tops: Woodford (CC) 8407' (-7237'), Hunton (core) 8434' (-7264'). Cored 8414'-8470' (Woodford-Hunton); chemical analyses; 5 thin sections; OU Core Library.

Specimens of Kirkidium pingue pingue (Amsden) from this well (depth 8437') illustrated in Amsden (1969, pl. 117, fig. 12). Specimens of Kirkidium observed directly below Woodford, indicating absence of any Lower Devonian strata.

Woodford Shale 8407'-8434'
Hunton Group 8434'-8500' (TD)
8434'-8470' Silurian; Kirkidium biofacies. Crystalline dolomite with subangular silt-size quartz detritus; $MgCO_3$ averages 36.36%, HCl insolubles 13.26%. Fossil debris, including brachiopod shells, preserved entirely in spar, mostly calcspar. Specimens of Kirkidium from 8434' to 8440'.
8470'-8500' No core.
8500' TD

CLEARY 1-12 ROSE--C E½NE¼NW¼ sec. 12, T. 22 N., R. 12 W., Major County, Oklahoma; elev. 1285'; TD 7794' (Sylvan); compl. 7/26/66, no Hunton production reported. Tops: Woodford (CC) 7518' (-6233'), Hunton 7553' (-6268'), Sylvan (CC) 7780' (-6495'); Hunton thickness 227'. Cored 7540'-7590' (Woodford-Hunton); no thin sections; chemical analyses; OU Core Library.

Woodford Shale 7518'-7553'

Hunton Group 7553'-7780'

7553'-7590' Silurian? Crystalline dolomite with relatively little insoluble detritus; $MgCO_3$ averages 38.58%, HCl insolubles 5.02%. No diagnostic fossils observed; assigned to Silurian on basis of lithology and stratigraphic position.

7590'-7780' No core.

Sylvan Shale 7780'

BARNES 1 ROUNDS--SE¼NW¼NE¼ sec. 6, T. 15 N., R. 18 W., Custer County, Oklahoma; elev. 1902'; TD 18,289' (Arbuckle); compl. 12/30/68, Hunton production reported. Tops: Woodford (CC) 15,223' (-13,321'), Hunton (CC) 15,315' (-13,413'), Sylvan (CC) 15,756' (-13,854'); Hunton thickness 441'. Cored 15,320'-15,407' (Hunton); no thin sections or chemical analyses; Cities Service, Tulsa, Oklahoma.

I briefly examined upper 90 feet of this core in Tulsa. It appears to be crystalline dolomite with some fossils, including brachiopods and corals. One specimen of Kirkidium observed at 15,320', this being 5' below Hunton-Woodford contact; if any Lower Devonian is present it must be very thin.

GULF 1 SCHROEDER--SW¼NE¼ sec. 3, T. 12 N., R. 2 W., Oklahoma County, Oklahoma; elev. 1193'; TD 6336' (Hunton); compl. 12/30/49, Hunton production reported (perforated 6291'-6325', all in Frisco Formation). Tops: Hunton (core) 6283' (-5090'). Cored 6272'-6336' (Woodford-Hunton); 5 thin sections; chemical analyses; OU Core Library.

Core from this well provides excellent biostratigraphic control on Frisco-Kirkidium biofacies boundary, with diagnostic Frisco fossils being found within 3' of Kirkidium-bearing beds (text-fig. 20).

Woodford Shale

6272'-6283' Core; black shale.

Hunton Group 6283'-6336' (TD)

6283'-6322' Lower Devonian; Frisco Formation. Light-gray organo-detrital sparite; $MgCO_3$ averages 0.98%, HCl insolubles 1.24%. Fossil debris includes much pelmatozoan material along with substantial shelly debris; brachiopods and bryozoans are common, as well as some corals, snails, etc. Parts of this rock have good visual porosity, with pore space mostly occupying matrix or in center of hollow fossils. Brachiopods from following intervals: 6287', Rensselaeria cf. R. elongata (Conrad), Dalejina musculosus (Hall)?; 6295', Acrospirifer murchisoni (Castelnau)?; 6300'-6302', Costispirifer arenosus (Conrad), Acrospirifer murchisoni?; 6322', Leptostrophia magnifica (Hall), Costispirifer arenosus?. This fauna and lithology are typical of Frisco Formation.

6322'-6336' Silurian; Kirkidium biofacies. Greenish-gray fossiliferous marlstone with silt-size subangular quartz detritus; $MgCO_3$ averages 9.36%; HCl insolubles 11.27%. This is fairly typical marlstone lithology, although insolubles are perhaps slightly low and fossil content slightly high for Henryhouse Formation, at least in much of Arbuckle Mountains region. Dictyonella sp. and Kirkidium sp. collected at 6324.5', this being one of few places where these two brachiopods are found together.

6336' TD

GULF 1 SHADDIX--C NW¼NE¼ sec. 29, T. 6 N., R. 3 W., McClain County, Oklahoma; elev. 1191'; TD 9253' (Hunton); compl. 7/15/57, Hunton production reported. Tops: Woodford (CC) 9042' (-7851'), Hunton (CC) 9190' (-7999'). Cored 9205'-9253' (Hunton); 3 thin sections; no analyses. OU Core Library.

Core has been reboxed, and some portions appear to have been mixed. It is organo-detrital sparite, low in dolomite and low in insoluble detritus (pl. 1, figs. 3a, 3b). Fossils at 9248'(?) yield number of large shells, including leptostrophid brachiopods, ?Meristella vascularia (cf. Amsden and Ventress, 1963, pl. 9, figs. 13-17), and large plethorhynchid (cf. Amsden and Ventress, 1963, pl. 4, figs. 5-10). These fossils and lithology indicate Frisco Formation rather than Fittstown Member of Bois d'Arc Formation.

GULF 1 SHADE--C SE¼SW¼ sec. 31, T. 25 N., R. 14 W., Woods County, Oklahoma; elev. 1596'; TD 8000' (Arbuckle); compl. 7/25/57, Hunton production reported. Tops: Woodford (CC) 7034' (-5438'), Hunton (CC) 7128' (-5532'), Sylvan (CC) 7173' (-5577'); Hunton thickness 45'. Cored 7131'-7172' (Hunton); no thin sections; chemical analyses; OU Core Library.

This well located near northern truncated margin of Hunton Group (panel 1, map A).

Woodford Shale 7034'-7128'

Hunton Group 7128'-7173'

7128'-7131' No core.

7131'-7172' Silurian; Chimneyhill Subgroup. Pale-gray to greenish-gray organo-detrital limestone; $MgCO_3$ averages 9.04%, HCl insolubles 8.19%. Parts with much pyrite and glauconite. Some visual porosity in form of open vugs lined with crystals. No diagnostic fossils observed, and this interval referred to Chimneyhill Subgroup on basis of lithology and stratigraphic position.

7172'-7173' No core.

Sylvan Shale 7173'

MOBIL 1 SHARP-HUNT UNIT--E½E½NW¼ sec. 26, T. 15 N., R. 16 W., Custer County, Oklahoma; elev. 1760'; TD 14,790' (Sylvan); compl. 2/26/66, Hunton production reported. Tops: Woodford (CC) 14,204' (-12,444'), Hunton (core) 14,299' (-12,539'), Sylvan (CC) 14,750' (-12,990'); Hunton thickness 451'. Cored 14,287'-14,453' (Woodford-Hunton); no thin sections or chemical analyses; Mobil ware-

house, Lindsay, Oklahoma.
Woodford Shale 14,204'-14,299'
Hunton Group 14,299'-14,750'
14,299'-14,453' Silurian; Kirkidium biofacies. Gray dolomite with minor chert nodules. Specimens of Kirkidium observed from 14,299' to 14,314'.
14,453'-14,750' No core.
Sylvan Shale 14,750'

KIRKPATRICK 1 SHEWEY UNIT--C SW¼NE¼ sec. 28, T. 22 N., R. 12 W., Major County, Oklahoma; elev. 1266'; TD 8135' (Sylvan); compl. 8/30/66, Hunton production reported. Tops: Woodford (CC) 7856' (-6590'), Hunton (CC) 7890' (-6624'), Sylvan (CC) 8056' (-6790'); Hunton thickness 166'. Cored 7895'-7932' (Hunton); 4 thin sections; chemical analyses; porosity test (P7-A); OU Core Library.

Cored interval is porous dolomite (P7-A); 15.6% porosity, 5 md permeability, with porosity, in large part, result of dissolution of crinoidal material.
Woodford Shale 7856'-7890'
Hunton Group 7890'-8056'
7890'-7895' No core.
7895'-7932' Silurian. Light-gray porous, crystalline dolomite with a few widely scattered chert nodules; $MgCO_3$ averages 40.33%, HCl insolubles 6.24%. Fossils include pelmatozoan material and some trilobites, preserved as molds. Porosity test P7-A at 7906'. Specimen of calymenid trilobite at 7913'. Assigned to Silurian on basis of this fossil and its stratigraphic position.
7932'-8056' No core.
Sylvan Shale 8056'

KIRKPATRICK 1-A SHEWEY--C NW¼ sec. 27, T. 22 N., R. 12 W., Major County, Oklahoma; elev. 1256'; TD 8070' (Hunton); compl. 9/6/66, Hunton production reported. Tops: Hunton (CC) 7818' (-6562'). Cored 7855'-7908' (Hunton); 4 thin sections; chemical analyses; porosity test (P5-A); OU Core Library.

Kirkpatrick 1 Shewey Unit, 1-A Shewey, and 1 Wichert, located in adjacent sections, all cored upper part of Hunton and all encountered gray porous, crystalline dolomite. Porosity appears to be in large part result of dissolution of fossil material, mostly pelmatozoan debris. Faunal information from 1 Shewey Unit and 1 Wichert indicates that Hunton is largely if not entirely Silurian in age.

Woodford Shale
Hunton Group 7818'-8070' (TD)
7818'-7855' No core.
7855'-7908' Silurian. Light-gray porous, crystalline dolomite; $MgCO_3$ averages 35.30%, HCl insolubles 11.35%. Fossiliferous, with bryozoans, brachiopods, trilobites and much pelmatozoan material. Fossils mostly preserved as molds or in spar. Porosity test P5-A, depth 7856', with 12.8% porosity, 0.00 md permeability. Assigned to Silurian on basis of lithology and stratigraphic position (cf. to 1 Shewey Unit and 1 Wichert).
7908'-8070' No core.
8070' TD

HUMBLE 1 STATE HUNTON--NE¼NW¼ sec. 16, T. 18 N., R. 7 W., Kingfisher County, Oklahoma; elev. 1129'; TD 8295' (Sylvan); compl. 2/25/69, Hunton production reported. Tops: Woodford (CC) 7876' (-6747'), Hunton (core) 7904' (-6775'), Sylvan (CC) 8262' (-7133'); Hunton thickness 358'. Cored 7892'-8007' (Woodford-Hunton); 7 thin sections; chemical analyses; 2 porosity tests (P17-A, P17-B), OU Core Library.

Sharp lithologic break at 7947', upper unit being low-insoluble, crystalline dolomite with some porosity and lower unit a dolomitic marlstone. No faunal data are available bearing on biostratigraphic significance of this change, but it probably only represents place where change from marlstone to low-insoluble dolomite is abrupt rather than gradational.

Woodford Shale 7876'-7904'
Hunton Group 7904'-8262'
7904'-7947' Silurian; ?Kirkidium biofacies. Medium-gray cherty, crystalline dolomite with scattered fossils. Some scattered silt-size subangular quartz detritus, but insoluble detritus is low; HCl insolubles average 6.29% (may include some silicification associated with chert), $MgCO_3$ averages 37.15%. This interval has some visual porosity in form of vugs commonly partly filled with dolomite crystals (pl. 12, fig. 1), dissolution of fossils, and solution cavities distributed in linear fashion suggesting solution along fractures; porosity test P17-A, depth 7905', with 2.29% porosity and 0.18 md permeability, and P17-B, depth 7919', with 2.90% porosity and 2.90 md permeability. Large pentamerid, probably representative of Kirkidium sp., at 7904', and Halysites sp. at 7921'; tabulate corals at 7929'; pelmatozoan debris scattered throughout. All fossils observed in this interval preserved as molds or in spar, generally dolospar. Assigned to Silurian, ?Kirkidium biofacies, on basis of fossils and stratigraphic position.
7947'-8007' Fossiliferous dolomitic marlstone with much silt-size subangular quartz detritus; HCl insolubles average 24.99%, $MgCO_3$ averages 16.66%. Fossils retain their original microtexture, and this unit has typical marlstone texture. Reasonably well-defined contact between this unit and overlying cherty crystalline dolomite. Specimens of small- to moderate-sized smooth pentamerid at 7956' and 7998'; specimens of Halysites sp. at 7976'. Biostratigraphic position of interval uncertain, but it probably represents part of Kirkidium biofacies.
8007'-8262' No core.
Sylvan Shale 8262'

FERGUSON 1 STINSON--NE¼ sec. 21, T. 18 N., R. 7 W., Kingfisher County, Oklahoma; elev. 1074'; TD 8160' (Sylvan); compl. January 1973, Hunton production reported. Tops: Woodford (GR log) 7744' (-6670'), Hunton (GR log) 7818' (-6744'), Sylvan (GR log) 8120' (-7046'); Hunton thickness 302'. Cored 7822'-7954' (Hunton); 45 thin sections; chemical analyses and porosity-permeability tests; OU Core Library.

Porosity-permeability tests were run on this core every foot by Core Laboratories, Inc., Oklahoma City, and results were made available through Mr. Ron Mercer, Ferguson Oil Co., Oklahoma City, Oklahoma (see text, Porosity and Permeability in Late Ordovician and Silurian Strata). Lithofacies and biofacies in this core are similar to those in 1 State Hunton, with which 1 Stinson is probably, at least in part, correlative.

Hunton Group 7818'-8120'

7818'-7822' No core.

7822'-7836' Silurian; ?Kirkidium biofacies. Crystalline dolomite with chert nodules and substantial silicification; $MgCO_3$ averages 31.79%, HCl insolubles 19.44% (probably include some silicified material). Sparse fossil debris, preserved in spar by silicification and as molds; most of fossils appear to be pelmatozoan plates, small colonial corals, and probably small bryozoan colonies. This interval contains significant porosity ranging from 7.9% to 9.3%; most of visual porosity is in form of small cavities associated with small colonial corals and possibly bryozoans (pl. 13, figs. 1-3). No diagnostic fossils observed; it is referred with question to Kirkidium biofacies on basis of fossils from underlying beds and a comparison with 1 State Hunton.

7836'-7841' ?Kirkidium biofacies. Dolomitic marlstone with scattered fossils including pelmatozoan debris, tetracorals, small colonial corals, bryozoans, and brachiopods; no fossils appear to be in growth position. This interval contains small chert nodules and considerable silicification of fossils. $MgCO_3$ averages 20.91%, and HCl insolubles 19.66% (in addition to insoluble detritus, this probably includes some silicification). Minor visual porosity, mostly in small cavities associated with colonial organisms; porosity ranges from 2.7% to 4.3%. Pentamerid brachiopod, possibly Kirkidium sp., at 7837', and Halysites sp. at 7841'. Reference of this interval to Kirkidium biofacies is uncertain, as faunal data are equivocal.

7841'-7856' Marlstone with substantial fossil debris, probably locally grading into organo-detrital limestone; fossils retain original microtexture, although some have been replaced by silica, and there are some small chert nodules. Fossils include much pelmatozoan debris, tetracorals, tabulate corals including Heliolites sp., brachiopods, and trilobites; probably none in growth position. Dolomite is represented by small euhedral crystals scattered through matrix; $MgCO_3$ averages 11.28%, HCl insolubles 21.25%. Porosity is fairly low, ranging from 1.2% to 2.5%. No diagnostic fossils observed.

7856'-7954' Marlstone with scattered fossils including pelmatozoan debris, tetracorals, tabulates (Heliolites sp.), bryozoans, and shelly debris. Similar to overlying unit except dolomite content is reduced; $MgCO_3$ averages 7.56%, HCl insolubles 19.85%. Porosity ranges from 0.9% to 3.4%. No diagnostic fossils observed.

7954'-8120' No core.

Sylvan Shale 8120'

SHELL 1-32 STOCKING--C E½NW¼ sec. 32, T. 22 N., R. 19 W., Woodward County, Oklahoma; elev. 1971'; TD 11,300' (Arbuckle); compl. 7/21/67, D&A. Tops: Hunton (CC) 10,226' (-8255'); other tops not available. Cored 10,247'-10,321' (Hunton); 5 thin sections; chemical analyses; OU Core Library.

Woodford Shale (not reported)

Hunton Group 10,226'

10,226'-10,247' No core.

10,247'-10,259' Silurian. Dolomitic limestone-chert breccia with much subrounded silt- to sand-size quartz detritus. This may be solution-type breccia associated with weathering which preceded deposition of Misener-Woodford sequence. Quite possibly quartz sand represents infiltration of Misener along numerous solution channels and cavities somewhat similar to that developed in Sycamore Sandstone of eastern Oklahoma (Amsden, 1961, p. 64-65); however, carbonate pieces, which make up large part of rock, are Silurian, as they include Halysites. In addition to Halysites, there are other corals, bryozoans, stromatoporids, much crinoidal material, and also skeletal debris. This interval averages 16.67% $MgCO_3$ and 58.79% HCl insolubles, although latter probably includes much cherty material.

10,259'-10,274' Silurian. Crystalline dolomite, mostly with low-insoluble detritus; $MgCO_3$ averages 32.22%, HCl insolubles 7.44%. Few scattered fossils, mainly pelmatozoan plates, preserved in spar. No diagnostic fossils observed.

10,274'-10,321' Silurian. Dark-gray dolomitic limestone with only minor insoluble detritus; $MgCO_3$ averages 16.35%, HCl-insoluble detritus 5.49%. Texture is mostly micritic (?lime mud) with scattered dolomite crystals and scattered fossils. No diagnostic fossils observed in this interval.

GULF 1 STREETER--SE¼SE¼ sec. 20, T. 13 N., R. 4 W., Oklahoma County, Oklahoma; elev. 1189'; TD 7307' (Sylvan); compl. 8/30/45, Hunton production reported. Tops: Hunton (CC) 6945' (-5756'), Sylvan (core) 7298' (-6109'); Hunton thickness 353'. Cored 6875'-7301' (two small skips); 22 thin sections; chemical analyses; OU Core Library.

This well, located in West Edmond field, cored almost entire interval from Woodford Shale through Hunton and into Sylvan Shale. Core provides excellent lithostratigraphic and biostratigraphic control for Frisco-Kirkidium biofacies contact (i.e., middle Lower Devonian-Silurian boundary). This is "welded" contact, and uppermost Silurian bed bearing specimens of Kirkidium can be observed in direct contact with overlying Frisco Formation; Silurian fossils (pl. 15, figs. 1, 2), including shells of Kirkidium, are cut off beneath pre-Frisco erosion surface (cf. to Frisco-Silurian boundary in eastern Oklahoma; Amsden, 1961, p. 37-42, pls. 4, 5, and frontispiece). Diagnostic Frisco brachiopods observed at 7041', only 2' above this contact.

Hunton in this well was described in some detail by Swesnick (1948, p. 370), although he referred strata here assigned to Frisco Formation to Bois d'Arc Formation.

Woodford Shale (cored from 6875' to 6938')
Hunton Group 6945'-7298'
6945'-6954' No core.
6954'-7043½' Lower Devonian; Frisco Formation. Light-gray low-magnesium organo-detrital limestone, mostly with spar cement and with very little insoluble detritus; $MgCO_3$ averages 1.99%, HCl insolubles 1.99%. This is grain-supported (fossil-clast) rock with much pelmatozoan material and also much shelly debris (pl. 1, figs. 1a, 1b; pl. 2, fig. 3; pl. 14, fig. 2). This rock shows evidence of solution and recrystallization. Visual porosity is common, being located mainly in matrix and in hollow parts of fossils (pl. 7, figs. 1a, 1b); also some irregular cavities with linear distribution suggesting solution along fractures (pl. 14, fig. 1). Fossils observed at 6960', 6967', 7015', 7034', 7041'; these include Leptostrophia magnifica?, Acrospirifer murchisoni, Plethorhyncha sp., large meristelloid brachiopods, large snails, and ramose favositid corals. Fauna and lithology are characteristic for Frisco Formation. Contact with underlying strata is sharply defined.
7043½'-7051' Silurian; Kirkidium biofacies. Organo-detrital limestone, mostly with micrite cement; $MgCO_3$ averages 3.43%, HCl insolubles 4.08%. Variety of fossils represented, with both pelmatozoan plates and shelly debris, latter including brachiopods, bryozoans, ostracodes, and trilobites. Contact with overlying Frisco is sharply defined. Specimens of Kirkidium are present in bed directly beneath Frisco Formation; also specimens at 7046' and 7047'.
7051'-7055' Silurian; Kirkidium biofacies. Fossiliferous oolite with spar cement; oolites with fossil core and concentric structure (pl. 12, fig. 4). Very low-magnesium rock; $MgCO_3$ averages 0.62%, HCl insolubles 1.30%. Specimens of Kirkidium at 7054'.
7055'-7085' Kirkidium biofacies. Fossiliferous dolomitic marlstone, probably grading into grain-supported organo-detrital limestone; HCl insolubles average 12.25%, $MgCO_3$ averages 10.92%. Specimen of Kirkidium pingue pingue (Amsden) at 7060' (Amsden, 1969, pl. 117, fig. 11); other specimens at 7065', 7068', 7073'.
7085'-7104' No core.
7104'-7148' ?Kirkidium biofacies. Fossiliferous marlstone like unit above; $MgCO_3$ averages 9.24%, HCl insolubles 18.15%. No diagnostic fossils observed; assigned to Kirkidium biofacies on basis of lithology and stratigraphic position.
7148'-7178' ?Chimneyhill Subgroup. Pink crinoidal limestone, partly spar, partly micrite cement; $MgCO_3$ averages 2.30%, HCl insolubles 4.92%. No diagnostic fossils observed; tentatively assigned to Chimneyhill on basis of lithology and stratigraphic position.
7178'-7298' Chimneyhill Subgroup. Fossiliferous limestone, very largely micrite cement, and probably ranging from mud supported to grain supported. Insolubles range widely from 2.17% to 21.85%, and $MgCO_3$ ranges from 2.76% to 20.03%. No diagnostic fossils observed, and this interval assigned to Chimneyhill on basis of stratigraphic position and lithology.
Sylvan Shale 7298'

TEXACO 1 THOMPSON--C SE¼SE¼ sec. 34, T. 17 N., R. 8 W., Kingfisher County, Oklahoma; elev. 1193'; TD 9130'; compl. 10/14/60, no Hunton production reported. Tops: none available. Cored 8867'-8904' (Hunton); 4 thin sections; two spot analyses; two porosity tests (P6-A, P6-B); OU Core Library.
Woodford Shale
Hunton Group
8867'-8870' ?Silurian; ?Kirkidium biofacies. Dolomitized, porous oolite. Porosity test P6-A, depth 8869', 13.7% porosity and 38.48 md permeability; $MgCO_3$ 43.08%; HCl insolubles 1.31%. Visual porosity is almost entirely in matrix surrounding oolites. No diagnostic fossils observed, and assignment to Silurian is based on stratigraphic position with respect to underlying Kirkidium-bearing strata.
8870'-8884' Silurian; Kirkidium biofacies. Gray crystalline dolomite. Porosity test P6-B, depth 8880'; porosity 1.3%, permeability 0.00 md; $MgCO_3$ 34.77%, HCl insolubles 12.18%. Specimens of Kirkidium 8876'-8884'.
8884'-8904' Silurian; Kirkidium biofacies. Fossiliferous dolomitic limestone with scattered silt-size subangular quartz grains. Fossils retain their original microtexture. Specimens of Kirkidium from 8884' to 8886', 8902'.

RODEN 12-1 THRASHER--C SE¼NE¼ sec. 12, T. 19 N., R. 8 W., Kingfisher County, Oklahoma; elev. 1244'; TD 8290' (Sylvan); compl. 6/8/69, Hunton production reported. Tops: Woodford (CC) 7872' (-6628'), Hunton (CC) 7899' (-6655'), Sylvan (CC) 8240' (-6996'); Hunton thickness 341'. Cored 7904'-7953' (Hunton); no thin sections; chemical analyses; OU Core Library.
Woodford Shale 7872'-7899'
Hunton Group 7899'-8240'
7899'-7904' No core.
7904'-7953' ?Silurian; ?Kirkidium biofacies. Dolomitic, fossiliferous limestone with much insolubles; $MgCO_3$ averages 10.73%, HCl insolubles 18.98%. No diagnostic fossils observed; assigned to Kirkidium biofacies on basis of lithology and stratigraphic position.
7953'-8240' No core.
Sylvan Shale 8240'

CALIFORNIA 1 TICER ET AL.--C NW¼SE¼ sec. 33, T. 5 S., R. 2 W., Carter County, Oklahoma; elev. 894'; TD 9640' (Sylvan); compl. 8/30/62, Hunton production reported. Tops: Woodford (CC) 8925' (-8031'), Hunton (CC) 9165' (-8271'), Sylvan (CC) 9567' (-8673'); Hunton thickness 402'. Cored 9490'-9532' (Hunton); 1 thin section; chemical analyses; OU Core Library.

Well located about 15 miles west of Criner Hills, where Hunton rocks are exposed at surface. Cored interval is similar to Henryhouse-Clarita lithostratigraphic sequence, exposed in Criner Hills, although there are no biostratigraphic data to confirm this correlation. Hunton rocks in 1 Ticer et al. and adjacent wells are much thicker than at surface (panel 6).

Woodford Shale 8925'-9165'
Hunton Group 9165'-9567'
9165'-9490' No core.
9490'-9517' ?Silurian; ?Henryhouse Formation. Gray to reddish-gray dolomitic marlstone; $MgCO_3$ averages 14.24%, HCl insolubles 39.75%. Insoluble content of interval is high for Henryhouse, although spot samples from Criner Hills have as much as 32% (Amsden, 1960, p. 290). There is an abrupt decrease in insolubles in underlying strata. No diagnostic fossils observed, and reference of this unit to Henryhouse is based on lithology and stratigraphic position.
9517'-9532' Silurian; ?Chimneyhill Subgroup; ?Clarita Formation. Light-gray organo-detrital limestone with micrite cement. Many pink crinoid plates along with numerous other fossils. Basal 1' is greenish calcareous shale. This interval is low-magnesium limestone with moderate insolubles; $MgCO_3$ averages 3.65%, HCl insolubles 10.30%. No diagnostic fossils observed; this unit is lithologically similar to Clarita Formation in Criner Hills (basal greenish shale may be Prices Falls Member), and it is in correct stratigraphic position.
9532'-9567' No core.
Sylvan Shale 9567'

KING 1 TIGER--NW¼NW¼SW¼NE¼ sec. 3, T. 8 N., R. 5 E., Seminole County, Oklahoma; elev. 911'; TD 4292' (Simpson Group); compl. 5/16/69, no Hunton production reported. Tops: Woodford (CC) 3794' (-2883'), Hunton (CC) 3917' (-3006'), Sylvan (core) 3954' (-3043'); Hunton thickness 37'. Cored 3921'-3960' (Hunton-Sylvan); 3 thin sections; chemical analyses; OU Core Library.

Well located near truncated margin of Hunton (panel 6); compare to Kahan et al. 6 Bean and Sunray DX 10-A Rentie.

Woodford Shale 3794'-3917'
Hunton Group 3917'-3954'
3917'-3921' No core.
3921'-3954' Silurian; Chimneyhill Subgroup. Brownish-gray, organo-detrital limestone, mostly with spar cement. Much pelmatozoan debris and shelly material. Some irregular areas with small euhedral crystals of dolomite, but $MgCO_3$ content averages only 8.82%; HCl insolubles 2.25%. Fragmentary trilobites and brachiopods present; one specimen of *Resserella* sp. at 3945' (cf. to *Resserella* sp., Amsden, 1968, pl. 3, figs. 5a-5h). Referred to Chimneyhill on basis of lithology and stratigraphic position.
Sylvan Shale 3954'
3954'-3960' Cored. Green argillaceous dolomite with numerous small pyrite crystals. HCl insolubles average 15.36%, $MgCO_3$ 30.87%.

GULF 1 TRIPLETT--NE¼SW¼ sec. 8, T. 15 N., R. 5 W., Kingfisher County, Oklahoma; elev. 1096'; TD 7692' (Sylvan); compl. 6/28/45, D&A. Tops: Hunton (CC) 7360' (-6264'), Sylvan 7682' (-6586'); Hunton thickness 322'. Cored 7406'-7411' (Hunton); no thin sections; no chemical analyses; OU Core Library.
Woodford Shale
Hunton Group 7360'-7682'
7360'-7406' No core.
7406'-7411' Silurian; *Kirkidium* biofacies. Brownish-gray dolomitic limestone with much shelly debris. Stained rock specimens show this rock to have many fine dolomite crystals scattered through matrix; fossils are preserved in calcite with original microtexture. Specimens of *Kirkidium* sp. at 7410'.
7411'-7682' No core.
Sylvan Shale 7682'

PAN AMERICAN 1 TSAUBY--C NW¼SW¼ sec. 30, T. 7 N., R. 13 W., Caddo County, Oklahoma; elev. 1448'; TD 8478' (Simpson Group); compl. 6/11/64, D&A. Tops: Woodford (CC) 3352' (-1904'), Hunton (CC) 4160' (-2712'), Sylvan (CC) 5510' (-4062'); Hunton thickness 1350'. Cored 5360'-5369' (Hunton); 1 thin section; chemical analyses; OU Core Library.

Well located on one of shallow fault blocks between the Wichita uplift and deep part of Anadarko basin. Thickness is comparable to that of Hunton in other wells in area (see panels 6, 10).

Woodford Shale 3352'-4160'
Hunton Group 4160'-5510'
4160'-5360' No core.
5360'-5369' ?Silurian, ?Chimneyhill Subgroup. Pale-gray cherty limestone. Texture of rock is mainly rather fine calcite crystals (?recrystallized sparite) with scattered fossils, including both pelmatozoan plates and shelly debris. $MgCO_3$ content is low, averaging 3.07%, and HCl residues are high, averaging 29.72%; however, latter is certainly influenced by inclusion of considerable silicified material, as thin section shows very little insoluble detritus. Unit is referred to Chimneyhill Subgroup on basis of lithology (it is not marlstone) and stratigraphic position; it lies 150' above Sylvan, but Chimneyhill is thick in this region (see panel 10).
5369'-5510' No core.
Sylvan Shale 5510'

MOBIL 1 WALKER--1980' FNL & 660' FWL sec. 6, J. Poitevent Survey, Wheeler County, Texas; elev. 2365'; TD 17,772'; compl. 1/16/69. Tops: Hunton (GR log) 14,968' (-12,603'), Sylvan (?core) 15,630'? (-13,265'); Hunton thickness 662'. Cored 14,970'-15,030', 15,607'-15,638' (Hunton); 16 thin sections (borrowed from Chevron Oil Co., Oklahoma City); no chemical analyses; Chevron Oil Company, Oklahoma City.

Upper cored portion of this well (14,970'-15,038') is interesting because Hunton rocks are represented by lithofacies which I have not seen elsewhere in subsurface or surface strata in Oklahoma or Texas Panhandle. This is dark-gray to almost black argillaceous organo-detrital limestone interbedded with dark calcareous shale. Organo-detrital limestone is mostly micrite cement, but there are beds of sparite; many beds are largely shelly debris, brachiopods, ostracodes, trilobites, and bryozoans, whereas others have much pelmatozoan debris. Some scattered euhedral crystals of dolomite, but this rock appears to be mainly low-magnesium stone. Small spiriferoid brachiopod (?*Howellella* sp.) is fairly common in parts of this interval, specimens collected at 14,992', 15,019', 15,023', 15,024'. Internal characters of this brachiopod are not known, but its external shape, ribbing, and concentric ornamentation are similar to "*Spirifer*" *vanuxemi* Hall from Manlius Limestone of New York (lithofacies also resembles that of Manlius). I have not recognized this brachiopod elsewhere in Oklahoma or Texas Panhandle.

Woodford Shale
Hunton Group 14,968'-15,630'?
14,968'-14,970' No core.
14,970'-15,030' ?Lower Devonian; ?Helderbergian. Dark-gray argillaceous organo-detrital limestone interbedded with calcareous shale (see above). Helderbergian ostracodes have been reported from this interval, but age of this unit requires further study.
15,030'-15,607' No core.
15,607'-15,625' ?Silurian; ?Chimneyhill Subgroup. Gray porous, crystalline dolomite. No chemical analyses available, but this is unquestionably high-magnesium dolomite with well over 30% $MgCO_3$. No diagnostic fossils observed, and its reference to Chimneyhill Subgroup is based on stratigraphic position. Note that in both Phillips 1-C Lee and nearby Phillips 1-A Horn (not described in this report) basal Hunton strata are represented by high-magnesium dolomite (panel 10, section B-B').
15,625'-15,630' Silurian; Chimneyhill Subgroup; ?Keel Formation. Dolomitized oolite; oolites completely replaced by crystalline dolomite. This unit rests on finely crystalline, argillaceous? dolomite which has been interpreted as being transitional between Sylvan Shale (15,338') and Hunton Group (Jenkins, 1971, p. 490). However, I tentatively assign these fine dolomites to Sylvan, interpreting them as facies of shale, mainly because in many places basal oolite rests directly on Sylvan Shale (panel 10, sections B-B', C-C').
Sylvan Shale 15,630'
(Interval from 15,630'-15,638' questionably included in Sylvan.)

STANDARD OF TEXAS 1 WHEELER UNIT--2470' FNL & 1980' FWL sec. 25, Blk. A-4, H&GN Survey, Wheeler County, Texas; elev. 2451'; TD 18,438'; compl. 2/4/69. Tops: Hunton (GR log) 15,910' (-13,459'), Sylvan (GR log) 16,627' (-14,176'); Hunton thickness 717'. Cored 15,943'-15,962' (Hunton); thin sections (borrowed from Chevron Oil Co., Oklahoma City); no chemical analyses; Chevron Oil Co., Oklahoma City, Oklahoma.

Cored portion of well is low-magnesium limestone yielding brachiopods, one of which is smooth terebratuloid brachiopod, probably *Amphigenia*. This certainly indicates Devonian age, very probably late Early Devonian fairly close to Sallisaw Formation of eastern Oklahoma, Turkey Creek limestone of Marshall County, Oklahoma, and Phillips 1-C Lina, Ochiltree County, Texas. Three wells in Texas Panhandle (1 Wheeler, 1 Walker, and 1-C Lina) include beds of Early Devonian age in Hunton Group, and it seems probable that patches of Early Devonian rocks are scattered over this region, probably thickening and becoming widely distributed in deeper part of Anadarko basin in Oklahoma.

Woodford Shale
Hunton Group 15,910'-16,627'
15,910'-15,943' No core.
15,943'-15,962' Lower Devonian; ?Emsian. Pale-gray crinoidal limestone with very little dolomite. Lower 7' with pinkish-gray color. Specimens of *Amphigenia*? sp. at 15,961' (see remarks above).
15,962'-16,627' No core.
Sylvan Shale 16,627'

KIRKPATRICK 1 WICHERT--SE¼NW¼ sec. 26, T. 22 N., R. 12 W., Major County, Oklahoma; elev. 1232'; TD 8001' (Sylvan); compl. 5/23/67, no Hunton production reported. Tops: Hunton (CC) 7769' (-6537'), Sylvan (CC) 7996' (-6764'); Hunton thickness 227'. Cored 7770'-7810' (Hunton); 2 thin sections; chemical analyses; OU Core Library.

Well is near Kirkpatrick 1 Shewey Unit, Kirkpatrick 1-A Shewey, and Kirkpatrick & Natol 1 Nickel Unit. In all 4 wells, upper Hunton strata are gray crystalline dolomites with much visible porosity; tests in 1 Shewey Unit and 1-A Shewey show 12% to 15% porosity. Trilobites from 1 Shewey Unit and 1 Wichert indicate that these upper Hunton dolomites are probably all Silurian. No specimens of *Kirkidium* have been recovered from these wells, although their apparent absence may be due to destruction by intense dolomitization.

Woodford Shale
Hunton Group 7769'-7996'
7769'-7770' No core.
7770'-7784' ?Silurian. Gray porous, crystalline dolomite with very little insolubles; HCl insolubles average 1.57%, $MgCO_3$ 42.08%. Pores in rock are, at least in considerable part, due to leaching of fossils, especially pelmatozoan plates; in fact, rock is so thoroughly leached that fossils are preserved almost entirely as molds. No fossils observed, and this unit referred to Silurian on basis of lithology and stratigraphic position (see remarks above).
7784'-7810' Silurian. Gray crystalline dolomite with some chert nodules in lower part; $MgCO_3$ averages 39.10%, HCl insolubles 5.56% (latter may include some silicified material). This unit has visible porosity,

although not as much as above; it is well leached, and fossils are preserved mostly as molds. Specimens of *Gravicalymene* cf. *G. celebra* Raymond (identified by K. S. W. Campbell; letter, 6/4/69) at 7798' indicate a Silurian age.
7810'-7996' No core.
Sylvan Shale 7996'

PAYNE 1 WILLIAMS--C NW¼SE¼ sec. 11, T. 15 N., R. 5 W., McClain County, Oklahoma; elev. 1104'; TD 7117' (Hunton); compl. 4/11/67, no Hunton production reported. Tops: Woodford (CC) 7016' (-5912'), Hunton (core) 7073' (-5969'). Cored 7068'-7095' (Woodford-Hunton); 2 thin sections; chemical analyses; OU Core Library.

Well not shown on stratigraphic section A-A', panel 10. It is located near Kirkpatrick 1 Cronkite, which yielded Lower Devonian fossils, but no diagnostic fossils have been observed in 1 Williams, and the age of cored portion is uncertain.

Woodford Shale 7016'-7073'
Hunton Group 7073'-7117' (TD)
7073'-7095' ?Lower Devonian. Dolomitic, fossiliferous marlstone with much silt-size subangular quartz detritus; HCl insolubles average 18.69%, $MgCO_3$ 20.92%. Fossils scattered through matrix and include a number of ostracodes. No diagnostic fossils observed and the reference of this unit to the Lower Devonian is based on its proximity to the 1 Cronkite; but note that lower, marlstone portion of the 1 Cronkite core did not yield any diagnostic fossils.
7117' TD

GULF 1 WILLIS--SW¼NW¼SE¼ sec. 20, T. 8 N., R. 2 E., Pottawatomie County, Oklahoma; elev. 1098'; TD 6315'; compl. 10/29/53, D&A. Tops: Woodford (CC) 5354' (-4256'), Hunton (CC) 5402' (-4304'), Sylvan 5874' (-4776'); Hunton thickness 472'. Cored 5403'-5477' (Hunton); 5 thin sections; one spot chemical analysis; OU Core Library.

Well cored Frisco Formation, with core probably ending in Cravatt Member of Bois d'Arc Formation. Only nearby well which cored Hunton is 1 Kytle-Ray, which is known to have cut Frisco.

Woodford Formation 5354'-5402'
Hunton Group 5402'-5874'
5402'-5403' No core.
5403'-5459' Lower Devonian; Frisco Formation. Organo-detrital sparite with much pelmatozoan material and shelly debris, including abundant bryozoans and brachiopods; shelly material much fragmented. A few beds have scattered subrounded quartz detritus, but for most part insoluble detritus is low; very little dolomite. Some visual porosity, mainly in matrix and in center of hollow fossils; some solution, possibly along fractures. Specimens of *Costispirifer arenosus*? at 5414'; *Meristella carinata*? at 5420'; *Costispirifer arenosus* at 5424'; *Rensselaeria elongata*?, *Costispirifer arenosus* at 5452'.
5459'-5468' Lower Devonian; ?Bois d'Arc Formation, Fittstown Member. Light-gray organo-detrital sparite with only small amount of detrital quartz; very little dolomite. Scattered chert nodules. Specimens of *Schellwienella* cf. *S. marcidula*, *Meristella* cf. *M.* sp. 2 (Amsden, 1958b, pl. 4, figs. 15-19), *Howellella cycloptera*? at 5464'. Preservation of these fossils is not very good, but fauna appears representative of Bois d'Arc Formation.
5468'-5477' Lower Devonian; ?Bois d'Arc Formation, Cravatt Member. Light-gray cherty, fossiliferous marlstone. Much silt-size subangular quartz detritus; very little dolomite. Specimens of *Atrypa* sp. and *Sphaerirhynchia glomerosa*? at 5473'. Lithology is typical for Cravatt Member, and the few fossils accord with this correlation.
5477'-5874' No core.
Sylvan Shale 5474'

FEDERAL 1 WOLLESON--C NW¼NE¼ sec. 22, T. 21 N., R. 2 W., Noble County, Oklahoma; elev. 1056'; TD 5250' (Ordovician); compl. 4/25/69, ?Misener production. Tops: Misener (CC) 5077' (-4021'), Ordovician (core) 5106' (-4050'); Misener thickness 29'. Cored 5083'-5122' (Misener-Ordovician); 4 thin sections, chemical analyses; OU Core library.

Misener in this core yields late Middle Devonian conodonts and is described and illustrated by Amsden and Klapper (1972, p. 2328-2330, fig. 4E). To my knowledge, this is only Middle Devonian unit which has been reported in Oklahoma. This well lies north of Hunton zero isopach (panel 6).

Woodford Shale
Misener Sandstone 5077'-5106'
5077'-5083' No core.
5083'-5106' Middle Devonian (Givetian). Dolomitic quartz sandstone interbedded with, and grading into, crystalline dolomite with many quartz-sand grains. Most of grains are well rounded, although quartz overgrowths give them angular external appearance. $MgCO_3$ ranges from 5% to 33%, and HCl insolubles from 20% to 81%. Conodonts from 5086'-5103' indicate late Givetian age (Amsden and Klapper, 1972, table 1, p. 2329).
Ordovician 5106'
5106'-5122' ?Viola Limestone. Organo-detrital limestone. Ordovician conodonts reported by Gilbert Klapper (letter, 5/13/71) at 5119'.

CONOCO 1 WOMAN GOING UP HILL--C SW¼SE¼ sec. 17, T. 13 N., R. 11 W., Blaine County, Oklahoma; elev. 1572'; TD 14,844' (Simpson Group); compl. 8/15/63, D&A. Tops: Woodford (CC) 13,468' (-11,896'), Hunton (CC) 13,712' (-12,140'), Sylvan (CC) 14,010' (-12,438'); Hunton thickness 298'. Cored 13,735'-13,831', 13,837'-13,849', 13,871'-13,877' (Hunton); 10 thin sections; chemical analyses; OU Core Library.

Well cored approximately 150' of upper Hunton, all low-magnesium marlstone. This is clearly part of Arbuckle Mountains marlstone lithofacies which is so well developed at surface and in deep part of Anadarko basin; however, organo-detrital limestones which overlie the marlstone, and which are so well developed in deep basin, are absent in 1 Woman Going Up Hill, perhaps owing to removal by post-Hunton erosion (Hunton rocks are substantially thinner in this well than in deep basin). No diagnostic fossils have been obtained from core, and it is not possible to determine whether core includes equivalents of Haragan Formation (Lower Devonian) as well as Henryhouse Formation (Silurian).

Woodford Shale 13,468'-13,712'

Hunton Group 13,712'-14,010'

13,712'-13,735' No core.

13,735'-13,877' (Two skips; see above.) ?Silurian; ?Henryhouse Formation. Gray to greenish-gray low-magnesium, fossiliferous marlstone. Considerable silt-size angular to subangular quartz detritus, including some mica; in some beds, generally with relatively low fossil content, quantity of detritus is substantial. HCl insolubles average 18.22%, $MgCO_3$ averages 7.74%. Fossils are scattered through matrix in varying concentrations, but rock is probably all mud supported; fossils include pelmatozoan plates and variety of shelly debris including brachiopods, trilobites, ostracodes, bryozoans, and a few corals. No diagnostic fossils observed, and this unit may include some of Haragan Formation (Lower Devonian) in upper part.

13,877'-14,010' No core.

Sylvan Shale 14,010'

GULF 1 WRIGHT HEIRS--NW¼SW¼NW¼ sec. 5, T. 12 N., R. 2 W., Oklahoma County, Oklahoma; elev. 1116'; TD 6345' (Hunton); compl. 8/10/50, Hunton production reported. Tops: Misener (core) 6300' (-5184'), Hunton (core) 6305' (-5189'). Cored 7276'-6343' (Woodford, Misener, Hunton); 3 thin sections; chemical analyses; OU Core Library.

Stratigraphic relations in this well are similar to those in Gulf 1 Holtzschue and Gulf 1 Schroeder; in all 3 wells Frisco Formation (Lower Devonian) rests directly on Kirkidium-Henryhouse strata (text-fig. 20).

Misener Sandstone 6300'-6305'

6300'-6305' ?Upper Devonian. Dark-gray calcareous sandstone. No diagnostic fossils observed; Misener is generally of Late Devonian age (Amsden and Klapper, 1972, p. 2328), but in Federal 1 Wolleson Misener has a late Middle Devonian conodont fauna.

Hunton Group 6305'-6345' (TD)

6305'-6315' Lower Devonian; Frisco Formation. Light-gray organo-detrital limestone with very little dolomite or insoluble detritus; $MgCO_3$ averages 1.69%, HCl insolubles 2.42%. Mostly cemented with spar, but a few beds with micrite. Some visual porosity, mainly in matrix and in center of hollow fossils (pl. 7, figs. 2a, 2b). Frisco fossils at 6306', 6309', 6311', 6314'; Leptostrophia magnifica, Costispirifer arenosus, large terebratuloid brachiopod, large ramose favositid coral.

6315'-6343' Silurian; Henryhouse Formation. Light-gray fossiliferous marlstone grading into argillaceous organo-detrital limestone; HCl insolubles average 8.01%, $MgCO_3$ 7.81%. Silurian tabulate corals of Henryhouse type at 6333'-6335' (identified by P. K. Sutherland).

6343'-6345' (TD) No core.

CHEVRON 1 ZELLERS--C SE¼SW¼ sec. 28, T. 5 S., R. 2 W., Carter County, Oklahoma; elev. 955'; TD 9958' (Sylvan); compl. 2/2/68, Hunton production reported. Tops: Woodford (CC) 9225' (-8270'), Hunton (CC) 9454' (-8499'), Sylvan (CC) 9895' (-8940'); Hunton thickness 441'. Cored 9825'-9875' (Hunton); 4 thin sections; chemical analyses; OU Core Library.

Strata here referred to Clarita Formation have substantial amount of insolubles (average 22.75%). This high insoluble content suggests Henryhouse Marlstone (cf. to 1 Ticer et al.), but in the main these beds have "pink-crinoidal" type of lithology, and since they directly overlie strata with Cochrane fossils they are tentatively assigned to Clarita Formation.

Woodford Shale 9225'-9454'

Hunton Group 9454'-9895'

9454'-9825' No core.

9825'-9851' Silurian; ?Chimneyhill Subgroup; ?Clarita Formation. Light-gray to pinkish-gray biomicrite with many pink crinoid plates. Two thin sections show only moderate insoluble detritus, but analyses indicate average of 22.75%; $MgCO_3$ averages 6.81%. In addition to crinoids, this rock has richly varied shelly fauna. No diagnostic fossils observed (see discussion above).

9851'-9875' Silurian; Chimneyhill Subgroup; Cochrane Formation. Light-gray to greenish-gray biosparite. This unit has much pelmatozoan material plus varied shelly fauna, almost all cemented with spar. Some beds have considerable glauconite; HCl insolubles average 1.22%, $MgCO_3$ 1.43%. Triplesia alata Ulrich and Cooper at 9869', indicating correlation with Cochrane Formation.

9875'-9895' No core.

Sylvan Shale 9895'

Part II–Sample Descriptions

Hunton samples from 27 deep wells are described in the following pages. These samples are from the deep part of the Anadarko basin, mostly below the −15,000-foot Hunton structure contour, and from shallow fault blocks between the Wichita uplift and the deep basin. No biostratigraphic information has been obtained from the samples, and the investigation is concerned exclusively with the lithologic and lithostratigraphic character of the rocks. The samples were examined with a binocular microscope, supplemented by a petrographic examination of several hundred thin sections, most of which were stained with Alizarin Red-S to facilitate the distinction between calcite and dolomite. Using this method, it is possible to make a reasonable estimate of the dolomite present, and I have tried to distinguish three categories: (1) limestone (less than 10 percent $MgCO_3$), (2) dolomitic limestone—calcitic dolomite, and (3) crystalline dolomite (approximately 28 percent or more $MgCO_3$). The crystalline-dolomite texture is especially useful, as an examination of numerous thin sections of carbonate rocks that have been chemically analyzed shows this texture to be developed almost invariably in dolomites with 28 to 29 percent or more $MgCO_3$ (see Silurian Dolomite section in main text). It is, of course, not possible to correlate precisely the visual estimates based on sample studies with the chemical analyses obtained from cores, and, accordingly, these data are kept separate on the lithofacies maps.

The sample descriptions are brief, as the main goal is to summarize those characters that are most useful in the present lithofacies investigation. These include (1) degree of dolomitization; (2) textural characteristics, such as organo-detrital, marlstone, etc.; (3) quantity and nature of the silt-size insoluble detritus; and (4) other features, such as chert.

The thicknesses cited are taken from the drilling records, and it is assumed that variations in dip and (or) faulting have not introduced any significant errors. Where there is a discrepancy between the sample-log and the mechanical-log tops for the Woodford-Hunton and Hunton-Sylvan contacts, the latter has been used. Generally the data from these two sources are in reasonable agreement, although a few wells do appear to have a significant sample lag. However, all lithostratigraphic divisions within the Hunton Group have been determined from the samples.

All thin sections are in the collections of the Oklahoma Geological Survey, and the repository of the samples is noted for each well.

HOWELL, HOLLOWAY, & HOWELL 1 ANADARKO BASIN--NW¼NW¼SE¼ sec. 4, T. 9 N., R. 12 W., Caddo County, Oklahoma; elev. 1547'; TD 21,021' (Viola); compl. 10/8/56, D&A. Tops: Woodford 19,385' (-17,838'), Hunton 19,520' (-17,973'), Sylvan 20,210' (-18,663'); Hunton thickness 690'. Cuttings examined 19,450' (Woodford) to 20,450' (Viola); borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma; good-quality samples; 14 thin sections prepared, stained with Alizarin Red-S.

The Hunton is essentially a limestone sequence resembling that of the Arbuckle Mountains region except that no recognizable Chimneyhill is present, the marlstone lithostratigraphic unit resting directly on the Sylvan Shale. The limestones carry some scattered euhedral dolomite crystals, becoming moderately abundant in the lower 200'; however, no crystalline dolomite is present, and in all probability the $MgCO_3$ content in no place exceeds 15% and the average must be 10% or less. Much silt-size angular quartz detritus is present in the marlstone, and this is probably accompanied by fine silt- and clay-size detritus; the quartz detritus appears to be comparable in amount to that of the Arbuckle Mountains sections. The dolomite crystals and quartz detritus are about the same size, mostly 0.05 mm or less. The lithologic sequence in the 1 Anadarko Basin is similar to that in the Lone Star 1 Baden and other deep wells in having an upper, light-gray organo-detrital limestone sequence underlain by a marlstone section (this is excluding the upper detrital carbonates, here assigned to the Misener). However, in the 1 Baden and other deep wells there is a light-colored organo-detrital limestone section at the base (Chimneyhill Subgroup), which is not recognizable in the 1 Anadarko Basin.

Woodford Shale 19,390'-19,520'
Dark shale.
Hunton Group 19,520'-20,210'
19,520'-19,780' ?Frisco Formation and (or) ?Fittstown Member, Bois d'Arc Formation. Light-gray organo-detrital limestone with very little quartz detritus or dolomite. Fossils with much shelly debris, including several bryozoans, and many pelmatozoan plates.
19,780'-20,210' ?Henryhouse and (or) Haragan Formation. Dark-gray marlstone. Matrix is finely divided calcite with clay- and silt-size insoluble detritus. Euhedral crystals of dolomite are scattered through matrix; dolomite crystals and quartz detritus have a similar size range, with a few up to 0.10 mm, but most about 0.05 mm or less. This unit is similar to marlstones in Arbuckle Mountains-Criner Hills.

Lower 190' is similar to upper part, but with some increase in quantity of quartz detritus and dolomite; quantity of dolomite in some samples is considerable, although it never approaches a crystalline texture. Some mica is present.

Sylvan Shale 20,210'-20,420'
Dark shale.
Viola Limestone
Organo-detrital limestone with very little quartz or dolomite.

LONE STAR 1 BADEN--C SE¼ sec. 28, T. 10 N., R. 22 W., Beckham County, Oklahoma; elev. 1953'; TD 30,050' (Viola); compl. 1972, no Hunton production reported. Tops: Woodford-Misener? contact 28,450' (-26,497'), Hunton 28,610' (-26,657'), Sylvan 29,760' (-27,807'), Viola 29,970' (-28,017'); Hunton thickness 1,150' (1,310' incl. Misener). Samples examined from 28,400' (Woodford) to 30,050' (TD; Viola); good quality; 26 thin sections prepared; samples borrowed from Lone Star.

The upper calcareous siltstone and shale lying just beneath the Woodford Shale (28,450'-28,610') is tentatively referred to the Misener, and the Hunton is defined to include the strata from 28,610' to the Sylvan Shale at 29,760'. Described in this manner, the Hunton rocks have a close resemblance in lithologic character and lithostratigraphic sequence to the Hunton Group in the Arbuckle Mountains and Criner Hills, the principal difference being thickness, with the 1 Baden totaling 1,150' (assuming no structural anomaly) as opposed to about 450' maximum in the outcrop area. The basal Hunton strata (29,580'-29,760') that rest directly on the Sylvan Shale consist of bioclastic limestones (including an oolite at the base) similar to the Chimneyhill Subgroup of the outcrop area; this is overlain by a marlstone sequence similar to that of the Haragan-Henryhouse (28,730'-29,580'), and this in turn is overlain by a biosparite resembling the Bois d'Arc (Fittstown Member)-Frisco Formations (28,610'-28,740') of the Arbuckles. The dolomite content is low in most parts of this section, being in the form of scattered dolomite crystals that at no place grade into a crystalline dolomite; the $MgCO_3$ content is probably everywhere less than 20%, and for the section as a whole I estimate less than 10%. There is no faunal evidence bearing on the age of these strata, although the lithostratigraphic sequence when compared to the Arbuckle Mountains suggests that the upper biosparites represent Early Devonian (see panel 10, sections C-C').

Woodford Shale

Misener? Sandstone 28,450'-28,610'

Dark-gray fine-grained, silty dolomite? Many dolomite crystals, in places grading into crystalline dolomite. Scattered angular, silt-size quartz grains and some mica. Little or no fossil debris.

Hunton Group 28,610'-29,760'

28,610'-28,740' ?Frisco Formation and (or) Fittstown Member, Bois d'Arc Formation. Light-gray organo-detrital limestone; shelly debris and pelmatozoan plates, mostly with spar cement. Very little dolomite. Some solution and recrystallization.

28,740'-29,580' ?Haragan and (or) Henryhouse Formation. Dark-gray marlstone with much silt-size, angular quartz detritus and some mica. Scattered fossils, including shelly debris and pelmatozoan plates; in places with numerous ostracodes. Scattered dolomite crystals, none approaching a crystalline dolomite.

29,580'-29,760' ?Chimneyhill Subgroup. Light-gray to pinkish-gray organo-detrital biosparite. Ostracodes, trilobites, and other shelly material along with many pelmatozoan plates. Only minor dolomite and very little quartz detritus. Basal 10' oolitic, ooids having both concentric and radial structure (?Keel Formation).

Sylvan Shale 29,760'-29,970'

Viola Limestone 29,970'-30,050' (TD)

Dark biosparite with very little quartz or dolomite.

PHILLIPS 1-A BAILEY--1320' FSL & 1320' FWL sec. 9, Blk. A-5, H&GN Survey, Wheeler County, Texas; elev. 2830'; TD 13,863'; compl. 1/19/72; Woodford-Hunton contact 11,990'; Hunton-Sylvan contact 12,310'; Hunton thickness 318'. Well samples borrowed from Phillips, examined from basal Woodford beds through Hunton and into Sylvan; sample quality good. Seven thin sections prepared, stained with Alizarin Red-S.

Hunton rocks in this well are similar to those in the nearby Phillips 1-C Lee (see panel 10, stratigraphic section B-B') although slightly thinner. The upper limestone in the 1-A Bailey is a low-magnesium stone like that in the 1-C Lee, with which it is probably at least in part correlative. The basal oolite, which is well developed in the 1-C Lee, was not observed in the 1-A Bailey. On the basis of lithostratigraphic similarity and thickness I provisionally assign all of the Hunton rocks in the 1-A Bailey to the Silurian; I correlated the upper part with the Kirkidium biofacies (illustrated, panel 10, C-C').

Woodford Shale

Hunton Group

11,990'-12,190' ?Silurian; ?Kirkidium biofacies, at least in part. Light-gray to pinkish-gray organo-detrital limestone; partly micrite, partly spar cement. This is a very low-magnesium limestone with almost no dolomite; also very low in detrital quartz.

12,190'-12,310' ?Chimneyhill Subgroup. Gray crystalline dolomite with very little detrital quartz. Considerable light-colored chert, at least in part fossiliferous.

Sylvan Shale

ARKLA 1 BEAUCHAMP--C NE¼ sec. 21, T. 13 N., R. 18 W., Custer County, Oklahoma; elev. 1745'; TD 20,898'; compl. 9/1/72, perforated Hunton 20,262'-20,317', no Hunton production reported. Hunton-Woodford contact (GR log) at 20,232' (-18,487'), and Sylvan-Hunton contact (GR log) at 20,782' (-19,037'). Note: samples show Sylvan top at about 20,850', difference presumably due to sample lag (GR log tops used); Hunton thickness 550'. I examined samples from lower part of Woodford through Hunton and Sylvan to bottom (last sample 20,893'-20,898'); 18 thin sections stained with Alizarin Red-S were prepared. Samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton rocks are largely in a limestone and dolomitic-limestone facies. There is some crystalline dolomite in the upper part of the Hunton, but mostly it is organo-detrital limestone and marlstone with scattered dolomite crystals; almost all the fossil debris retains its original texture. The upper 170' (to a depth of 20,400') is organo-detrital limestone grading downward into crystalline dolomite with only minor quartz detritus. Below this is marlstone with scattered fossils, most of which has a substantial quantity of subangular to angular quartz (to about 0.05 mm) and some mica; dolomite crystals are scattered through this section in varying degrees of concentration, and the rock only rarely if ever approaches a crystalline dolomite. Most of the marlstone is probably a dolomitic limestone, only rarely grading into calcareous dolomite. The marlstone extends down to within 50' or so of the Sylvan Shale, where it is probably replaced by a biosparite with some chert; the thin sections in this lower part are generally of poor quality except for the basal beds, which contain excellent oolites (Keel Formation). This lower portion almost certainly includes some Chimneyhill equivalents, although its exact boundary with the overlying marlstone is not well defined (in part because of sample lag).

The Beauchamp differs from the cored wells to the north (1 Frans, 1 Sharp-Hunt Unit, 1 Horton, 1-1 Hoffman), where at least the upper 100' to 150' of the Hunton is almost completely crystalline dolomite, mostly averaging over 30% $MgCO_3$ (see part I of Appendix). In contrast, the upper 60' to 70' of the 1 Beauchamp appears to be mostly low-magnesium limestone, underlain by dolomitic limestone and crystalline dolomite. The age of this upper part is uncertain; it could correlate with the upper part of the Hunton in Custer County, in which case it is probably at least in part Silurian, or it could correlate with the upper organo-detrital limestones in the south and east, in which case it may be Lower Devonian. The age of the marlstone is also uncertain, but the lower bioclastic limestones and oolites are almost certainly at least in part correlative with Chimneyhill strata.

Woodford Shale

Hunton Group 20,232'-20,782' (GR log)

20,232'-20,330' Light-gray bioclastic limestone; upper part with very little dolomite, lower part moderately dolomitic. Some detrital quartz to 0.05 mm.

20,330'-20,400' Mostly crystalline dolomite; minor dolomitic bioclastic limestone; only minor detrital quartz.

20,400'-20,750'? (base in question because of sample lag). Dark-gray marlstone with much angular silt-size detrital quartz. Scattered fossils. This unit contains scattered dolomite crystals, in places quite abundant, but none appears to be in the crystalline-dolomite facies.

20,750'?-20,782' (GR log) ?Chimneyhill Subgroup. Biosparite with much chert and oolites (?Keel Formation). Oolites well developed, mostly set in spar cement. Very little dolomite. Poor sample quality.

Sylvan Shale 20,782'

TENNECO 1-27 BRADSHAW--SW¼SW¼NE¼NW¼ sec. 27, T. 14 N., R. 24 W., Roger Mills County, Oklahoma; elev. 2164'; TD 21,700' (Sylvan Shale); compl. 7/11/73, Morrow production. Tops: Hunton 21,031' (-18,867') (CC), Sylvan 21,635' (-19,471') (samples); Hunton thickness 604'. Samples examined from 21,200' to 21,635' (missing from 20,600' to 21,200'); good quality; 12 thin sections prepared, stained with Alizarin Red-S.

The Hunton in this well resembles the Inexco 1 Lovett, about a mile to the northwest. The upper part of the Hunton examined (21,200'-21,490') is a low-magnesium limestone or marlstone resembling this part of the 1 Lovett, although the 1-27 Bradshaw has somewhat more detrital quartz and somewhat less fossil debris; the lower Hunton in both wells is crystalline dolomite (see panel 10, section C-C').

Woodford Shale (samples lost)

Hunton Group 21,031'-21,635' (no samples to 21,200')

21,200'-21,490' ?*Kirkidium* biofacies in part. Medium to dark-gray moderately to weakly dolomitic limestone, mostly with substantial quantities of detrital quartz, angular to well rounded. Much micrite cement; in considerable part this rock has a marlstone texture.

21,490'-21,635' ?Chimneyhill Subgroup in part. Gray crystalline dolomite with much chert. Some silicification and some detrital quartz.

Sylvan Shale 21,635'-21,700' TD

UNION OF CALIFORNIA 1-33 BRUNER--N½N½SW¼NE¼ sec. 33, T. 11 N., R. 25 W., Beckham County, Oklahoma; elev. 2090'; TD 24,548' (?Hunton); compl. 4/8/72, Hunton production. This well penetrated 483' of Hunton, Woodford-Hunton contact being at 24,065' (-21,975'), and total depth at 24,548' (in Hunton).

This well was drilled initially to a depth of 24,136', where the drill twisted off; samples were collected from this interval, including about 40' of Hunton; these samples appear to be good, and information bearing on the Hunton lithology is believed to be reliable (3 thin sections prepared). At a depth of 24,136' the well was whipstocked and drilled on to the total depth. The samples from this part are extremely poor and consist in large part of "mica" and other material introduced into the hole, with only a few pieces of rock (11 thin sections prepared). The samples above the whipstocked portion consist of organo-detrital sparite with very little dolomite or detrital quartz; fossils include both pelmatozoan debris and shelly material including brachiopods and bryozoans. Below the whipstock the rock fragments are mainly of three types: (1) an organo-detrital limestone; (2) a peculiar, mottled limestone that may be a recrystallized organo-detrital limestone or perhaps at least in part an algal limestone (this type has not been observed heretofore in any of the Hunton rocks, surface or subsurface); (3) crystalline dolomite. In view of the very sparse representation of rock fragments, and the mixture of rock types including the unusual mottled limestone, it seems best to regard this interval as of questionable lithologic affinities (the presence of crystalline dolomite suggests that this well lies within the dolomite province). Samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma, and Union of California. In 1972 (Oklahoma Geology Notes, p. 91) this was reported as the world's deepest producing well.

See description of the Union of California 1 Goode, located about a mile northeast of the 1-33 Bruner.

Woodford Shale to 24,065'
Dark shale.

Hunton Group 24,065'-24,548' TD

24,065'-24,130' Light-gray organo-detrital limestone with very little detrital quartz or dolomite.

The lithology and stratigraphic position of these strata are similar to those in the upper part of the 1 Baden and other deep wells to the east, the strata here being assigned with question to the Lower Devonian; however, these limestone beds in the 1-33 Bruner could represent undolomitized Kirkidium beds, similar to those found in the Phillips 1-C Lee.

24,130'-24,547' Poor-quality samples.

MOBIL 1-A CEMENT (Ordovician test)--SW¼NE¼SE¼ sec. 18, T. 5 N., R. 8 W., Grady County, Oklahoma; elev. 1337'; TD 20,330' (Bromide); compl. 9/26/69, D&A. Tops: Woodford-?Misener 17,894' (CC; some sample lag) (-16,557'), ?Misener-Hunton 17,950' (samples) (-16,613'), Hunton-Sylvan 18,388' (CC) (-17,051'); Hunton thickness 438'. Examined samples from lower part of Woodford through Hunton (samples skip from 18,080' to 18,250') into Sylvan; sample quality in upper part of Hunton is poor, mostly very fine and mixed with much mica; from 18,300' into Sylvan quality improves; 12 thin sections prepared, stained with Alizarin Red-S.

The stratigraphic sequence is fairly well defined in spite of the poor samples in the upper part and the sample skip. The upper Hunton, just beneath the Woodford, is a dark calcareous siltstone, here tentatively referred to the Misener Sandstone. This is underlain by marlstone, followed by a light-gray organo-detrital limestone tentatively referred to the Chimneyhill Subgroup. The dolomite content is low throughout, and the Hunton appears to be a part of the Arbuckle Mountains limestone facies.

Woodford Shale
?Misener Sandstone 17,894'-17,950'
Dark calcareous siltstone with some chert.
Hunton Group 17,950'-18,388' (sample skip 18,080'-18,250')
17,950'-18,340' Dark-gray fossiliferous marlstone with much silt-size quartz detritus; very little dolomite. Age of this rock is undetermined biostratigraphically, but its lithology and stratigraphic position suggest correlation with Haragan and (or) Henryhouse Formation.
18,340'-18,388' ?Chimneyhill Subgroup. Light-gray organo-detrital limestone with some chert; very little dolomite or detrital quartz.
Sylvan Shale 18,388'

CITIES SERVICE 1 CHALEPAH--NW¼NW¼ sec. 10, T. 5 N., R. 12 W., Caddo County, Oklahoma; elev. 1385'; TD 7200' (Ordovician); compl. 4/18/50, D&A. Tops: Woodford-?Misener 4940' (-3555'), ?Misener-Hunton 5010' (-3625'), Sylvan 5710' (-4325'); Hunton thickness 700'. Examined samples from lower Woodford, through Hunton and into Sylvan Shale; 17 thin sections stained with Alizarin Red-S; samples, OU Core Library.

This well is located in one of the fault blocks between the Wichita Mountains uplift and the deep part of the Anadarko basin. It is a low-magnesium limestone throughout and clearly a part of the Arbuckle Mountains limestone lithofacies. The sequence is typical for this area, and for the Arbuckles, consisting of an upper organo-detrital limestone (uppermost strata assigned to the ?Misener), a middle marlstone, and a lower organo-detrital limestone with an oolite just above the Sylvan Shale (see panel 10, section C-C').

Woodford Shale 4290'-4940'
?Misener Sandstone 4940'-5010'
Fine, silty calcareous dolomite with some chert.
Hunton Group 5010'-5710'
5010'-5180' ?Frisco Limestone and (or) ?Fittstown Member, Bois d'Arc Formation. Weakly to moderately dolomitic biosparite, becoming biomicritic and with increasing quartz detritus in lower part; some chert. Appears to grade into underlying marlstone; this is suggestive of Fittstown-Haragan relationship in Arbuckle Mountains-Criner Hills outcrop area.
5180'-5640' ?Haragan and (or) ?Henryhouse Formation. Typical fossiliferous marlstone lithology with very little dolomite. In lower 160' red beds are common; these have substantial fossil content but also a significantly increased quantity of angular to subangular quartz debris. Lithology and stratigraphic position similar to that of Henryhouse-Haragan marlstone in outcrop.
5640'-5710' ?Chimneyhill Subgroup. Light-gray biomicrite; low in detrital quartz and in dolomite crystals. Fossil content is higher and detrital quartz content lower than in overlying marlstone (resembles micritic facies of Clarita Formation). Basal 10' of samples has many pieces of oolite, fossiliferous and with spar cement. Very low dolomite content (Keel Formation). Stratigraphic position and lithology are like those of Chimneyhill Subgroup.
Sylvan Shale 5710'

SIGNAL 1 CITY OF ARDMORE--1755' FNL and 860' FEL sec. 4, T. 5 S., R. 2 E., Carter County, Oklahoma; elev. 843' GL; TD 20,183' (?Schlumberger log); compl. 1973, production?. Woodford-Misener contact 17,490' (-16,647'), Misener-Hunton contact 17,590' (-16,747'), Hunton-Sylvan contact 17,620' (-16,777') (from samples and Schlumberger log); Hunton thickness 30'. I examined cuttings from 17,230' to 18,100' (top of Woodford through Hunton, Sylvan, and into Viola); 14 thin sections prepared, stained with Alizarin Red-S. Cuttings borrowed from Jack Cagle, Ardmore, Oklahoma.

This well, located between Criner Hills and Arbuckle Mountains outcrop areas (panel 1, map A), is in an area where Hunton rocks have been thinned by pre-Woodford erosion, leaving only Chimneyhill; it is not far west of truncated margin of Hunton. Hunton strata in this well are represented entirely by Chimneyhill Subgroup with Keel oolite at its base; these are low-magnesium limestones, typical in all respects of strata exposed in outcrop area.

Woodford Shale 17,250'-17,490'
Black shale.
Misener Sandstone 17,490'-17,590'
Dark-gray dolomitic siltstone and silty dolomite; angular quartz-silt grains; dolomite crystals appear worn (?detrital dolomite). Much chert, which appears to be in considerable part silicified siltstone with angular quartz detritus similar in size and form to that present in dolomite.
Hunton Group 17,590'-17,620'
Chimneyhill Subgroup. Light-gray organo-detrital limestone with much oolite (Keel Formation); very little quartz detritus and only moderate scattered dolomite crystals. Oolite is cemented with spar; typical radial and concentric ooids, very little detrital quartz or dolomite. Section probably consists of an upper organo-detrital limestone and an underlying oolite.
Sylvan Shale 17,620'-17,910'
Gray shale.
Viola Limestone 17,910'- (examined to 18,100')
Impure organo-detrital limestone with chert.

ARKLA 1-21 CLANCY ESTATE--C NE¼ sec. 21, T. 9 N., R. 11 W., Caddo County, Oklahoma; elev. 1445'; TD 19,623' (Viola); compl. 12/17/72, Springer production. Tops: Hunton 18,700' (-17,255') (CC), Sylvan 19,270' (-17,825'), Viola 19,450' (-18,005'). Samples examined from Woodford through Hunton, Sylvan, and into Viola; 13 thin sections, stained with Alizarin Red-S.

The Hunton rocks are in the Arbuckle Mountains limestone lithofacies, generally with only scattered dolomite crystals moderately concentrated in a few beds. The lithostratigraphic sequence consists of an upper organo-detrital limestone (?Lower Devonian), a middle marlstone unit (?Haragan and/or ?Henryhouse Formation), and a lower organo-detrital limestone (Chimneyhill Subgroup), with a well-developed basal oolite (Keel Formation). However, the lithologic distinction between the upper limestone and the underlying marlstone is not as sharply marked as in the nearby 1 Anadarko Basin, as the upper limestone has a substantial amount of detrital quartz.

Woodford Shale
Hunton Group 18,700'-19,270'
18,700'-18,850' ?Frisco Formation and (or) ?Fittstown Member, Bois d'Arc Formation. Biosparite with considerable angular quartz detritus; scattered dolomite crystals, in places moderately abundant. Contact with underlying unit not sharply defined.
18,850'-19,170' ?Haragan and (or) ?Henryhouse Formation. Medium- to dark-gray marlstone; matrix of finely divided (partly finely crystalline) limestone with much angular quartz detritus and some scattered dolomite crystals. Some fossils, including ostracodes and bryozoans.
19,170'-19,270' Chimneyhill Subgroup. Light-gray biomicrite with minor detrital quartz and some dolomite in lower part. Lower 10' with well-formed oolites set in spar matrix (Keel Formation).
Sylvan Shale 19,270'-19,450'
Viola Limestone 19,450'

PURE 1 FUQUA--SW¼SW¼NE¼ sec. 18, T. 6 N., R. 16 W., Kiowa County, Oklahoma; elev. 1460'; TD 2019' (Fernvale Limestone from sample log); compl. 5/20/39, D&A. Tops: Pennsylvanian-Hunton contact 430' (+1030'), Sylvan 1690' (-230'), Fernvale 1990' (sample log); Hunton thickness 1260'. Cuttings examined from Woodford through Hunton and into Sylvan; 23 thin sections prepared, stained with Alizarin Red-S.

This well is in one of the shallow fault blocks between the Wichita Mountains uplift and the deep part of the Anadarko basin. It is low-magnesium limestone throughout and clearly a part of the Arbuckle Mountains lithofacies. The sequence is typical for this general region, and for the Arbuckle Mountains and Criner Hills, consisting of an upper organo-detrital limestone (?Lower Devonian), a middle marlstone (?Devonian and/or ?Silurian), the basal bed of which is oolite (Chimneyhill Subgroup).

Pennsylvanian Sandstone and Conglomerate
Hunton Group 430'-1690'
430'-780' ?Frisco Limestone and (or) ?Fittstown Member, Bois d'Arc Formation. Light-colored organo-detrital sparite with minor detrital quartz and crystals of dolomite; some chert. Lower boundary not well defined.
780'-1000' Mixture of light- and dark-colored organo-detrital sparite and micrite; some chert. This interval includes some fairly typical marlstone as below. Very little dolomite. This interval appears to be gradational between overlying and underlying strata.
1000'-1540' Haragan and (or) Henryhouse Formation. Typical marlstone texture with considerable quartz detritus and very little dolomite. Lower 200' has substantial red beds; these have much quartz detritus with some mica, noticeably more than in the upper, gray parts. Many fossils, especially shelly debris and bryozoans, but not much coral material.
1540'-1690' ?Chimneyhill Subgroup. Light-colored organo-detrital limestone with only minor quartz detritus; spar and micrite cement. Many fossils: shelly debris, crinoids, bryozoans, and ostracodes. From 1630' to 1660' much glauconite and some dolomite crystals (?Cochrane Formation). Basal 20' mostly oolite with spar matrix and very little dolomite (Keel Formation).
Sylvan Shale 1690'-1990'

GOFF-LEEPER 1 GILES--C NW¼NE¼ sec. 15, T. 6 N., R. 13 W., Caddo County, Oklahoma; elev. 1412'; TD 7461' (Bromide); compl. 2/15/62, D&A. Tops: Woodford-?Misener 4490' (-3078'), ?Misener-Hunton 4510' (-3098'), Sylvan 5710' (-4298'); Hunton thickness 1200'. Samples examined from lower Woodford through Hunton and into Sylvan (skip 5120'-5540'); 19

thin sections, stained with Alizarin Red-S; samples in OU Core Library.

This well is in one of the shallow fault blocks between the Wichita Mountains uplift and the deep part of the Anadarko basin. The Hunton strata include only minor amounts of dolomite and are a part of the Arbuckle Mountains limestone lithofacies. The lithostratigraphic sequence, consisting of an upper organo-detrital limestone (?Lower Devonian), a middle marlstone (?Lower Devonian and/or ?Silurian), and a lower organo-detrital limestone with a basal oolite, is similar to that of other wells in this area and to that of the outcrop area. It should be noted that, according to the sample log and the completion card this is a faulted section and the Hunton is repeated (in the upper part of the well). There is also a substantial skip in the samples, but since the lithology and lithostratigraphic sequence are like those of other wells in this area the limestone lithofacies is considered to be present in this block (see panel 10, section C-C').

Woodford Shale
?Misener Sandstone 4490'-4510'
Fine dolomitic limestone with quartz detritus; chert. Very little fossil debris.
Hunton Group 4510'-5710'
4510'-4900' ?Frisco Formation and (or) Fittstown Member, Bois d'Arc Formation. Light-gray biosparite and biomicrite with some scattered dolomite crystals and minor detrital quartz. Fossil debris includes much shelly material, including many bryozoans.
4900'-5120' ?Haragan and (or) ?Henryhouse Formation. Mainly fossiliferous marlstone with only minor dolomite in upper part and very little in lower part. Much silt-size angular to subangular quartz detritus.
5120'-5540' Sample skip.
5540'-5710' ?Chimneyhill Subgroup. Light-gray to pinkish-gray biosparite and biomicrite with much light-colored chert in upper part; very little dolomite or detrital quartz. Some glauconite in lower part. Basal 10' is oolite with spar cement, some fossil debris, and very little dolomite (Keel Formation).
Sylvan Shale 5710'

UNION OF CALIFORNIA 1 GOODE--sec. 29, T. 11 N., R. 25 W., Beckham County, Oklahoma; elev. 2094'; TD 25,655' (Sylvan); compl. 1973. Tops: Woodford 24,260' (-22,166'), ?Misener 24,520' (-22,426'), Hunton 24,550' (-22,456'), Sylvan 25,590' (-23,496'); Hunton thickness 1040'. This well drilled in section northwest of Union of California 1-33 Bruner; the latter twisted off about 70' into Hunton (24,136') and then whipstocked to drill to 24,548'; cuttings below whipstock are very poor in quality and were not used. The 1 Goode cuttings were examined from lower part of the Sycamore through Woodford, Hunton, and into top of Sylvan; most cuttings in lower part of Hunton are very fine, but otherwise appear satisfactory; 26 thin sections stained with Alizarin Red-S.

The 30' of strata just beneath the Woodford consists of cherty carbonate with much angular silt-size quartz detritus here referred to the Misener?. The Hunton in this well cannot be effectively compared with the nearby 1-33 Bruner because only the upper 30' of the Hunton in the latter yielded usable cuttings. Hunton rocks in the 1 Goode appear to be transitional between the Arbuckle limestone lithofacies, as typified by the Lone Star 1 Baden and other eastern deep wells, and the crystalline-dolomite lithofacies of the wells to the north and west (panel 2). The threefold stratigraphic division in the 1 Baden and other eastern deep wells (panel 10, stratigraphic section C-C') is not well defined in the 1 Goode, as the marlstones are poorly developed and dolomitization obscures the sequence; however, only in the middle portion of the Hunton (24,880'-25,200') is there any extensive development of the crystalline-dolomite lithofacies. The Hunton section in the 1 Goode is thick, and as there are light-colored organo-detrital limestones present at the top of this well it could include some Lower Devonian; however, it can also be compared to the Phillips 1-C Lee, in which the uppermost Hunton limestones represent the Kirkidium biofacies.

Woodford Shale 24,260'-24,520'
Dark noncalcareous shale.
Misener Sandstone? 24,520'-24,550'
Carbonate, in part dolomitic, with much angular quartz detritus and considerable chert.
Hunton Group 24,550'-25,590'
24,550'-24,650' Light-gray organo-detrital limestone with only minor detrital quartz and dolomite. Spar and micrite matrix.
24,650'-24,880' Medium-gray fossiliferous limestone, mostly with only minor detrital quartz and scattered dolomite crystals. Much micrite cement, but also some sparite. In part this is finely crystalline limestone which may be recrystallized.
24,880'-24,950' Crystalline dolomite with very little detrital quartz.
24,950'-25,040' Mixture of crystalline dolomite, dolomitic limestone, and fossiliferous limestone. Only minor quartz detritus.
25,040'-25,120' Poor-quality cuttings.
25,120'-25,180' Crystalline dolomite with considerable detrital quartz; subangular and with some mica. Minor dolomitic, fossiliferous limestone.
25,180'-25,340' Medium-gray dolomitic limestone with considerable detrital quartz and mica. Very little crystalline dolomite. Similar to marlstone lithology of eastern deep wells.
25,340'-25,530' Mainly finely divided (micrite? recrystallized?) limestone with scattered fossils; very little detrital quartz and only minor dolomite.
25,530'-25,590' Limestone as above, with some oolite (Keel Formation?). Very little detrital quartz. Some crystalline dolomite.
Sylvan Shale 25,590'-25,655' (TD)

CONTINENTAL 1 GORDON UNIT--C SE¼ sec. 20, T. 10 N., R. 26 W., Beckham County, Oklahoma; elev. 2072'; TD 19,956' (Ordovician); compl.

3/15/72. Tops: no Woodford present, Pennsylvanian?-Hunton contact 16,910' (-14,838'), Sylvan 17,160' (-15,088') (GR log); Hunton thickness 250'. Samples examined from 16,580' to 18,800' (?Pennsylvanian, Hunton, Sylvan, Viola, Simpson; a few minor skips); 36 thin sections, 7 in strata above Hunton, 10 in Hunton, and 19 in underlying beds; samples borrowed from Continental Oil Co.

The 1 Gordon Unit is in a fault block between the Wichita Mountains uplift and the deep Anadarko basin. It has a relatively thin Hunton section of only 250', but this is presumably due to post-Hunton, pre-Pennsylvanian erosion rather than to structure. The samples present minor difficulties, because they appear to have some contamination, presumably owing at least in part to caving from above. This, combined with the absence of the Woodford Shale, makes it difficult to identify precisely the upper Hunton contact; however, there is a moderately well-defined carbonate contact at 16,910', which I interpret as the upper boundary. Above this the samples are mostly dark silt-shale along with dolomite and chert, and this interval is tentatively placed in the Pennsylvanian. The upper part of the Hunton is mainly dolomitic limestone, and the lower part mainly crystalline dolomite. This Hunton section has its closest resemblance to strata located to the north and west, and thus it is referred to the dolomite facies; cf. Phillips 1-C Lee and Phillips 1-A Bailey, in the Texas Panhandle.

Pennsylvanian
Hunton Group ?16,910'-17,160'
16,910'-16,998' Fossiliferous, dolomitic limestone and calcareous dolomite with very little detrital quartz. Minor amount of crystalline dolomite.
16,998'-17,160' Almost entirely crystalline dolomite with only minor detrital quartz. Some appears to be porous.
Sylvan Shale 17,160'-17,410'
Viola Limestone 17,410'

TANOLIND 1 GROVES UNIT--SW¼SW¼NW¼ sec. 36, T. 8 N., R. 18 W., Washita County, Oklahoma; elev. 1625'; TD 5500' (Bromide); compl. 2/22/55, D&A. Tops: Pennsylvanian-Hunton contact 1940' (-315'), Sylvan 3600' (-1975'); Hunton thickness 1660'; examined cuttings from base of Pennsylvanian through Hunton and into Sylvan Shale; 22 thin sections prepared, stained with Alizarin Red-S; cuttings borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is in one of the shallow fault blocks between the Wichita Mountains uplift and the deep part of the Anadarko basin. The lithology is low-magnesium limestone throughout and is clearly a part of the Arbuckle Mountains limestone facies. This is one of the thickest Hunton sections studied, but the sequence is similar to that in the Arbuckle Mountains-Criner Hills region, which consists of an upper organo-detrital limestone section (?Lower Devonian), underlain by marlstone (?Lower Devonian and/or ?Silurian), which is in turn separated from the Sylvan Shale by a light-colored organo-detrital limestone with a basal oolite (Chimneyhill Subgroup) (see panel 10, section C-C').

Pennsylvanian Sandstone and Conglomerate
Hunton Group 1940'-3600'
1940'-2350'± ?Frisco Formation and (or) ?Fittstown Member, Bois d'Arc Formation. Light-colored organo-detrital limestone, mostly with micrite cement, only minor spar. Very little detrital quartz and only minor, scattered dolomite crystals. Fossils are mainly crinoids, shelly debris (probably mostly brachiopods), and many bryozoans; very few corals, if any. Some light-colored chert.
2350'±-2530'± Appears to be transitional between above biomicrite and underlying fossiliferous marlstone. Very little dolomite in this interval.
2530'±-3370' ?Haragan and (or) Henryhouse Formation. Gray to red fossiliferous marlstone; all has detrital quartz, and red beds have substantial amount of quartz and some mica. Very little dolomite. Lower contact well defined.
3370'-3600' Chimneyhill Subgroup. Light-colored organo-detrital limestone, mostly micrite cement. Many crinoids and ostracodes. Very little detrital quartz. Some crystals of dolomite in lower part, not much elsewhere; glauconite sparingly present in lower part. Oolite with micrite cement at base (Keel Formation).
Sylvan Shale 3600'-3955'
Viola Limestone 3955' (Sample log)

ARKLA 1-17 HARRELL--E½E½W½SE¼ sec. 17, T. 16 N., R. 21 W., Roger Mills County, Oklahoma; elev. 2108'; TD 17,829' (Sylvan); compl 10/5/72, D&A. Tops: Hunton-Woodford contact 17,330' (-15,222'), Sylvan 17,785' (-15,677'); Hunton thickness 455'. Samples examined from lower part of Woodford through Hunton and to TD in Sylvan; 13 thin sections; samples at Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton strata in this well are a part of the western dolomite facies, including much crystalline dolomite. Their relationship to Hunton rocks in the Custer County area to the east and in the Texas Panhandle area to the west is shown in panel 10, section C-C'; this relationship suggests that all of the Hunton Group in the 1-17 Harrell is Silurian.

Woodford Shale
Hunton Group 17,330'-17,785'
17,330'-17,430' ?Silurian. Medium-gray crystalline dolomite with some chert. Minor silt-size angular to subangular quartz detritus.
17,430'-17,560' Fossiliferous limestone with scattered euhedral crystals of dolomite; dolomite content variable but appears to be everywhere low, probably all less than 15% $MgCO_3$. Fossils retain original microtexture. Minor silt-size quartz detritus.
17,560'-17,590' Crystalline dolomite with some chert.

17,590'-17,610' ?Chimneyhill Subgroup. Organo-detrital limestone with pink crinoids; very little dolomite, and only minor detrital quartz.

17,610'-17,785' Crystalline dolomite with scattered detrital quartz. Some chert. Overlying pink crinoidal limestone suggests that this unit may be dolomitized Chimneyhill. (Sample skip from 17,750' to 17,770'.)

Sylvan Shale 17,785'-17,829' (TD)

GLOVER HEFNER KENNEDY 1-27 HAYES--NW¼NW¼SW¼SE¼ sec. 27, T. 12 N., R. 14 W., Custer County, Oklahoma; elev. 1807'; TD 19,474' (Ordovician); compl. 10/1/72, Atoka production. Tops: Woodford 18,370' (-16,563'), Hunton 18,528' (-16,721'), Sylvan 19,050' (-17,243'), Viola 19,474' (-17,667') (samples indicate Viola top at 19,220'); Hunton thickness 522'. Samples examined from Mississippian (Sycamore) through Woodford, Hunton, Sylvan, and into upper Viola; 15 thin sections, stained with Alizarin Red-S; samples from Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in the 1-27 Hayes are in a fairly typical Arbuckle Limestone facies, both in terms of lithology and lithostratigraphic sequence; however, this well is probably located near the northern extension of this facies, although control in this region is sparse. Compare Hunton rocks in this well with those present in wells to the south, in the deeper parts of the Anadarko basin (panel 10, section C-C').

Woodford Shale 18,370'-18,528'

Hunton Group 18,528'-19,050'

18,528'-18,610' ?Frisco Formation and (or) Fittstown Member, Bois d'Arc Formation. Light-gray organo-detrital sparite with very little dolomite and not much detrital quartz. Organic material fragmented, consisting of pelmatozoan plates and shelly debris, latter with fragments of large brachiopods, trilobites, ostracodes, and numerous bryozoans. Contact with underlying unit well defined.

18,610'-18,980' ?Haragan and (or) ?Henryhouse Formation. Medium- to dark-gray marlstone with varying concentrations of angular to subangular silt-size quartz detritus, mostly less than 0.1 mm in diameter; some mica present. Dolomite crystals (about same size as quartz detritus) moderately common, in places fairly concentrated but at no place approaching a crystalline-dolomite texture. Fossils present, including pelmatozoan plates and shelly debris; ostracodes common in some beds.

18,980'-19,050' Chimneyhill Subgroup. Light-gray to pinkish-gray pelmatozoan limestone with very little detrital quartz or dolomite. Includes some shelly debris, but largely crinoidal limestone.

Sylvan Shale 19,050'-19,474'

Viola Limestone 19,474'

Dark-gray organo-detrital limestone with very little quartz or dolomite.

INEXCO 1 KENDALL--NE¼SW¼NW¼ sec. 14, T. 15 N., R. 24 W., Roger Mills County, Oklahoma; elev. 2285'; TD 19,926' (Sylvan); compl. 4/11/71, D&A. Tops: Woodford 19,310' (-17,025'), Hunton 19,374' (-17,089'), Sylvan 19,826' (-17,541'); Hunton thickness 452'. Cuttings examined from Woodford Shale through Hunton and into Sylvan Shale; 14 thin sections prepared, stained with Alizarin Red-S. Samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton in this well is predominantly in a dolomite and dolomitic-limestone facies, although there is a fair amount of rather low-magnesium limestone in the middle portion. The 1 Kendall has decidedly less dolomite than does the 1 Viersen and probably somewhat less than the 1 Lovett, although the lithologic sequence is similar to the latter. The Hunton is probably all Silurian in age, judging from the lithostratigraphic relations in this area (see panel 10, section B-B').

Woodford Shale 19,310'-19,374'

Hunton Group 19,374'-19,826'

19,374'-19,390' ?Silurian. Gray crystalline dolomite with minor quartz detritus.

19,390'-19,550' Dolomitic limestone with fossils. Parts rather strongly dolomitized, but no crystalline dolomite observed. Fossils retain original microstructure; moderate angular silt-size quartz detritus.

19,550'-19,630' Dark-gray dolomitic limestone with considerable fossil debris, including shelly material and ostracodes. Minor silt-size detrital quartz.

19,630'-19,720' ?Chimneyhill Subgroup. Light-gray to pinkish-gray organo-detrital limestone with much chert. Very little quartz detritus.

19,720'-19,826' Chimneyhill Subgroup. Gray crystalline dolomite with much chert. Lower few feet is dolomitized oolite (Keel Formation).

Sylvan Shale 19,826'

PHILLIPS 1-C LEE (see part I of Appendix, Descriptions of Cores)

TEXAS PACIFIC 1-33 LIBBY--E½E½NW¼ sec. 33, T. 14 N., R. 26 W., Roger Mills County, Oklahoma; elev. 2540'; TD 22,450' (Ordovician, ?Sylvan); compl. 6/30/73, Morrow production. Tops: Woodford 21,656' (-19,116'), Hunton 21,764' (-19,224'), Sylvan 22,356' (-19,816'); Hunton thickness 592'. Samples examined from top of Woodford Shale through Hunton and into upper Sylvan; 14 thin sections, stained with Alizarin Red-S; samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton in this well is largely in the western dolomitic facies, the upper 440' composed of dolomitic limestone and calcitic dolomite with some beds of crystalline dolomite, and the lower 150' composed of crystalline dolomite. The Hunton is similar to that present in the 1 Lovett; it is probably all Silurian (see panel 10, section B-B').

Woodford Shale 21,656'-21,764'

Hunton Group 21,764'-22,356'

21,764'-21,790' ?Silurian. Organo-detrital limestone with pelmatozoans and shelly de-

bris. Very little dolomite, and only minor detrital quartz.
21,790'-21,830' Crystalline dolomite with very little quartz.
21,830'-21,860' Poor-quality samples.
21,860'-22,150' Medium- to dark-gray dolomitic limestone and calcitic dolomite with a few beds of crystalline dolomite. Some detrital quartz. Fossiliferous in places.
22,150'-22,200' ?Chimneyhill Subgroup. Light-gray to pinkish-gray organo-detrital limestone with some chert. Very little dolomite or detrital quartz. Sharp contact with overlying strata.
22,200'-22,356' Chimneyhill Subgroup. Crystalline dolomite with some chert.
Sylvan Shale 22,356'

INEXCO 1 LOVETT--NW¼NW¼SE¼NW¼ sec. 21, T. 14 N., R. 24 W., Roger Mills County, Oklahoma; elev. 2096'; TD 21,276' (?Sylvan); compl. 8/11/71, Hunton gas production. Tops: Woodford 20,490' (-18,394'), Woodford-?Misener contact 20,594' (-18,498'), ?Misener-Hunton contact 20,630' (-18,534'), Sylvan 21,170' (-19,074'); Hunton thickness 540'. Samples examined from Woodford through Hunton and into Sylvan; samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in the 1 Lovett are a part of the western dolomite facies, being in considerable part crystalline dolomite, in part dolomitic limestone and calcitic dolomite, and with some low-magnesium, organo-detrital limestone. The relationship to Hunton rocks from other wells in this area suggests that the 1 Lovett is largely if not entirely of Silurian age (see panel 10, section B-B').

Woodford Shale 20,490'-20,594'
?Misener Sandstone 20,594'-20,630'
Dark-gray fine-grained siliceous shale? with some small dolomite crystals.
Hunton Group 20,630'-21,170'
20,630'-20,680' ?Silurian. Medium-gray crystalline dolomite with very little fossil debris; minor detrital quartz.
20,680'-20,800' Calcareous dolomite and dolomitic limestone with much angular silt-size quartz detritus. Some fossil material, both pelmatozoans and shelly debris.
20,800'-21,050' ?Chimneyhill. Organo-detrital limestone with shelly and pelmatozoan debris. Mostly with only minor detrital quartz, and weakly to moderately dolomitic.
21,050'-21,170' Medium-gray crystalline dolomite with very little organic debris and only minor quartz.
Sylvan Shale 21,170'

EL PASO 1 PIERCE (not shown on maps)--1320' FSL and 1320' FWL sec. 9, T. 13 N., R. 25 W., Roger Mills County, Oklahoma; elev. 2376'; TD 23,449' (Viola); compl. 1974, Hunton production reported. Tops: Woodford 22,390' (-20,014'), Misener 22,545' (-20,169'), Hunton 22,570' (-20,194'), Sylvan 23,160' (-20,784'), Viola 23,285' (-20,909'); Hunton thickness 615'. Samples examined from 22,500' to TD; borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma; good-quality samples; 22 thin sections prepared, stained with Alizarin Red-S.

Hunton strata in the 1 Pierce are in a dolomite facies, although a considerable part of the middle part contains substantial low-magnesium limestone. Hunton rocks in this well are similar to those in the 1-33 Libby, 1-27 Bradshaw, and 1 Kendall, the lower 100' to 150' being in a crystalline-dolomite facies overlain by relatively low-magnesium limestones with considerable detrital quartz; the upper 100' or so of the Hunton in the 1 Pierce is crystalline dolomite and in this respect is comparable to the 1 Lovett. I assign the 30' of crystalline dolomite with a large amount of fine (less than 0.1 mm) quartz detritus lying just under the Woodford Shale to the Misener Sandstone. All the Hunton strata are probably Silurian in age, judging from the regional relations in this area (panel 10, section B-B').

Woodford Shale 22,380'-22,545'
Misener Sandstone 22,545'-22,570'
Fine angular quartz detritus (to 0.1 mm) set in a crystalline-dolomite matrix.
Hunton Group 22,570'-23,160'
22,570'-22,700' Predominantly crystalline dolomite with very little detrital quartz; some chert; minor dolomitic limestone.
22,700'-23,100' Predominantly fossiliferous marlstone, commonly with scattered dolomite crystals and substantial fine angular quartz detritus. Interbedded with some dolomitic limestone and crystalline dolomite. Chert is present through much of interval.
23,100'-23,160' Largely crystalline dolomite with minor amount of fine angular detrital quartz. Upper part has some interbedded fossiliferous marlstone with scattered dolomite crystals, but lower 70' or so is almost entirely crystalline dolomite. No oolites observed.
Sylvan Shale 23,160'-23,285'
Viola Limestone 23,285'-23,449' (TD)

LONE STAR 1 ROGERS--C SE¼ sec. 27, T. 10 N., R. 19 W., Washita County, Oklahoma; elev. 1893'; TD 31,441' (Arbuckle Group; at time of completion this was world's deepest well); compl. 1974, no Hunton production reported. Tops (from well samples): Woodford ?27,550' (-25,657'), Hunton 27,760' (-25,867'), Sylvan 28,870' (-26,977'), Viola 29,040' (-27,147'), Simpson 29,760' (-27,867'), Arbuckle 31,220' (-29,327'); Hunton thickness 1110'. Samples examined from 27,500' to 31,441' (skips 29,960'-30,900' in Simpson Group, and 31,300' to 31,430' in Arbuckle Group); samples of good quality; 26 thin sections prepared from Hunton samples, and 30 thin sections from Ordovician samples; samples borrowed from Lone Star.

The Hunton strata in this well are in the Arbuckle Mountains-Criner Hills lithofacies, and, in fact, the gross lithology is remarkably similar to that in the northeastern part of the Arbuckle region (the outcrop section is much thinner). The uppermost

Hunton beds comprise a sequence of light-colored organo-detrital limestones (27,760'-27,970'), underlain by medium- to dark-gray marlstone (27,970'-28,580'), and a bottom section consisting of light-colored (becoming darker in the basal portion) organo-detrital limestones with some chert (28,580'-28,870'), ending with an oolite. Lithologically this sequence suggests that the uppermost limestones correlate with the Frisco-Fittstown beds of the outcrop area, the middle marlstones with the Henryhouse-Haragan Formations, and the lower limestones with the Chimneyhill Subgroup. This lithologic sequence is similar to that found in the Sunray DX (Phillips) 1-A Wesner and the Lone Star 1 Baden; it also resembles that found in other deep wells, including those in the shallow fault blocks.

<u>Woodford Shale</u> (no Misener recognized)
<u>Hunton Group</u> 27,760'-28,870'
27,760'-27,970' ?Frisco Formation and (or) Fittstown Member, Bois d'Arc Formation. Light-colored organo-detrital limestone with pelmatozoan plates, bryozoans, and shelly debris; mostly spar cement and with very little dolomite. Possibly some recrystallization.
27,970'-28,580' ?Haragan and (or) Henryhouse marlstone. Medium- to dark-gray fossiliferous marlstone; fossil content variable, most fragments showing some organic material. Much silt-size subangular quartz detritus. Very little dolomite.
28,580'-28,840' Chimneyhill Subgroup. Light colored in upper part, becoming darker in lower part (about 28,770'); organo-detrital limestone, mixed with some medium-crystalline (?recrystallized) limestone; lower, darker portion has substantial dolomite, although only a few pieces are crystalline dolomite. Considerable chert and silicification, but very little detrital quartz.
28,840'-28,870' Keel oolite. Much oolitic material, oolites set in spar matrix; some fossils in oolites, and some organo-detrital limestone in this interval.
<u>Sylvan Shale</u>

TEXAS 1 ROLLS--C SE¼SW¼ sec. 5, T. 3 N., R. 10 W., Comanche County, Oklahoma; elev. 1241'; TD 8078' (Oil Creek); compl. 9/15/42, D&A. Tops: Woodford 1858' (-617') (sample log), ?Misener 2290' (-1049'), Hunton 2300' (-1059'), Sylvan 3440' (-2199'); Hunton thickness 1140'. Samples examined from Woodford Shale through Hunton and into upper Sylvan; 19 thin sections, stained with Alizarin Red-S; samples in OU Core Library.

This well is located on one of the fault blocks between the Wichita Mountains uplift and the deep Anadarko basin. The Hunton is a low-magnesium limestone throughout and represents a part of the Arbuckle Mountains limestone facies. The lithostratigraphic sequence consists of an upper organo-detrital limestone (?Lower Devonian) and a lower marlstone (?Lower Devonian, ?Silurian), the latter resting directly on the Sylvan Shale. The Hunton section in the 1 Rolls is similar to Hunton rocks in other wells in this area except that it lacks the lower organo-detrital limestones (?Chimneyhill Subgroup) (see panel 10, section C-C', and discussion in text under Chimneyhill Subgroup).

<u>Woodford Shale</u> 1858'-2290'
<u>?Misener Sandstone</u> 2290'-2300'
Dense limestone with considerable silt-size quartz detritus and much chert; very little dolomite.
<u>Hunton Group</u> 2300'-3440'
2300'-2400' ?Frisco Limestone and (or) Fittstown Member, Bois d'Arc Formation. Light-gray organo-detrital sparite with some light-colored chert. Mostly only minor dolomite, but lower beds have a moderate amount of dolomite crystals. Minor detrital quartz.
2400'-3400' ?Haragan and (or) ?Henryhouse Formation; no Chimneyhill lithology recognized in well. Medium-gray marlstone with red beds at 3180'-3210'. Matrix of rock is fine-grained limestone with varying amounts of silt-size angular to subangular quartz detritus; many beds have substantial quantity of quartz, and red beds are especially high in quartz detritus including some mica. Fossils are present throughout. There is a fair quantity of dolomite in upper 100' or so, but rest of interval is generally low in dolomite.
<u>Sylvan Shale</u> 3440'-3823' (sample log)

INEXCO 1 SANVE--C SE¼NW¼ sec. 4, T. 14 N., R. 22 W., Roger Mills County, Oklahoma; elev. 2149'; TD 20,922' (Sylvan); compl. 12/17/72, D&A. Tops: Woodford 20,250' (-18,101'), Hunton 20,324' (-18,175'), Sylvan 20,860' (-18,711'); Hunton thickness 536'. Samples examined from top of Woodford through Hunton and into Sylvan; 11 thin sections, stained with Alizarin Red-S; samples from Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well appears to be a part of the western dolomite facies, having considerable crystalline dolomite, calcitic dolomite, and dolomitic limestone. The concentration of dolomite in the 1 Sanve appears to be roughly comparable to that in the 1 Kendall and the 1 Lovett, and less than that in the 1 Viersen Unit. See panel 10, section B-B'. Stratigraphic relations in this area suggest that the Hunton in the 1 Sanve is all Silurian.

<u>Woodford Shale</u> 20,250'-20,324'
<u>Hunton Group</u> 20,324'-20,860'
20,324'-20,420' ?Silurian. Medium-gray crystalline dolomite, mostly low in detrital quartz.
20,420'-20,700' Medium- to dark-gray fossiliferous limestone, dolomitic limestone and calcitic dolomite; very little crystalline dolomite. Some angular silt-size quartz detritus and some chert.
20,700'-20,760' ?Chimneyhill Subgroup. Light-gray organo-detrital limestone with much light-gray chert. Some dolomite crystals and very little detrital quartz. Contact with overlying strata sharply defined.
20,760'-20,860' ?Chimneyhill Subgroup. Medium-gray crystalline dolomite with some chert.
<u>Sylvan Shale</u> 20,860'

DENVER 1-A SCHOOL LAND--C SE¼SW¼ sec. 16, T. 10 N., R. 9 W., Caddo County, Oklahoma; elev. 1540'; TD 17,090' (?Bromide); compl. 12/7/48. Tops: Woodford 14,310' (-12,770'), ?Misener 14,420' (-12,880'), Hunton 14,480' (-12,940'), Sylvan 15,220' (-13,680'); Hunton thickness 740'. Samples examined from lower Woodford through Hunton and into upper Sylvan; 19 thin sections prepared, stained with Alizarin Red-S; samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is located in the eastern part of the Anadarko basin in an area with relatively few Hunton tests. The rock is a low-magnesium limestone throughout and appears to be typical for the Arbuckle Mountains limestone facies. The lithostratigraphic sequence suggests that the upper organo-detrital limestone is Early Devonian in age, but there is no biostratigraphic evidence to confirm this; however, the Sinclair 1 Horlivy, about 30 miles east, does have an upper organo-detrital limestone which was cored and which yields diagnostic Frisco megafossils. (See part I of Appendix, core descriptions.)

<u>Woodford Shale</u> 14,310'-14,420'
<u>?Misener Sandstone</u> 14,420'-14,480'
<u>14,420'-14,480'</u> Dolomitic quartz sandstone and sandy dolomite; angular quartz grains to about 0.2 mm. Much chert, some with detrital quartz.
<u>Hunton Group</u> 14,480'-15,220'
<u>14,480'-14,675'</u> ?Frisco and (or) ?Fittstown Member, Bois d'Arc Formation. Light-gray organo-detrital limestone with very little dolomite and very little detrital quartz; mostly micrite cement, some spar. Fossils include numerous pelmatozoan plates and bryozoans, as well as other shelly debris.
14,675'-15,130' ?Haragan and (or) ?Henryhouse Formation. Medium- to dark-gray marlstone; much angular quartz to 0.2 mm. Scattered fossils, including numerous crinoids and ostracodes.
15,130'-15,180' ?Chimneyhill Subgroup. Dark-gray to faint-reddish-gray fossiliferous micrite with much reduced quartz and very little dolomite; many ostracodes.
15,180'-15,220' ?Chimneyhill Subgroup. Light-gray organo-detrital limestone with much light chert. Very little detrital quartz, and only a small amount of dolomite.
<u>Sylvan Shale</u> 15,220'

CARTER 1 STATE TAYLOR--C SW¼SW¼ sec. 31, T. 9 N., R. 21 W., Beckham County, Oklahoma; elev. 1862'; TD 10,500', Ordovician; compl. 1951, D&A. Tops: Pennsylvanian-Hunton contact 7750' (-5888'), Sylvan 8180' (-6318'); Hunton thickness 430'. Samples examined from base of Pennsylvanian through Hunton and into Sylvan Shale; 13 thin sections prepared (two in basal Pennsylvanian strata), stained with Alizarin Red-S; borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is in one of the shallow fault blocks between the Wichita Mountains uplift and the deep Anadarko basin. The Hunton is thin for this area (in the Lone Star 1 Baden, located in the deep part of the Anadarko basin about 6 miles northwest of the 1 State Taylor, the Hunton is over 1000' thick); however, the thinning, at least in part, is due to pre-Pennsylvanian, post-Hunton erosion, as the Hunton rocks appear to have been thinned from the top, with the upper organo-detrital limestones and some of the marlstones in the 1 Baden being absent in the 1 State Taylor (panel 10, section C-C'). The marlstone and the upper (?Chimneyhill) part of the 1 State Taylor are low-magnesium limestones and resemble the limestone facies in the Arbuckle Mountains-Criner Hills region; the lower part of the ?Chimneyhill, including the Keel oolite, is somewhat dolomitized, suggesting a gradation toward the strongly dolomitized ?Chimneyhill of western Oklahoma and the Texas Panhandle. The following is a summary of the lithostratigraphy.

<u>Pennsylvanian</u>
Brecciated limestone with much detrital quartz up to 0.5 mm; many of the quartz grains are well rounded; considerable silicification.
<u>Hunton Group</u> 7750'-8180'
<u>7750'-7950'</u> ?Haragan and (or) ?Henryhouse Formation. Gray fossiliferous marlstone with substantial silt-size angular to subangular quartz detritus. Very little dolomite.
7950'-8180' ?Chimneyhill Subgroup. Light-colored organo-detrital micrite; minor spar cement and very little detrital quartz; some chert. Only minor dolomite in upper part, but lower 70' to 80' has considerable dolomite in form of euhedral crystals. Basal bed is oolite, mostly with spar cement and substantial dolomite crystals (?Keel Formation).
<u>Sylvan Shale</u> 8180'

GENERAL AMERICAN TEXAS 1 VIERSEN UNIT--Well started under Clark Canadian Exploration Company; NW¼NE¼SE¼NW¼ sec. 8, T. 15 N., R. 22 W., Roger Mills County, Oklahoma; elev. 2158'; TD 19,244' (Ordovician); compl. 1972, Morrow production, Hunton information not available. Tops: Woodford 18,740' (-16,582'), Hunton 18,834' (-16,676'), Sylvan 19,144' (-16,986'), Viola 19,240' (-17,082'); Hunton thickness 310'. Samples examined from Woodford through Hunton and into Sylvan and Viola; 14 thin sections stained with Alizarin Red-S; samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton in this well is strongly dolomitic throughout, although there is a little calcareous dolomite and dolomitic limestone in the central part. It is a part of the western dolomite lithofacies. Stratigraphic relations in this area suggest that the Hunton is entirely Silurian in age (panel 10, section C-C').

<u>Woodford Shale</u> 18,740'-18,834'
<u>Hunton Group</u> 18,834'-19,144'
<u>18,434'-18,900'</u> ?Silurian. Medium-gray crystalline dolomite with some chert. Very little detrital quartz.
18,900'-19,020' Calcareous dolomite (some crystalline dolomite from 18,920' to 18,940') and dolomitic limestone, latter

in part organo-detrital and with some recrystallization. Moderate angular quartz detritus ranging up to 0.05 mm (dolomite in euhedral crystals ranges up to approximately 0.05 mm).

19,020'-19,144' Crystalline dolomite with some chert. Minor detrital quartz.

Sylvan Shale 19,144'-19,240'

SUNRAY DX (PHILLIPS) 1-A WESNER--C SW¼ sec. 35, T. 9 N., R. 17 W., Washita County, Oklahoma; elev. 1543'; TD 23,534' (Hunton); compl. 5/3/68, D&A. Tops: Woodford 22,220' (-20,677'), ?Misener 22,538' (-20,995'), Hunton 22,570' (-21,027'); drilled 964' of Hunton (to TD). Samples examined from Woodford through Hunton to TD; 15 thin sections; samples borrowed from Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in the 1-A Wesner are typical of the Arbuckle Mountains limestone facies and are similar in lithology and lithostratigraphic sequence to other wells in this area. The 1-A Wesner is much like the Lone Star 1 Baden although somewhat thinner, and both resemble Hunton rocks at the northeastern end of the Arbuckle Mountains region (although the latter section is substantially thinner) (see panel 10, section C-C').

Woodford Shale 22,220'-22,538'

?Misener Sandstone 22,538'-22,570'

Medium-gray fine-grained calcitic dolomite with silt-size angular quartz detritus and substantial silicification.

Hunton Group 22,570'-23,534' (TD)

22,570'-22,750' ?Frisco and (or) Fittstown Member, Bois d'Arc Formation. Light-gray to pinkish-gray organo-detrital limestone, partly with spar cement and partly with micrite cement (latter may be in part recrystallized). Sparse euhedral dolomite crystals and minor silt-size detrital quartz. Some solution?

22,750'-23,390' ?Haragan and (or) ?Henryhouse Formation. Dark-gray marlstone; finely divided limestone with silt-size angular quartz detritus and some mica, abundant in some beds. Scattered dolomite crystals, moderately common in some beds. Scattered fossils throughout.

23,390'-23,534' ?Chimneyhill Subgroup. Light-gray to pinkish-gray organo-detrital limestone; partly micrite cement, partly spar. Some detrital quartz and some dolomite crystals, but never abundant.

TD 23,534'

Part III–Chemical Analyses of Cores

The chemical analyses of cores are arranged by well, alphabetized by farm name (see part I of Appendix, Core Descriptions, for well locations and other information). With a few exceptions, all wells studied were completely analyzed (a few wells are represented only by spot samples, and a few have no analyses). The method used in sampling is as follows: Each core was examined and divided into lithostratigraphic and biostratigraphic units, which form the basic units for chemical analysis; however, all such divisions were further subdivided into 10-foot intervals, so that no analyzed core interval includes more than 10 feet. The sampling procedure was to take 1 inch of core from each foot, the only visual selection being the elimination of chert nodules insofar as possible. The sample from each interval was then crushed and passed through a series of sample splitters to reduce the volume to manageable proportions.

The samples were initially analyzed by X-ray fluorescence, the Ca and Mg being determined and the HCl-insoluble residues being determined by difference. Owing to technical difficulties, this method did not prove entirely satisfactory, and most of the samples were reanalyzed, using conventional wet-chemical methods; those analyses determined by X-ray fluorescence are marked with an asterisk in the table.

The chemical data are recorded as follows: (1) $CaCO_3$, $MgCO_3$, and HCl-insoluble residues expressed as a percentage of the total rock volume; (2) $CaCO_3$ and $MgCO_3$ expressed as a percentage of the acid-soluble portion; (3) the mineral dolomite and the mineral calcite expressed as a percentage of the total rock; (4) $CaCO_3/MgCO_3$ ratios.

The age and formation are given for each interval sampled. The evidence bearing on this determination, as well as the lithologic and biostratigraphic description of the core from each well, is given in part I of the Appendix, Core Descriptions.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	CaCO$_3$ (%)[a] Mineral calcite (%)[b]	MgCO$_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)	CaCO$_3$-MgCO$_3$ ratio	Age and unit
COX 1-A ANNIS									
19A	7,310- 7,319	58.79 28.74	25.36 55.42	11.75	95.90	69.86	30.14	2.32	SILURIAN. CHIMNEYHILL SUBGROUP(?).
19B	7,322- 7,332	93.95 89.73	3.55 7.77	2.50	*100.00	96.36	3.64	26.46	
19C	7,332- 7,342	96.76 94.15	2.19 4.80	1.05	*100.00	97.79	2.21	44.18	
19D	7,342- 7,352	95.62 92.54	2.59 5.67	1.79	*100.00	97.36	2.64	36.92	
19E	7,352- 7,362	97.70 96.15	1.31 2.87	0.98	* 99.99	98.68	1.32	74.58	
19F	7,362- 7,365	98.40 97.39	0.85 1.86	0.75	*100.00	99.14	0.86	115.76	
Weighted avg, 19B-F		96.17	2.30	1.52					
Weighted avg, 19A-F		89.70	6.29	3.29					
RIDDLE 1 ATTERBERRY									
61A	3,932- 3,937	60.06 36.96	19.35 42.38	18.69	98.10	75.63	24.37	3.10	EARLY DEVONIAN. HARAGAN FORMATION.
JONES 1 BARTOW									
25A	8,852- 8,862	54.63 10.24	37.30 81.69	8.05	99.98	59.43	40.57	1.46	SILURIAN. *KIRKIDIUM* BIOFACIES.
25B	8,862- 8,872	58.92 16.69	35.49 77.72	4.48	98.89	62.41	37.59	1.66	
25C	8,872- 8,882	60.87 20.83	33.65 73.69	4.19	98.71	64.40	35.60	1.81	
25D	8,882- 8,892	54.74 11.73	36.14 79.15	7.89	98.77	60.23	39.77	1.51	
25E	8,892- 8,902	56.36 14.28	35.37 77.46	7.20	98.93	61.44	38.56	1.59	
25F	8,902- 8,907	62.54 24.19	32.23 70.58	4.47	99.24	65.99	34.01	1.94	
Weighted avg, 25A-F		57.59	35.28	6.19					

AMERADA 4-A BAYNE									
26A	2,686- 2,697	52.82 39.13	11.51 25.21	33.98	98.31	82.11	17.89	4.59	SILURIAN. HENRYHOUSE FORMATION.
26B	2,697- 2,707	69.19 59.34	8.28 18.13	22.53	*100.00	89.31	10.69	8.36	
26C	2,707- 2,717	65.97 56.07	8.32 18.22	25.71	*100.00	88.80	11.20	7.93	
26D	2,717- 2,720	72.71 60.49	9.85 21.57	17.94	*100.50	88.00	12.00	7.33	
26E	2,720- 2,725	73.96 64.15	8.24 18.05	17.80	*100.00	89.98	10.02	8.98	
26F	2,725- 2,735	76.74 67.79	7.52 16.47	15.74	*100.00	91.08	8.92	10.20	
Weighted avg, 26A-F		67.07	8.95	23.60					
26G	2,735- 2,745	88.50 82.31	5.20 11.39	6.30	*100.00	94.45	5.55	17.02	SILURIAN(?). CHIMNEYHILL SUBGROUP(?).
Weighted avg, 26A-G		70.70	8.31	20.66					
KAHAN 6 BEAN									
1, 2	4,011- 4,017	69.38 45.14	20.38 44.63	7.08	96.84	77.30	22.70	3.40	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION(?).
3, 4	4,017- 4,022	69.59 50.50	16.38 35.87	12.09	98.06	80.95	19.05	4.25	
5, 6	4,022- 4,028	73.53 50.60	19.27 42.20	6.86	99.66	79.23	20.77	3.82	
Weighted avg, 1-6		70.83	18.34	8.68	98.19				
7, 8	4,028- 4,033	85.68 75.36	8.68 19.01	2.76	98.12	90.80	9.20	9.87	
9, 10	4,033- 4,039	91.86 84.61	6.10 13.36	1.40	99.36	93.77	6.23	15.06	
11, 12	4,039- 4,045	93.47 87.63	4.91 10.75	1.30	99.68	95.01	4.99	19.04	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)[3]	$MgCO_3$ (%)[3]	$CaCO_3$-$MgCO_3$ ratio	Age and unit
13, 14	4,045- 4,050	89.36 79.95	7.90 17.30	1.65	98.91	91.88	8.12	11.31	
Weighted avg, 7-14		90.09	6.90	1.80	98.79				
Weighted avg, 1-14		81.84	11.95	4.75	98.52				
CALVERT 1 BERTIE									
2N	8,333- 8,343	58.47 16.13	35.58 77.92	5.84	99.89	62.17	37.83	1.64	SILURIAN. *KIRKIDIUM* BIOFACIES.
2O	8,343- 8,353	71.38 49.60	18.30 40.08	9.83	99.51	79.59	20.41	3.90	
2P	8,353- 8,363	64.06 40.45	19.90 43.58	15.30	99.26	76.30	23.70	3.22	
2Q	8,363- 8,373	43.96 8.46	29.83 65.33	25.78	99.57	59.57	40.43	1.47	
2R	8,373- 8,379	49.03 17.91	26.16 57.29	24.45	99.64	65.21	34.79	1.87	
2S	8,379- 8,389	68.28 50.00	15.36 33.64	16.14	99.78	81.64	18.36	4.45	
2T	8,389- 8,398	66.50 49.04	15.26 33.42	18.32	100.08	81.34	18.66	4.36	
Weighted avg, 2N-2T		60.83	22.83	16.00					
	8,398- 8,515	No	core						
2A	8,514- 8,523	72.67 61.84	9.10 19.93	18.05	99.82	88.87	11.13	7.99	SILURIAN(?). CHIMNEYHILL SUBGROUP(?).
2B	8,523- 8,534	72.61 58.15	12.15 26.61	15.58	100.34	85.67	14.33	5.98	
2C	8,534- 8,544	77.92 61.93	13.44 29.43	8.71	100.07	85.29	14.71	5.80	
2D	8,544- 8,554	70.38 47.22	19.46 42.62	10.08	99.92	78.34	21.66	3.62	

2E	8,554- 8,558	77.83 57.98	16.69 36.55	4.84	99.36	82.34	17.66	4.66	
Weighted avg, 2A-2E		73.97	13.89	12.30					
2F	8,558- 8,568	57.42 13.15	37.20 81.47	5.02	99.64	60.68	39.32	1.54	SILURIAN. CHIMNEYHILL SUBGROUP.
2G - duplicate		57.54 18.88	36.74 80.46	2.53	96.81	61.03	38.97	1.57	
2H	8,568- 8,578	57.00 12.83	37.12 81.29	2.47	96.59	60.56	39.44	1.54	
2I	8,578- 8,582	56.60 11.75	37.69 82.54	2.40	99.69	60.03	39.97	1.50	
2J	8,582- 8,592	55.58 11.25	37.25 81.58	4.31	97.14	59.87	40.13	1.49	
2K	8,592- 8,602	56.92 9.71	39.67 86.88	3.24	99.83	58.93	41.07	1.43	
2L	8,602- 8,605	56.82 10.05	39.30 86.07	3.66	99.78	59.11	40.89	1.45	
2M	8,605- 8,616	56.70 8.54	40.50 88.70	2.45	99.65	58.33	41.67	1.40	
Weighted avg, 2F-2M		56.72	38.38	3.41					
Weighted avg, 2N-2M		62.86	25.88	10.65					
JONES & PELLOW 1 BEST									
23A	7,960- 7,970	61.78 41.92	16.69 36.55	21.53	*100.00	78.73	21.27	3.70	SILURIAN(?).
23B	7,970- 7,980	61.42 33.03	26.44 57.90	8.16	96.02	69.91	30.09	2.32	
23C	7,980- 7,991	77.28 52.43	20.89 45.75	1.82	*100.00	78.72	21.28	3.70	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
		$CaCO_3$ (%)[a]	$MgCO_3$ (%)[c]						
Core sample	Depth (ft)	Mineral calcite (%)[b]	Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)[3]	$MgCO_3$ (%)[3]	$CaCO_3$-$MgCO_3$ ratio	Age and unit
23D	7,991	55.17 15.38	33.44 73.23	9.42	98.03	62.26	37.74	1.65	
23E	7,991-8,001	73.05 43.07	25.19 55.17	1.69	99.93	74.36	25.64	2.90	
23F	8,002	56.92 11.57	38.61 83.90	2.84	98.37	59.58	40.42	1.47	
23G	8,002-8,012	60.07 29.17	25.97 56.87	12.93	98.97	69.82	30.18	2.31	
23H	8,012-8,015	70.15 49.42	17.42 38.15	12.43	*100.00	80.11	19.89	4.03	
Weighted avg, 23A-H		66.71	23.16	9.15					
KIRKPATRICK 1 BLEVINS UNIT									
38A	7,003-7,013	93.44 90.74	2.27 4.97	4.29	*100.00	97.63	2.37	41.16	SILURIAN. CHIMNEYHILL SUBGROUP. CLARITA FORMATION.
38B	7,013-7,022	93.91 89.45	3.79 8.30	3.53	101.23	96.12	3.88	24.78	
38C	7,022-7,032	73.68 60.42	11.14 24.40	15.03	99.85	86.87	13.13	6.61	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION.
38D	7,032-7,039	69.98 58.41	9.72 21.29	20.30	*100.00	87.80	12.20	7.20	
Weighted avg, 38A-D		82.47	6.81	10.97					
CALVERT-MID-AMERICA 2 BLOYD									
13A	6,208-6,218	54.30 17.33	31.07 68.04	10.17	95.54	63.61	36.39	1.75	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION (6,238-6,240-ft interval may be KEEL FORMATION).
13B	6,218-6,228	56.28 11.31	37.80 82.78	4.87	98.95	59.82	40.18	1.49	
13C	6,228-6,232	46.06 8.13	31.79 69.62	20.35	98.20	59.17	40.83	1.45	
Weighted avg, 13B,C		53.36	33.58	9.29					

13D	6,232- 6,238	82.00 70.61	9.57 20.96	7.58	99.15	89.55	10.45	8.57	
13E	6,238- 6,240	57.09 8.86	40.42 88.52	0.26	97.77	58.55	41.45	1.41	
Weighted avg, 13A-E		59.26	28.72	8.68					
JONES & PELLOW 1 BOYD									
31A	6,487- 6,497	95.99 94.98	0.85 1.86	3.16	*100.00	99.12	0.88	112.93	EARLY DEVONIAN. FRISCO FORMATION.
31B	6,497- 6,507	98.11 96.86	1.05 2.30	0.84	*100.00	98.94	1.06	93.44	
31C	6,507- 6,517	98.98 98.43	0.46 1.01	0.56	*100.00	99.54	0.46	215.17	
31D	6,517- 6,527	98.83 98.01	0.69 1.51	0.48	*100.00	99.31	0.69	143.23	
31E	6,527- 6,533	99.15 98.13	0.85 1.86	0.01	*100.00	99.15	0.85	116.65	
Weighted avg, 31A-E		98.13	0.77	1.096					
AMERADA 1 BRECKENRIDGE									
Spot sample	6,254	7.21 4.98	1.88 4.12	90.0	99.09	79.32	20.68	3.84	LATE DEVONIAN. MISENER SANDSTONE.
Spot sample	6,255	20.70 5.11	13.10 28.69	65.1	98.90	61.24	38.76	1.58	
ATLANTIC 1 CHOATE									
14A	8,316 8,320	47.26 4.03	29.61 64.85	21.15	98.02	61.48	38.52	1.60	SILURIAN. *KIRKIDIUM* BIOFACIES.
14B	8,326- 8,336	44.91 9.08	30.12 65.96	23.00	98.03	59.86	40.14	1.49	
14C	8,336- 8,348	61.13 34.72	22.19 48.60	16.68	*100.00	73.37	26.63	2.75	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
		$CaCO_3$ (%)[a]	$MgCO_3$ (%)[c]						
Core sample	Depth (ft)	Mineral calcite (%)[b]	Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
14D	8,348- 8,358	66.95 48.16	15.79 34.58	17.26	*100.00	80.92	19.08	4.24	
14E	8,358- 8,368	72.59 58.58	11.77 25.78	15.64	*100.00	86.05	13.95	6.17	
Weighted avg, 14A-E		58.66	21.90	18.66					
14F	8,368- 8,378	77.29 66.50	9.07 19.86	13.64	*100.00	89.50	10.50	8.52	
14G	8,378- 8,389	71.56 70.66	4.13 9.04	20.30	*100.00	94.54	5.46	17.33	
Weighted avg, 14F-G		74.29	6.48	17.13					
Weighted avg, 14A-G		63.15	17.46	18.22					
GETTY 1-B COFFMAN									
18A	11,201- 11,211	96.08 93.89	1.84 4.03	2.08	*100.00	98.12	1.88	52.22	SILURIAN. *KIRKIDIUM* BIOFACIES(?).
18B	11,211- 11,221	94.84 93.76	0.92 2.01	4.23	*100.00	99.04	0.96	103.09	SILURIAN. *KIRKIDIUM* BIOFACIES.
18C	11,221- 11,231	95.24 93.54	1.44 3.15	3.31	*100.00	98.51	1.49	66.14	
18D	11,231- 11,241	94.24 92.50	1.46 3.20	4.30	*100.00	98.47	1.53	64.55	
18E	11,241- 11,251	92.91 90.33	2.17 4.75	4.92	*100.00	97.72	2.28	42.82	
Weighted avg, 18A-E		94.66	1.56	3.76					
GULF 1 COSTELLO									
52A	10,433- 10,443	80.44 72.10	7.01 15.35	12.11	99.56	91.98	8.02	11.48	EARLY DEVONIAN. HARAGAN-BOIS D'ARC FORMATIONS.
52B	10,443- 10,453	72.40 64.15	6.93 15.18	19.05	98.38	91.26	8.74	10.45	

52C	10,453- 10,458	73.81 61.96	9.95 21.79	15.13	98.89	88.12	11.88	7.42	
Weighted avg, 52A-C		75.90	7.56	15.49					
KIRKPATRICK 1 CRONKITE									
7A	7,098- 7,108	70.76 47.55	19.51 42.73	9.43	99.70	78.39	21.61	3.63	EARLY DEVONIAN. SALLISAW FORMATION(?).
7B	7,108- 7,118	92.17 90.17	1.69 3.70	6.42	100.28	98.20	1.80	54.54	
7C	7,118- 7,119	89.60 79.12	8.30 18.18	2.88	100.78	91.52	8.48	10.80	
Weighted avg, 7A-C		81.85	10.49	7.68					
7D	7,119- 7,129	52.60 19.74	27.61 60.47	19.94	100.15	65.58	34.42	1.91	
7E	7,129- 7,132	54.60 23.95	25.75 56.39	18.78	99.13	67.95	32.05	2.12	
7F	7,132- 7,136	58.56 32.70	21.74 47.61	18.94	99.24	72.93	27.07	2.69	
Weighted avg, 7D-F		54.35	25.90	18.38					
Weighted avg, 7A-F		69.55	17.38	12.47					
SUNRAY DX 1 DAVIS									
1, 2	3,818- 3,823	54.91 42.82	10.16 22.25	31.43	96.50	84.39	15.61	5.40	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION.
3, 4, 5	3,823- 3,830.5	77.13 74.07	2.56 5.61	19.61	99.30	96.79	3.21	30.13	
Weighted avg		66.02	6.36	25.52	97.90				
5, 6	3,830.5- 3,835	93.24 89.15	3.44 7.53	3.09	99.77	96.44	3.56	27.10	SILURIAN. CHIMNEYHILL SUBGROUP. KEEL FORMATION.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		CaCO$_3$-MgCO$_3$ ratio	Age and unit
		CaCO$_3$ (%)[a] Mineral calcite (%)[b]	MgCO$_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)		
7, 8	3,835- 3,842	84.55 75.03	8.04 17.57	5.83	98.42	91.32	8.68	10.52	
Weighted avg		88.90	5.74	4.46	99.10				
Weighted avg, 1-8		77.46	6.05	14.99	98.50				
SHELL 1-15 DILL									
56A	8,530- 8,537	46.80 3.25	36.60 80.15	14.30	97.70	56.12	43.88	1.28	SILURIAN. *KIRKIDIUM* BIOFACIES.
56B	8,537- 8,542	54.18 3.20	42.85 93.84	1.46	98.49	55.84	44.16	1.26	
Weighted avg, 56A-B		49.87	39.20	8.95					
56C	8,542- 8,553	52.19 10.15	35.32 77.35	11.63	99.14	59.64	40.36	1.48	
56D	8,553- 8,563	57.05 13.29	36.77 80.53	5.39	99.21	60.81	39.19	1.55	
56E	8,563- 8,571	52.90 8.61	37.23 81.53	8.83	98.96	58.69	41.31	1.42	
56F	8,571- 8,577	52.60 8.04	37.44 81.99	9.04	99.08	58.42	41.58	1.40	
Weighted avg, 56C-F		53.81	36.53	8.76					
Weighted avg, 56A-F		52.80	37.21	8.81					
JONES & PELLOW 1 FARRELL									
27A	7,770- 7,780	88.23 77.73	8.87 19.43	3.55	100.65	90.87	9.13	9.95	SILURIAN. *KIRKIDIUM* BIOFACIES (oolite, 7,780-7,794 ft).
27B	7,780- 7,790	97.95 96.58	1.15 2.52	0.90	*100.00	98.84	1.16	85.17	
27C	7,790- 7,794	95.63 91.82	3.20 7.01	1.17	*100.00	96.76	3.24	29.88	
Weighted avg, 27B-C		97.29	1.74	0.98					

27D	7,794- 7,804	59.27 34.85	20.53 44.96	19.52	99.32	74.27	25.73	2.89	
27E	7,804- 7,814	74.34 59.05	12.85 28.14	13.02	100.21	85.26	14.74	5.79	
27F	7,814- 7,823	81.31 69.06	10.29 22.54	8.40	*100.00	88.77	11.23	7.90	
Weighted avg, 27D-F		71.31	14.70	13.83					
Weighted avg, 27A-F		81.36	10.18	8.50					
ASPEN 1-A FEDERAL 11A	8,456- 8,467	53.30 14.02	33.01 72.29	11.90	98.21	61.75	38.25	1.61	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
11B	8,467- 8,477	52.79 11.52	34.68 75.95	10.93	98.40	60.35	39.65	1.52	
11C	8,477- 8,487	55.77 12.23	36.58 80.11	7.34	99.69	60.39	39.61	1.52	
11D	8,487- 8,497	54.57 12.48	35.38 77.48	9.75	99.70	60.67	39.33	1.54	
11E	8,497- 8,507	55.95 12.37	36.62 80.20	6.70	99.27	60.44	39.56	1.53	
11F	8,507- 8,517	54.32 7.57	39.29 86.05	4.96	98.57	58.03	41.97	1.38	
11G	8,517- 8,527	56.54 9.34	39.66 86.86	2.66	98.86	58.77	41.23	1.43	
11H	8,527- 8,537	56.74 9.63	39.59 86.70	2.55	98.88	58.90	41.10	1.43	
Weighted avg, 11A-H		54.97	36.80	5.54					
TENNECO 1-11 FISHER UNIT 4A	8,127- 8,129	33.13 6.21	22.62 49.54	42.62	98.37	59.43	40.57	1.46	LATE DEVONIAN. MISENER SANDSTONE.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
		$CaCO_3$ (%)^a	$MgCO_3$ (%)^c						
Core sample	Depth (ft)	Mineral calcite (%)^b	Mineral dolomite (%)^d	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)^3	$MgCO_3$ (%)^3	$CaCO_3$-$MgCO_3$ ratio	Age and unit
4B	8,129- 8,139	60.94 44.09	14.16 31.01	23.29	98.39	81.15	18.85	4.30	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
4C	8,139- 8,149	64.94 49.49	12.98 28.43	21.19	99.11	83.34	16.66	5.00	
4D	8,149- 8,159	53.33 32.78	17.26 37.80	28.65	99.24	75.55	24.45	3.09	
4E	8,159- 8,167	58.10 18.58	33.22 72.75	7.69	99.01	63.62	36.38	1.75	
4F	8,167- 8,177	54.23 6.03	40.51 88.72	2.46	97.20	57.24	42.76	1.34	
Weighted avg, 4B-F		58.31	23.22	17.29					
TENNECO 1 LUCY FISHER									
50A	8,088- 8,094	39.23 14.32	21.20 46.43	38.04	98.47	64.92	35.08	1.85	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
50B	8,094- 8,104	74.17 62.63	9.70 21.24	16.13	*100.00	88.43	11.57	7.65	
50C	8,104- 8,106	80.25 71.62	7.25 15.88	12.50	*100.00	91.71	8.29	11.07	
50D	8,106- 8,116	61.25 46.53	12.60 27.59	23.36	97.21	82.94	17.06	4.86	
Weighted avg, 50A-D		62.50	13.02	23.15					
50E	8,116- 8,118	88.47 86.32	1.81 3.96	9.72	*100.00	98.00	2.00	48.88	SILURIAN.
50F	8,118- 8,128	87.55 83.60	3.32 7.27	9.13	*100.00	96.35	3.65	26.36	
50G	8,128- 8,131	86.19 75.81	8.72 19.10	5.09	*100.00	90.81	9.19	9.88	
Weighted avg, 50E-G		87.39	4.20	8.40					
Weighted avg, 50A-G		71.18	9.94	18.00					

SUNRAY DX 1 FRANS									
40A	14,504- 14,514	59.07 11.84	39.69 86.92	1.31	100.07	59.81	40.19	1.49	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
40B	14,514- 14,524	55.35 14.03	34.73 76.06	7.99	98.07	61.45	38.55	1.59	
40C	14,524- 14,534	52.46 11.39	34.51 75.58	11.57	98.54	60.32	39.68	1.52	SILURIAN. *KIRKIDIUM* BIOFACIES.
40D	14,534- 14,544	56.26 11.68	37.46 82.04	4.13	97.85	60.03	39.97	1.50	
40E	14,544- 14,554	57.58 11.57	38.66 84.67	4.38	100.62	59.83	40.17	1.49	
40F	14,554- 14,564	57.13 11.17	38.62 84.58	3.78	99.53	59.67	40.33	1.48	
40G	14,564- 14,574	57.85 12.22	38.35 83.99	4.61	100.81	60.14	39.86	1.51	SILURIAN. *KIRKIDIUM* BIOFACIES(?).
40H	14,574- 14,584	53.85 10.69	36.27 79.43	9.04	99.16	59.75	40.25	1.48	
40I	14,584- 14,594	56.16 10.63	38.26 83.79	5.30	99.72	59.48	40.52	1.47	
55A	14,594- 14,604	55.85 9.99	38.55 84.42	4.75	99.15	59.16	40.84	1.45	
55B	14,604- 14,614	56.15 12.02	37.09 81.23	5.87	99.11	60.22	39.78	1.51	
55C	14,614- 14,624	57.10 13.46	36.67 80.31	5.84	99.61	60.89	39.11	1.56	
Weighted avg, 40A-55C		56.23	37.40	5.71					
55D	14,624- 14,634	57.68 15.00	35.79 78.38	5.19	98.66	61.71	38.29	1.61	
55E	14,634- 14,635	55.75 8.43	39.76 87.07	4.11	99.62	58.37	41.63	1.40	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

* Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock: CaCO$_3$ (%)[a] Mineral calcite (%)[b]	MgCO$_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	Percentage of rock soluble in HCl: CaCO$_3$ (%)	MgCO$_3$ (%)	CaCO$_3$-MgCO$_3$ ratio	Age and unit
55F	14,635-14,645	57.87 11.03	39.36 86.20	2.26	99.49	59.52	40.48	1.47	
55G	14,645-14,648	58.28 10.05	40.54 88.78	0.92	99.74	58.98	41.02	1.44	
Weighted avg, 55D-G		57.75	38.04	3.39					
55H	14,648-14,658	61.06 17.47	36.63 80.22	2.22	99.91	62.50	37.50	1.67	
55I	14,658-14,668	57.98 12.22	38.46 84.23	3.26	99.70	60.12	39.88	1.51	
55J	14,668-14,678	58.26 16.33	35.24 77.18	7.10	100.60	62.31	37.69	1.65	
55K	14,678-14,688	55.24 12.69	35.76 78.31	8.68	99.68	60.70	39.30	1.54	
Weighted avg, 55H-K		58.13	36.52	5.32					
55L	14,688-14,691	62.54 29.29	27.95 61.21	9.39	99.88	69.11	30.89	2.24	
55M	14,691-14,701	61.49 32.55	24.31 53.24	14.16	99.96	71.67	28.33	2.53	
55N	14,701-14,711	72.45 50.23	18.68 40.91	9.02	100.15	79.50	20.50	3.88	
550	14,711-14,720	63.78 46.98	14.12 30.92	18.33	96.23	81.87	18.13	4.52	
Weighted avg, 55L-0		65.60	19.85	13.43					
Weighted avg, 40A-550		58.17	34.64	6.56					
CLEARY 1-21 GILBERT									
	7,560-7,570	57.72 35.79	18.43 40.36	23.05	99.20	75.80	24.20	3.13	SILURIAN. *KIRKIDIUM* BIOFACIES.
	7,570-7,576	53.52 28.43	21.08 46.17	24.63	99.23	71.74	28.26	2.54	
Weighted avg		56.14	23.90	23.64					

CALIFORNIA 1 GOODELL ET AL.									
44A	9,462– 9,470	85.24 76.73	7.15 15.66	7.61	*100.00	92.26	7.74	11.92	EARLY DEVONIAN(?). HARAGAN FORMATION(?).
44B	9,470– 9,480	78.18 68.23	8.36 18.31	13.46	*100.00	90.34	9.66	9.35	
Weighted avg, 44A, B		81.31	7.82	10.86					
44C	9,480– 9,490	78.94 68.86	8.47 18.55	12.59	*100.00	90.31	9.69	9.32	SILURIAN(?). HENRYHOUSE FORMATION(?).
44D	9,490– 9,500	76.49 67.91	7.21 15.79	16.30	*100.00	91.39	8.61	10.61	
44E	9,500– 9,506	75.26 66.16	7.65 16.75	17.09	*100.00	90.77	9.23	9.84	
Weighted avg, 44C-E		77.14	7.79	15.05					
Weighted avg, 44A-E		78.77	7.80	13.33					
LONE STAR 1 HANNAN UNIT									
41A	14,342– 14,354	50.82 8.05	35.94 78.71	10.57	97.33	58.58	41.42	1.41	SILURIAN(?). *KIRKIDIUM* BIOFACIES.
41B	14,364– 14,374	53.31 13.55	33.41 73.17	12.80	99.52	61.47	38.53	1.60	
41C	14,374– 14,384	51.39 8.15	36.35 79.61	9.38	97.12	58.57	41.43	1.41	
Weighted avg, 41A-C		51.84	35.23	10.92					
41D	14,384– 14,389	69.45 49.70	16.60 36.35	13.95	*100.00	80.71	19.29	4.18	
Weighted avg, 41A-D		54.36	32.57	11.35					
ANADARKO 1-A HAWKINS									
59A	6,143– 6,145	79.10 56.48	19.02 41.65	1.08	99.20	80.62	19.38	4.16	
59B	6,145– 6,155	79.36 57.05	18.75 41.06	1.36	99.47	80.89	19.11	4.23	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

* Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
Weighted avg, 59A, B		79.31	18.79	1.31					
PARKER 1 HENSLEY									
57A	8,966- 8,975	52.94 11.04	35.21 77.11	10.43	98.58	60.06	39.94	1.50	SILURIAN(?). All of cored interval tentatively assigned to Upper Silurian.
57B	8,975- 8,982	53.97 9.80	37.12 81.29	7.53	98.62	59.25	40.75	1.45	
57C	8,982- 8,991	55.34 12.31	36.16 79.19	7.40	98.90	60.48	39.52	1.53	
57D	8,991- 9,000	58.79 17.94	34.33 75.18	6.36	99.48	63.13	36.87	1.71	
Weighted avg, 57A-D		55.34	35.62	7.59					
57E	9,009- 9,018	77.45 55.33	18.59 40.71	4.02	100.06	80.64	19.36	4.17	
57F	9,018- 9,030	85.63 72.27	11.22 24.57	3.26	100.11	88.42	11.58	7.63	
57G	9,030- 9,040	87.32 75.93	9.58 20.98	2.86	99.76	90.11	9.89	9.11	
Weighted avg, 57E-G		83.80	12.83	3.35					
Weighted avg, 57A-G		68.91	24.75	5.57					
CARTER 1 HESTER									
32A	7,770- 7,774.9	87.52 82.25	3.59 7.86	8.89	*100.00	96.06	3.94	24.38	SILURIAN. CHIMNEYHILL SUBGROUP. CLARITA FORMATION.
32B	7,774.9- 7,783	93.00 90.72	1.92 4.20	5.08	*100.00	97.98	2.02	48.44	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION. (*Triplesia alata* at 7,777 ft.)
Weighted avg, 32A-B		90.93	2.54	6.52					
ANADARKO 1 HILPERT									
36A	6,581- 6,588	92.24 87.42	4.05 8.87	3.71	*100.00	95.79	4.21	22.78	SILURIAN. CHIMNEYHILL SUBGROUP.

36B	6,595– 6,601	94.26 91.77	2.09 4.58	3.65	*100.00	97.83	2.17	45.10	
Weighted avg, 36A, B		93.17	3.15	3.68					
36C	6,641– 6,646	94.97 92.39	2.17 4.75	2.86	*100.00	97.77	2.23	43.76	
36D	6,650– 6,656	94.76 92.73	1.71 3.74	3.53	*100.00	98.23	1.77	55.42	
Weighted avg, 36C,D		94.85	1.92	3.22					
Weighted avg, 36A–D		93.94	2.58	3.47					
GLOVER HEFNER KENNEDY 1-1 HOFFMAN									
35A	14,267– 14,277	53.73 11.94	35.12 76.91	9.22	98.07	60.47	39.53	1.53	SILURIAN. *KIRKIDIUM* BIOFACIES. *Kirkidium* sp. ranges from 14,281 to 14,349 ft.
35B	14,277– 14,287	51.73 11.58	33.74 73.89	11.96	97.43	60.52	39.48	1.53	
35C	14,287– 14,297	53.42 11.24	35.46 77.66	8.99	97.87	60.10	39.90	1.51	
35D	14,297– 14,307	43.99 8.71	30.42 66.62	23.10	98.51	59.12	40.88	1.45	
35E	14,307– 14,317	44.74 8.55	30.41 66.60	23.43	98.58	59.53	40.47	1.47	
35F	14,317– 14,319	49.80 10.84	32.74 71.70	16.36	98.90	60.33	39.67	1.52	
Weighted avg, 35A–F		49.53	33.01	15.37					
35G	14,319– 14,329	58.12 25.25	27.60 60.44	13.52	99.24	67.80	32.20	2.11	
35H	14,329– 14,339	65.02 39.49	21.45 46.98	13.53	*100.00	75.19	24.81	3.03	
35I	14,339– 14,349	56.72 39.25	14.68 32.15	28.60	*100.00	79.44	20.56	3.86	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		$CaCO_3$-$MgCO_3$ ratio	Age and unit
		$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)		
Weighted avg, 35G-I		59.95	21.24	18.52					
Weighted avg, 35A-I		53.34	28.70	16.52					
GULF 1 HOLTZSCHUE									
3A	6,447- 6,454	98.48 97.79	0.57 1.25	0.88	99.93	99.42	0.58	172.77	EARLY DEVONIAN. FRISCO fossils. Oolitic in lower part (pl. 2, fig. *6*). Frisco fossils recovered range throughout this interval.
3B	6,454- 6,464	94.91 93.58	1.11 2.43	3.81	99.83	98.84	1.16	85.50	
3C	6,464- 6,474	97.27 96.11	0.97 2.12	0.33	98.57	99.01	0.99	100.28	
3D	6,474- 6,479	93.66 92.65	0.86 1.88	3.97	98.49	99.09	0.91	108.91	
Weighted avg, 3A-D		96.42	0.91	2.10					
3E	6,479- 6,489	61.80 41.18	17.33 37.95	18.68	97.81	78.10	21.90	3.57	SILURIAN. *KIRKIDIUM* BIOFACIES. Specimen of *Kirkidium* within 3 feet of Frisco Formation.
3F	6,489- 6,499	63.20 44.06	16.08 35.22	18.34	97.62	79.72	20.28	3.93	
3G	6,499- 6,505	79.31 68.66	8.96 19.62	9.44	97.71	89.85	10.15	8.85	
Weighted avg, 3E-G		66.38	14.12	15.48					
SINCLAIR 1 HORLIVY									
54A	8,780- 8,790	98.56 97.00	1.31 2.87	0.18	100.05	98.69	1.31	75.24	EARLY DEVONIAN. FRISCO FORMATION.
54B	8,790- 8,800	99.09 98.33	0.64 1.04	0.31	100.04	99.36	0.64	154.83	
54C	8,800 8,810	98.52 97.25	1.07 2.34	0.43	100.02	98.93	1.07	92.07	
54D	8,810- 8,820	98.06 96.56	1.26 2.76	0.74	100.06	98.73	1.27	77.83	
54E	8,820- 8,830	98.28 96.95	1.12 2.45	0.55	99.95	98.87	1.13	87.75	

54F	8,830- 8,837	95.64 93.87	1.49 3.26	2.51	99.64	98.47	1.53	64.19	
Weighted avg, 54A-F		98.15	1.13	0.70					
54G	8,837- 8,839	89.81 85.86	3.33 7.29	7.06	100.20	96.42	3.58	26.97	EARLY DEVONIAN(?). BOIS D'ARC FORMATION. FITTSTOWN MEMBER.
MOBIL 1 HORTON									
12A	14,262- 14,272	78.41 58.50	16.73 36.64	4.86	*100.00	82.42	17.58	4.69	SILURIAN. *KIRKIDIUM* BIOFACIES.
12B	14,272- 14,280	61.96 39.27	19.07 41.76	18.97	*100.00	76.47	23.53	3.25	
	14,280- 14,290	No core							
12C	14,290- 14,300	58.23 22.92	29.67 64.98	12.10	*100.00	66.25	33.75	1.96	
12D	14,300- 14,310	77.37 54.82	18.95 41.50	3.68	*100.00	80.33	19.67	4.08	
12E	14,310- 14,320	44.36 0.04	37.31 81.71	18.33	*100.00	54.32	45.68	1.19	
12F	14,320- 14,330	67.84 41.46	22.17 48.55	9.99	*100.00	75.37	24.63	3.06	
12G	14,330- 14,340	52.89 24.07	24.22 53.04	22.89	*100.00	68.59	31.41	2.18	
12H	14,340- 14,350	68.71 50.74	15.10 33.07	16.19	*100.00	81.98	18.02	4.55	
12I	14,350- 14,358	70.07 54.29	13.27 29.06	16.65	*100.00	84.08	15.92	5.28	
	14,358- 14,370	No core							
12J	14,370- 14,380	67.91 55.25	10.64 23.30	21.45	*100.00	86.45	13.55	6.38	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock: $CaCO_3$ (%)[a] Mineral calcite (%)[b]	Percentage of total rock: $MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Percentage of total rock: Insoluble residue (%)	Percentage of total rock: Recovery (%)	Percentage of rock soluble in HCl: $CaCO_3$ (%)	Percentage of rock soluble in HCl: $MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
Weighted avg, 12A-J		64.72	20.90	12.36					
12K	14,380- 14,390	64.33 51.13	11.10 24.31	24.56	*100.00	85.28	14.72	5.80	SILURIAN. *KIRKIDIUM* BIOFACIES(?) (no specimens of *Kirkidium* sp. observed in this interval).
12L	14,390- 14,400	69.47 55.39	11.83 25.91	18.70	*100.00	85.45	14.55	5.87	
12M	14,400- 14,410	72.29 60.08	10.26 22.47	17.45	*100.00	87.57	12.43	7.05	
12N	14,410- 14,420	70.43 56.54	11.67 25.56	17.90	*100.00	85.79	14.21	6.04	
12O	14,420- 14,430	70.62 59.87	9.03 19.78	20.35	*100.00	88.66	11.34	7.82	
12P	14,430- 14,440	76.94 66.19	9.03 19.78	14.03	*100.00	89.50	10.50	8.52	
12Q	14,440- 14,450	80.46 71.90	7.19 15.75	12.35	*100.00	91.80	8.20	11.19	
12R	14,450- 14,460	61.09 45.91	12.67 27.75	26.34	*100.00	82.82	17.18	4.82	
12S	14,460- 14,470	39.79 15.11	20.74 45.42	39.47	*100.00	65.74	34.26	1.92	
12T	14,470- 14,480	42.82 19.01	20.01 43.82	37.17	*100.00	68.15	31.85	2.14	
Weighted avg, 12K-T		64.82	12.35	22.83					
$12U_1$	14,480- 14,490	68.53 56.89	9.78 21.42	21.69	*100.00	87.51	12.49	7.01	
$12U_2$	14,490- 14,500	76.28 66.31	8.38 18.35	15.34	*100.00	90.10	9.90	9.10	
12V	14,500- 14,510	77.52 69.83	6.96 14.65	15.52	*100.00	91.76	8.24	11.14	
12W	14,510- 14,520	74.48 64.85	8.09 17.72	17.43	*100.00	90.20	9.80	9.21	

12X	14,520– 14,530	74.99 64.24	9.03 19.78	15.98	*100.00	89.25	10.75	8.30
Weighted avg, $12U_1$–X		74.36	8.45	17.19				
12Y	14,530– 14,540	86.41 79.29	5.98 13.10	7.61	*100.00	93.53	6.47	14.45
$12Z_1$	14,540– 14,550	79.69 72.00	6.69 14.65	13.35	*100.00	92.26	7.74	11.91
$12Z_2$	14,550– 14,560	83.35 75.61	6.50 14.24	10.15	*100.00	92.66	7.23	12.82
12AA	14,560– 14,570	84.45 76.56	6.63 14.52	8.92	*100.00	92.72	7.28	12.74
12BB	14,570– 14,580	91.08 86.70	3.68 8.06	5.24	*100.00	96.12	3.88	24.75
12CC	14,580– 14,590	91.80 87.44	3.66 8.02	4.54	*100.00	96.17	3.83	25.08
12DD	14,590– 14,592	92.78 87.47	4.45 9.75	2.85	100.08	95.42	4.58	20.85
	14,592– 14,599	No core						
12EE	14,599– 14,609	93.53 89.65	3.26 7.14	3.21	*100.00	96.63	3.37	28.69
12FF	14,609– 14,610	91.30 86.10	4.37 9.57	4.33	*100.00	95.43	4.57	20.89
	14,610– 14,629	No core						
12GG	14,629– 14,639	78.69 62.36	13.72 30.05	7.59	*100.00	85.15	14.85	5.74
$12G_1G_1$	14,639– 14,642	85.93 75.39	8.91 19.51	5.10	*100.00	90.61	9.39	9.64
	14,642– 14,660	No core						

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		CaCO$_3$-MgCO$_3$ ratio	Age and unit
		CaCO$_3$ (%)^a Mineral calcite (%)^b	MgCO$_3$ (%)^c Mineral dolomite (%)^d	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)^3	MgCO$_3$ (%)^3		
	14,660-14,672	N o	a n a l y s i s						
Weighted avg, 12Y-G$_1$G$_1$		86.33	6.29	7.34					
12HH	14,682-14,690	84.77 75.92	7.44 16.29	7.79	*100.00	91.93	8.07	11.39	SILURIAN. CHIMNEYHILL SUBGROUP.
12II	14,690-14,692	93.54 89.07	3.76 8.23	2.70	*100.00	96.14	3.86	24.88	
12JJ	14,692-14,702	72.81 62.02	9.07 19.86	18.12	*100.00	88.92	11.08	8.03	
12KK	14,702-14,712	75.35 65.45	8.32 18.22	16.33	*100.00	90.06	9.94	9.06	
12LL	14,712-14,720	53.73 38.11	13.13 28.75	31.46	98.32	80.36	19.64	4.09	
12MM	14,720-14,730	37.44 21.04	13.78 30.18	48.03	99.25	73.10	26.90	2.72	
12NN	14,730-14,740	50.14 33.25	14.19 31.08	33.49	97.82	77.94	22.06	3.53	
12OO	14,740-14,742	40.95 20.29	17.36 38.02	40.57	98.88	70.23	29.77	2.36	
12PP	14,742-14,751	80.31 71.09	7.75 16.97	11.94	*100.00	91.20	8.80	10.36	
12QQ	14,751-14,753	53.30 46.34	5.85 12.81	39.61	98.76	90.11	9.89	9.11	
Weighted avg, 12HH-QQ		64.28	10.45	24.61					
Weighted avg, 12A-QQ		70.47	12.27	16.64					
PAYNE 1 HOUCK									
8A	7,000-7,010	86.14 81.18	4.17 9.13	9.61	99.92	95.38	4.62	20.66	SILURIAN. CHIMNEYHILL SUBGROUP(?).
8B	7,010-7,020	93.61 91.24	1.99 4.36	4.82	100.42	97.92	2.08	47.04	

8C	7,020- 7,030	81.78 79.61	1.82 3.99	16.35	99.95	97.82	2.18	44.93	
8D	7,030- 7,040	89.70 85.52	3.51 7.69	6.82	100.03	96.23	3.77	25.56	
8E	7,040- 7,050	No	core						
8F	7,050- 7,060	83.00 76.47	5.49 12.02	10.72	99.21	93.80	6.20	15.12	SILURIAN. CHIMNEYHILL SUBGROUP.
8G	7,060- 7,070	82.65 74.94	6.48 14.19	9.60	98.73	92.73	7.27	12.75	
8H	7,070- 7,074	91.17 87.78	2.85 6.24	5.37	99.39	96.97	3.03	31.99	
8I	7,074- 7,084	94.31 91.76	2.14 4.69	2.84	99.29	97.78	2.22	44.07	
8_1	7,084- 7,094	94.22 91.03	2.68 5.87	3.60	100.50	97.23	2.77	35.16	
8_2	7,094- 7,099	86.43 79.20	6.08 13.32	6.74	99.25	93.43	6.57	14.22	
Weighted avg, 8A-8_2		88.21	3.65	7.85					
MIDWEST 1 HUGHES UNIT 9A	8,062- 8,072	74.46 65.47	7.56 16.56	17.14	99.16	90.78	9.22	9.85	SILURIAN. *KIRKIDIUM* BIOFACIES.
9B	8,072- 8,082	68.09 58.17	8.34 18.26	22.51	98.94	89.09	10.91	8.16	
Weighted avg, 9A,B		71.27	7.95	19.82					
9C	8,082- 8,092	78.01 65.58	10.44 22.86	11.18	99.63	88.20	11.80	7.47	SILURIAN. *KIRKIDIUM* BIOFACIES(?). CHIMNEYHILL SUBGROUP(?).
9D	8,092- 8,102	83.05 73.92	7.67 16.80	8.40	99.12	91.55	8.45	10.83	
9E	8,102- 8,112	91.27 85.19	5.11 11.19	3.42	99.80	94.70	5.30	17.86	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock: $CaCO_3$ (%)[a] Mineral calcite (%)[b]	Percentage of total rock: $MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Percentage of total rock: Insoluble residue (%)	Percentage of total rock: Recovery (%)	Percentage of rock soluble in HCl: $CaCO_3$ (%)	Percentage of rock soluble in HCl: $MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
9F	8,112- 8,122	82.64 66.30	13.73 30.07	3.34	99.71	85.75	14.25	6.02	
9G	8,122- 8,132	79.96 64.66	12.86 28.16	6.18	99.00	86.15	13.85	6.22	
9H	8,132- 8,142	74.23 55.93	15.39 33.70	9.22	98.84	82.83	17.17	4.82	
Weighted avg, 9C-H		81.53	10.87	6.96					
9I	8,142- 8,152	68.72 44.82	19.75 43.25	10.70	99.17	77.68	22.32	3.48	SILURIAN. CHIMNEYHILL SUBGROUP. CLARITA FORMATION.
9J	8,152- 8,158	77.88 61.49	13.77 30.16	8.09	99.74	84.98	15.02	5.66	
Weighted avg, 9I, J		72.15	17.51	9.72					
Weighted avg, 9A-J		77.83	11.37	10.10					
TIDEWATER 1 JOHNSON									
Spot samples; average	7,514- 7,565	95.90 91.79	3.51 7.69	0.52	*100.00	96.47	3.53	27.32	EARLY DEVONIAN. FRISCO FORMATION. (Analyses are averages of two spot samples from the *Rensselaeria*-bearing beds.)
MOBIL 1 JONES UNIT									
Spot sample	14,503	54.35 7.90	39.03 85.48	2.87	96.25	58.20	41.80	1.39	SILURIAN. *KIRKIDIUM* BIOFACIES.
Spot sample	14,521	49.55 7.53	35.31 77.33	12.15	97.01	58.39	41.61	1.40	
Spot sample	14,561	35.95 3.92	26.92 58.95	34.19	97.06	57.18	42.82	1.34	
Spot sample	14,601	48.00 7.37	34.14 74.77	14.89	97.03	58.44	41.56	1.41	
Average		49.96	33.85	16.02					

TENNECO 1-A JORDAN UNIT									
1A	8,489- 8,499	52.39 5.12	39.72 86.99	7.57	99.68	56.88	43.12	1.32	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
1B	8,499- 8,509	51.20 3.24	40.30 88.26	9.90	101.40	55.96	44.04	1.27	
Weighted avg, 1A,B		51.79	40.01	8.73					
1C	8,509- 8,519	52.20 2.81	41.50 90.89	5.50	99.20	55.71	44.29	1.26	SILURIAN. *KIRKIDIUM* BIOFACIES.
1D	8,519- 8,529	47.37 3.07	37.25 81.58	14.88	99.50	55.98	44.02	1.27	
1E	8,529- 8,539	48.93 1.09	40.21 88.06	10.13	99.27	54.89	45.11	1.22	
1F	8,539- 8,541	51.68 1.33	42.31 92.66	5.56	99.55	54.98	45.02	1.22	
1G	8,541- 8,551	50.03 2.05	40.31 88.28	9.01	99.35	55.38	44.62	1.24	
Weighted avg, 1C-G		49.73	39.94	9.67					
1H	8,551- 8,561	47.74 7.59	33.73 73.87	17.48	98.95	58.60	41.40	1.42	SILURIAN.
1I	8,561- 8,571	53.45 8.33	37.91 83.02	7.41	98.77	58.50	41.50	1.41	
1J	8,571- 8,581	57.70 20.45	31.30 68.55	11.00	100.00	64.83	35.17	1.84	
Weighted avg, 1H-J		52.96	34.31	11.96					
1K	8,581- 8,591	72.37 52.12	16.98 37.19	10.47	99.82	81.00	19.00	4.26	
1L	8,591- 8,601	78.13 58.98	16.09 35.24	5.90	100.12	82.92	17.08	4.86	
1M	8,601- 8,611	87.36 75.55	9.93 21.75	3.29	100.58	89.79	10.21	8.80	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		CaCO$_3$-MgCO$_3$ ratio	Age and unit
		CaCO$_3$ (%)[a] Mineral calcite (%)[b]	MgCO$_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)		
1N	8,611- 8,614	77.18 57.51	16.52 36.18	6.33	100.03	82.37	17.63	4.67	
Weighted avg, 1K-N		79.09	14.53	6.53					
Weighted avg, 1A-N		66.87	31.89	9.24					
TENNECO 2-34 JORDAN UNIT									
10A	8,464- 8,474	47.86 4.57	36.38 79.67	14.86	99.10	56.81	43.19	1.32	SILURIAN(?).
10B	8,474- 8,484	51.54 12.13	33.11 72.51	12.68	97.33	60.89	39.11	1.56	
10C	8,484- 8,494	53.42 14.65	32.59 71.37	11.89	97.90	62.11	37.89	1.64	
10D	8,494- 8,504	48.15 8.09	33.66 73.72	16.80	98.61	58.86	41.14	1.43	
10E	8,504- 8,514	51.92 9.58	35.58 77.92	10.96	98.46	59.34	40.66	1.46	
Weighted avg, 10A-E		50.58	34.26	13.44					
10F	8,514- 8,520	60.05 21.80	32.15 70.41	6.04	98.24	65.13	34.87	1.87	
10G	8,520- 8,530	54.62 12.40	35.48 77.70	7.69	97.79	60.62	39.38	1.54	
10H	8,530- 8,540	51.95 6.53	38.17 83.59	9.11	99.23	57.65	42.35	1.36	
Weighted avg, 10F-H		54.84	35.75	7.85					
10I	8,540- 8,550	53.73 5.40	40.61 88.94	3.12	97.46	56.95	43.05	1.32	
10J	8,550- 8,560	54.34 3.97	42.34 92.72	2.69	99.37	56.21	43.79	1.28	
10K	8,560- 8,570	52.50 4.13	40.65 89.02	6.62	99.77	56.36	43.64	1.29	

Weighted avg, 10I-K		53.52	41.20	4.14					
Weighted avg, 10A-K		52.45	36.59	9.43					
CLEARY 1-20 KINNEY 21A	8,721- 8,725	88.71 82.25	5.43 11.89	5.86	*100.00	94.23	5.77	16.34	SILURIAN. CHIMNEYHILL SUBGROUP.
21B	8,725- 8,730	81.53 70.93	8.91 19.51	9.56	*100.00	90.15	9.85	9.15	
Weighted avg, 21A,B		84.72	7.36	7.92					
21C	8,730- 8,735	96.32 93.44	2.42 5.30	1.26	*100.00	97.55	2.45	39.80	
21D	8,735- 8,740	98.61 98.62	0.00 0.00	1.38	*100.00	100	0		
21E	8,740- 8,745	96.99 95.75	1.04 2.28	1.97	*100.00	98.94	1.06	93.26	
21F	8,745- 8,750	97.82 96.88	0.79 1.73	1.39	*100.00	99.20	0.80	123.82	
21G	8,750- 8,751	97.15 95.84	1.10 2.41	1.75	*100.00	98.88	1.12	88.32	
21H	8,751- 8,756	98.84 97.92	0.77 1.69	0.39	*100.00	99.23	0.77	128.36	
21I	8,756- 8,760	97.82 95.86	1.65 3.61	0.53	*100.00	98.34	1.66	59.28	
Weighted avg, 21C-I		97.71	1.09	1.19					
Weighted avg, 21A-I		94.71	2.54	2.74					
CLEARY 1-24 KRAMP-COBB 51A	8,495- 8,505	54.25 0.79	44.93 98.40	0.88	100.06	54.70	45.30	1.21	SILURIAN. *KIRKIDIUM* BIOFACIES.
51B	8,505- 8,512	54.58 2.78	43.53 95.33	0.98	99.09	55.63	44.37	1.25	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
Weighted avg, 51A,B		54.39	44.35	0.92					
	8,512-8,515	No core							
51C	8,515-8,525	52.84 9.82	36.15 79.17	9.82	98.81	59.38	40.62	1.46	
51D	8,525-8,532	55.17 9.29	38.55 84.42	5.59	99.31	58.87	41.13	1.43	
Weighted avg, 51C,D		53.80	37.14	8.08					
Weighted avg, 51A-D		54.09	40.74	4.50					
SMITH BROS. 1 KYTLE-RAY									
Spot sample	4,930	97.79 96.06	1.44 3.15	1.09	100.32	98.55	1.45	67.91	EARLY DEVONIAN. FRISCO FORMATION.
PHILLIPS 1-C LEE (Spot samples)									
1	15,100	93.69 90.50	2.68 5.87	1.79	98.16	97.22	2.78	34.97	SILURIAN. *KIRKIDIUM* BIOFACIES.
2	15,073	96.04 94.06	1.66 3.64	0.68	98.38	98.30	1.70	57.82	
3	15,044	96.82 95.63	1.00 2.19	0.12	97.94	98.98	1.02	97.04	
4	14,996-15,000	94.97 92.57	2.02 4.42	0.39	97.38	97.92	2.08	47.08	
5	14,993-14,994	86.71 79.93	5.70 12.48	4.75	97.16	93.83	6.17	15.21	
APCO 1 LEON									
Spot sample		70.09 57.90	10.24 22.43	17.45	97.78	87.25	12.75	6.84	SILURIAN. *KIRKIDIUM* BIOFACIES.

GETTY 1 LUETKEMEYER UNIT									
33A	8,827- 8,837	54.17 3.20	42.83 93.80	2.08	99.08	55.85	44.15	1.26	SILURIAN. *KIRKIDIUM* BIOFACIES.
33B	8,837- 8,847	54.76 2.06	44.29 97.00	0.85	99.90	55.29	44.71	1.24	
33C	8,847- 8,852	54.17 10.81	36.43 79.78	7.39	97.99	59.79	40.21	1.49	
Weighted avg, 33A-C		54.41	42.13	2.65					
33D	9,192- 9,202	34.54 18.05	13.86 30.35	52.93	101.33	71.36	28.64	2.49	SILURIAN. CHIMNEYHILL SUBGROUP.
33E	9,202- 9,212	26.36 13.76	10.60 23.21	60.93	97.89	71.32	28.68	2.49	
33F	9,212- 9,222	65.90 61.27	3.89 8.52	30.09	99.88	94.43	5.57	16.94	
33G	9,222- 9,232	80.40 74.93	4.60 10.07	15.00	*100.00	94.59	5.41	17.48	
33H	9,232- 9,242	90.86 85.84	4.22 9.24	4.92	*100.00	95.56	4.44	21.53	
33I	9,242- 9,245	89.29 82.42	5.77 12.64	4.94	*100.00	93.93	6.07	15.47	
Weighted avg, 33D-I		65.03	7.34	31.20					
33J	9,245- 9,248	84.49 70.32	11.90 26.06	3.62	*100.00	87.65	12.35	7.10	SILURIAN. CHIMNEYHILL SUBGROUP. KEEL FORMATION.
Weighted avg, 33D-J		64.91	7.58	29.72					
Weighted avg, 33A-J		62.47	18.25	21.37					
GULF 1 MAY									
49A	8,723- 8,725	80.74 73.14	6.39 13.99	12.43	99.56	92.67	7.33	12.64	SILURIAN. CHIMNEYHILL SUBGROUP.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

* Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
YINGER 1 MAYES									
34A	7,780- 7,789	52.91 9.86	36.13 79.12	10.89	99.93	59.42	40.58	1.46	SILURIAN. *KIRKIDIUM* BIOFACIES.
34B	7,789- 7,796	68.50 41.30	22.86 50.06	8.64	*100.00	74.98	25.02	3.00	
Weighted avg, 34A,B		59.73	30.32	9.91					
34C	7,796- 7,806	77.47 63.71	11.56 25.32	10.97	*100.00	87.02	12.98	6.70	SILURIAN.
34D	7,806- 7,809	70.53 63.32	6.06 13.27	23.41	*100.00	92.09	7.91	11.64	
Weighted avg, 34C,D		75.87	10.29	13.84					
Weighted avg, 34A-D		66.96	21.34	11.67					
CALIFORNIA 1 MULLEN ET AL.									
43A	9,187- 9,196	87.65 80.99	5.60 12.26	6.75	*100.00	93.99	6.01	15.65	EARLY DEVONIAN(?). HARAGAN FORMATION.
	9,196- 9,208	No sample							
43B	9,208- 9,218	78.61 70.72	6.63 14.52	14.76	*100.00	92.22	7.78	11.86	
43C	9,218- 9,228	73.68 63.17	8.79 19.25	16.73	99.20	89.34	10.66	8.38	
43D	9,228- 9,238	82.61 77.80	4.04 8.85	12.42	99.07	95.34	4.66	20.45	
43E	9,338- 9,348	87.76 84.04	3.13 6.85	9.11	*100.00	96.56	3.44	28.04	EARLY DEVONIAN(?). HARAGAN FORMATION(?).
43F	9,248- 9,258	83.74 78.56	4.35 9.53	11.91	*100.00	95.06	4.94	19.25	
Weighted avg, 43B-F		82.25	5.42	12.03					

43G	9,258- 9,268	83.25 78.10	4.33 9.48	11.08	98.66	95.06	4.94	1.23	SILURIAN(?). HENRYHOUSE FORMATION(?).
43H	9,268- 9,278	83.50 77.65	4.91 10.75	11.60	*100.00	94.45	5.55	17.01	
43I	9,278- 9,288	79.01 72.62	5.37 11.76	15.62	*100.00	93.64	6.36	14.71	
	9,288- 9,299	No sample							
43J	9,299- 9,309-	83.21 77.89	4.47 9.79	12.32	*100.00	94.90	5.10	18.62	
43K	9,309- 9,319	82.42 77.55	4.09 8.96	13.49	*100.00	95.27	4.73	20.15	
43L	9,319- 9,329	78.59 72.00	5.54 12.13	15.87	*100.00	93.41	6.59	14.19	
43M	9,329- 9,332	79.91 74.79	4.30 9.42	15.79	*100.00	94.89	5.11	18.58	
Weighted avg, 43G-M		81.41	4.72	13.68					
KIRKPATRICK & NATOL 1 NICKEL UNIT									
28A	7,880- 7,890	55.38 8.20	39.69 86.92	2.57	97.64	58.25	41.75	1.40	SILURIAN(?).
28B	7,890- 7,900	53.90 2.12	43.51 95.29	1.47	98.88	55.22	44.58	1.24	
28C	7,900- 7,907	53.72 3.12	42.51 93.10	2.17	98.40	55.82	44.18	1.26	
Weighted avg, 28A-C		54.40	41.83	2.06					
COLUMBIA FUEL 2 RAINY MOUNTAIN									
48B	623- 633	98.48 98.37	0.09 0.20	0.64	99.21	99.91	0.09	1,094.22	HUNTON GROUP(?).

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock: $CaCO_3$ (%)[a] Mineral calcite (%)[b]	Percentage of total rock: $MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Percentage of total rock: Insoluble residue (%)	Percentage of total rock: Recovery (%)	Percentage of rock soluble in HCl: $CaCO_3$ (%)[3]	Percentage of rock soluble in HCl: $MgCO_3$ (%)[3]	$CaCO_3$-$MgCO_3$ ratio	Age and unit
COLUMBIA FUEL 3 RAINY MOUNTAIN									
48C	757- 761	90.81 83.61	6.10 13.36	3.03	*100.00	93.71	6.29	14.89	HUNTON GROUP(?).
JONES & PELLOW 1 REHERMAN									
20A	7,867- 7,870	68.17 55.32	10.80 23.65	21.05	100.02	86.32	13.68	6.31	SILURIAN. CHIMNEYHILL SUBGROUP(?).
20B	7,870- 7,880	84.31 75.30	7.57 16.58	8.12	*100.00	91.76	8.24	11.14	SILURIAN. CHIMNEYHILL SUBGROUP(?).
20C	7,880- 7,884	92.84 86.88	5.01 10.97	2.15	*100.00	94.88	5.12	18.53	
20D	7,884- 7,894	93.06 86.62	5.41 11.85	1.53	*100.00	94.51	5.49	17.20	SILURIAN. CHIMNEYHILL SUBGROUP(?).
20E	7,894- 7,904	89.16 78.47	8.98 19.67	1.86	*100.00	90.85	9.15	9.93	
20F	7,904- 7,909	85.56 73.12	10.45 22.89	3.99	*100.00	89.12	10.88	8.19	
Weighted avg, 20B-F		88.83	7.48	3.68					SILURIAN. CHIMNEYHILL SUBGROUP.
20G	7,909- 7,919	72.04 54.20	14.99 32.83	12.97	*100.00	82.78	17.22	4.81	
20H	7,919- 7,923	80.95 71.08	8.30 18.18	10.74	*100.00	90.70	9.30	9.75	
Weighted avg, 20G-H		74.55	13.07	12.33					
Weighted avg, 20A-H		84.15	9.06	6.77					
SUNRAY DX 10-A RENTIE									
1,2	4,030.5- 4,035	90.73 82.69	6.76 14.80	2.05	99.54	93.07	6.93	13.42	SILURIAN. CHIMNEYHILL SUBGROUP.
3,4	4,035- 4,039	91.07 83.12	6.69 14.65	1.90	99.66	93.16	6.84	13.61	

5,6,7	4,039- 4,046	93.52 87.21	5.06 11.08	1.38	99.66	94.87	5.13	18.48	
8,9	4,046- 4,050	97.80 95.91	1.59 3.48	0.39	99.78	98.40	1.60	61.51	
10,11	4,050- 4,055	96.07 93.24	2.38 5.21	1.29	99.74	97.58	2.42	40.37	SILURIAN. CHIMNEYHILL SUBGROUP.
12,13	4,055- 4,059	88.09 77.42	8.96 19.62	2.70	99.75	90.77	9.23	9.83	
14,15	4,059- 4,065	85.07 71.24	11.62 25.45	2.89	99.58	87.98	12.02	7.32	
16,17,18	4,065- 4,070	71.59 45.48	21.94 48.05	6.19	99.72	76.54	23.46	3.26	
19,20	4,070- 4,074	91.38 83.23	6.85 15.00	1.96	100.19	93.03	6.97	13.34	
21,22	4,074- 4,079	91.85 84.70	6.01 13.16	1.46	99.32	93.86	6.14	15.28	
23,24	4,079- 4,084	93.17 86.85	5.31 11.63	1.04	99.52	94.61	5.39	17.55	
25,26	4,084, 4,088	92.81 86.18	5.58 12.22	0.95	99.34	94.33	5.67	16.63	
27,28	4,088- 4,093	91.84 84.46	6.22 13.62	1.45	99.51	93.66	6.34	14.77	
29,30	4,093- 4,097	89.58 79.92	8.12 17.78	1.52	99.22	91.69	8.31	11.03	
31,32,33	4,097- 4,104	78.57 60.17	15.46 33.86	3.81	97.84	83.56	16.44	5.08	
Weighted avg, 1-33		89.54	7.9	2.07	99.49				
34,35	4,104- 4,110	24.19 6.21	15.11 33.09	57.20	96.50	61.55	38.45	1.60	ORDOVICIAN. SYLVAN SHALE.
AMERADA 1 RICHEY Spot sample	6,241	23.8 8.33	13.0 28.47	62.8	99.60	64.67	35.33	1.83	LATE DEVONIAN. MISENER SANDSTONE.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl			
		CaCO$_3$ (%)[a] Mineral calcite (%)[b]	MgCO$_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)	CaCO$_3$-MgCO$_3$ ratio	Age and unit
Spot sample	6,256	43.3 6.89	30.6 67.01	26.6	100.50	58.59	41.41	1.42	
PAN AMERICAN 1-B ROETZAL UNIT									
42A	8,434- 8,444	54.76 10.23	37.42 81.95	7.05	99.23	59.41	40.59	1.46	SILURIAN. *KIRKIDIUM* BIOFACIES.
42B	8,444- 8,454	53.68 8.17	38.24 83.75	7.93	99.85	58.40	41.60	1.40	
42C	8,454- 8,464	50.28 7.76	35.80 78.40	13.48	99.56	58.41	41.59	1.40	
42D	8,464- 8,470	44.02 5.44	32.42 71.00	23.12	99.56	57.59	42.41	1.36	
Weighted avg, 42A-D		51.43	36.36	13.26					
CLEARY 1-12 ROSE									
17A	7,553- 7,563	51.05 7.75	36.39 79.69	11.07	98.51	58.38	41.62	1.40	SILURIAN(?).
17B	7,563- 7,573	57.15 13.33	36.82 80.64	1.76	95.73	60.82	39.18	1.55	
17C	7,573- 7,583	54.73 5.10	41.71 91.34	1.96	98.40	56.75	43.25	1.31	
17D	7,583- 7,591	53.45 6.31	39.61 86.75	5.36	98.42	57.44	42.56	1.35	
Weighted avg, 17A-D		54.13	38.58	5.02					
GULF 1 SCHROEDER									
53A	6,283- 6,293	96.88 95.19	1.42 3.11	1.74	100.04	98.56	1.44	68.23	EARLY DEVONIAN. FRISCO FORMATION.
53B	6,293- 6,303	96.74 96.01	1.02 2.23	2.30	100.06	98.96	1.04	94.84	
53C	6,303- 6,313	98.72 97.72	0.85 1.86	0.43	100.00	99.15	0.85	116.14	

53D	6,313- 6,322	98.81 98.03	0.65 1.42	0.48	99.94	99.35	0.65	152.02	
Weighted avg, 53A-D		97.78	0.98	1.24					
53E	6,322- 6,332	74.55 60.74	11.60 25.40	12.90	99.05	86.54	13.46	6.43	SILURIAN. *KIRKIDIUM* BIOFACIES.
53F	6,332- 6,337	84.23 76.82	6.23 13.64	9.00	99.46	93.11	6.89	13.52	
Weighted avg, 53E-F		78.58	9.36	11.27					
GULF 1 SHADE									
47A	7,131- 7,141	93.01 87.67	4.49 9.83	2.50	*100.00	95.39	4.61	20.71	SILURIAN. CHIMNEYHILL SUBGROUP.
47B	7,141- 7,145	92.82 87.58	4.41 9.66	2.54	99.77	95.46	4.54	21.05	
Weighted avg, 47A,B		92.95	4.47	2.51					
47C	7,145- 7,155	51.93 26.07	21.73 47.59	26.34	*100.00	70.50	29.50	2.39	
47D	7,155- 7,160	98.60 98.18	0.35 0.77	1.05	*100.00	99.65	0.35	281.71	SILURIAN. CHIMNEYHILL SUBGROUP.
47E	7,160- 7,170	91.03 82.59	7.10 15.55	1.56	99.69	92.76	7.24	12.82	
47F	7,170- 7,172	No	sample						
Weighted avg, 47D-E		93.55	4.85	1.39					
Weighted avg, 47A-F		82.66	9.04	8.19					
KIRKPATRICK 1 SHEWEY UNIT									
15E	7,895- 7,905	No	sample						SILURIAN.
15G	7,905- 7,915	52.02 3.06	41.14 90.10	5.40	98.56	55.84	44.16	1.26	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
15H	7,915- 7,925	53.08 4.15	41.11 90.03	4.47	98.66	56.35	43.65	1.29	
15I	7,925- 7,932	49.61 4.32	38.06 83.35	9.98	97.65	56.59	43.41	1.30	
Weighted avg, 15G-I		51.78	40.33	6.24					
KIRKPATRICK 1-A SHEWEY									
15A	7,855- 7,865	51.18 3.47	40.08 87.78	6.70	97.96	56.08	43.92	1.28	SILURIAN.
15B	7,865- 7,875	50.42 3.35	39.55 86.61	7.90	97.87	56.04	43.96	1.27	
15C	7,875- 7,885	52.33 9.62	35.90 78.62	10.06	98.29	59.31	40.69	1.46	
15D	7,885- 7,895	50.61 10.22	33.94 74.33	14.29	98.84	59.86	40.14	1.49	
15E	7,895- 7,905	55.35 20.57	29.23 64.01	12.91	97.49	65.44	34.56	1.89	
Weighted avg, 15A-E		51.98	35.74	10.37					
15F	7,905- 7,909	39.94 10.99	24.33 53.28	35.17	99.44	62.14	37.86	1.64	
Weighted avg, 15A-F		51.52	35.30	11.32					
HUMBLE 1 STATE HUNTON									
6A	7,904- 7,914	56.13 8.32	40.18 87.99	3.00	99.31	58.28	41.72	1.40	SILURIAN. *KIRKIDIUM* BIOFACIES(?).
6B	7,914- 7,917	56.03 8.68	39.79 87.14	4.24	100.06	58.47	41.53	1.41	
6C	7,917- 7,927	58.01 17.30	34.21 74.92	7.27	99.49	62.90	37.10	1.70	
6D	7,927- 7,937	57.18 13.41	36.78 80.55	5.93	99.89	60.86	39.14	1.55	

6E	7,937- 7,947	52.77 9.15	36.66 80.29	9.56	98.99	59.01	40.99	1.44	
Weighted avg, 6A-E		56.02	37.15	6.29					
6F	7,947- 7,955	64.51 37.72	22.51 49.30	12.62	99.64	74.13	25.87	2.87	SILURIAN.
6G	7,955- 7,965	50.79 24.74	21.89 47.94	26.24	98.92	69.88	30.12	2.32	
6H	7,965- 7,975	47.46 22.42	21.04 46.08	30.27	98.77	69.28	30.72	2.26	
6I	7,975- 7,985	53.76 34.23	16.42 35.96	29.18	99.36	76.60	23.40	3.27	
6J	7,985- 7,995	67.08 57.37	9.85 21.57	23.09	100.02	87.20	12.80	6.81	
6K	7,995- 8,005	66.13 50.51	13.13 28.75	20.46	99.72	83.43	16.57	5.04	
6L	8,005- 8,007	73.61 49.93	15.69 34.36	15.89	105.19	82.43	17.57	4.69	
Weighted avg, 6F-L		57.93	16.66	24.99					
Weighted avg, 6A-L		57.08	25.74	16.70					
FERGUSON 1 STINSON									
1	7,822- 7,823	52.46 12.61	33.49 73.34	12.85	98.80	61.04	38.96	1.57	SILURIAN. *KIRKIDIUM* BIOFACIES(?).
2	7,823- 7,824	51.12 15.52	29.92 65.52	17.46	98.50	63.08	36.92	1.71	
3	7,824- 7,825	46.57 7.27	33.03 72.34	19.21	98.81	58.51	41.49	1.41	
4	7,825- 7,826	50.54 13.72	30.93 67.74	17.84	99.31	62.04	37.96	1.63	
5	7,826- 7,827	46.99 6.64	33.92 74.28	17.62	98.53	58.08	41.92	1.39	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
		$CaCO_3$ (%)[a]	$MgCO_3$ (%)[c]						
Core sample	Depth (ft)	Mineral calcite (%)[b]	Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
6	7,827- 7,828	45.06 7.41	31.65 69.31	22.22	98.93	58.74	41.26	1.42	
7	7,828- 7,829	46.14 7.00	32.89 72.03	19.99	99.02	58.38	41.62	1.40	
8	7,829- 7,830	45.27 7.92	31.38 68.72	21.02	97.67	59.06	40.94	1.44	
9	7,830- 7,831	47.07 8.14	32.71 71.63	19.35	99.13	59.00	41.00	1.44	
10	7,831- 7,832	45.16 7.62	31.55 69.09	21.37	98.08	58.87	41.13	1.43	
11	7,832- 7,833	46.06 8.44	31.62 69.25	21.45	99.13	59.29	40.71	1.46	
12	7,833- 7,834	46.89 8.65	32.13 70.36	20.07	99.09	59.34	40.66	1.46	
13	7,834- 7,835	45.87 8.39	31.49 68.96	21.73	99.09	59.29	40.71	1.46	
14	7,835- 7,836	41.99 8.25	28.37 62.13	26.99	97.35	59.68	40.32	1.48	
Weighted avg, 1-14		46.94	31.79	19.94					
15	7,836- 7,837	51.16 22.51	24.08 52.74	23.79	99.03	68.00	32.00	2.12	
16	7,837- 7,838	57.17 30.17	22.69 49.69	18.46	98.32	71.59	28.41	2.52	
17	7,838- 7,839	59.21 34.52	20.74 45.42	19.58	99.55	74.06	25.94	2.85	
18	7,839- 7,840	59.51 35.97	19.79 43.34	17.88	97.18	75.04	24.96	3.01	
19	7,840- 7,841	63.33 42.77	17.28 37.84	18.60	99.21	78.56	21.44	3.66	
Weighted avg, 15-19		58.07	20.91	19.66					

20	7,841- 7,842	64.87 51.12	11.55 25.29	23.00	99.42	84.89	15.11	5.62	SILURIAN.
21	7,842- 7,843	72.02 66.53	4.61 10.10	22.85	99.48	93.98	6.02	15.62	
22	7,843- 7,844	76.86 70.07	5.71 12.50	17.58	100.15	93.08	6.92	13.46	
23	7,844- 7,845	58.49 33.77	20.78 45.51	18.34	97.61	73.79	26.21	2.81	
24	7,847- 7,848	59.54 42.15	14.61 32.00	24.65	98.80	80.30	19.70	4.08	
25	7,850- 7,851	64.51 53.32	11.45 25.08	20.83	96.79	84.93	15.07	5.63	
26	7,853- 7,854	67.13 54.69	10.23 22.40	21.52	98.88	86.78	10.23	6.56	
Weighted avg, 20-26		66.20	11.28	21.25					
27	7,856- 7,857	66.37 57.17	7.73 16.93	24.00	98.10	89.57	10.43	8.59	
28	7,859- 7,860	70.88 62.18	7.29 15.97	20.71	98.88	90.67	9.33	9.72	
29	7,862- 7,863	71.85 60.64	9.93 21.75	19.28	101.06	87.86	12.14	7.24	
30	7,865- 7,866	73.99 66.38	6.40 14.02	17.77	98.16	92.04	7.96	11.56	
31	7,868- 7,869	73.55 68.60	4.16 9.11	21.85	99.56	94.65	5.35	17.68	
32	7,871- 7,872	65.75 60.63	4.30 9.42	28.70	98.75	93.86	6.14	15.29	
33	7,873- 7,874	72.69 67.63	4.25 9.31	21.86	98.80	94.48	5.52	17.10	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock: $CaCO_3$ (%)[a] Mineral calcite (%)[b]	Percentage of total rock: $MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Percentage of total rock: Insoluble residue (%)	Recovery (%)	Percentage of rock soluble in HCl: $CaCO_3$ (%)	Percentage of rock soluble in HCl: $MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
34	7,898- 7,899	70.48 59.03	9.63 21.09	17.02	97.13	87.98	12.02	7.32	
35	7,903- 7,904	70.76 60.28	8.81 19.29	18.26	97.83	88.93	11.07	8.03	
36	7,908- 7,909	75.56 66.49	7.63 16.71	17.47	100.66	90.83	9.17	9.90	
37	7,913- 7,914	79.72 73.65	5.09 11.15	13.74	98.55	94.00	6.00	15.66	
38	7,918- 7,919	69.72 56.80	10.86 23.78	17.50	98.08	86.52	13.48	6.42	
39	7,923- 7,924	81.23 76.30	4.15 9.09	13.00	98.38	95.14	4.86	19.57	
40	7,928- 7,929	75.32 66.94	7.03 15.40	16.24	98.59	91.46	8.54	10.71	
41	7,933- 7,934	77.19 70.18	5.89 12.90	15.78	98.86	92.91	7.09	13.11	
42	7,938- 7,939	76.72 68.00	7.33 16.05	14.94	98.99	91.28	8.72	10.47	
43	7,943- 7,944	71.72 66.00	4.81 10.53	20.26	96.79	93.71	6.29	14.91	
44	7,948- 7,949	45.26 24.98	17.04 37.32	35.06	97.36	72.65	27.35	2.66	
45	7,953- 7,954	64.48 50.88	11.43 25.03	23.62	99.53	84.94	15.06	5.64	
Weighted avg, 27-45		71.23	7.57	19.85					
Weighted avg, 1-45		61.42	17.16	20.07					
SHELL 1-32 STOCKING									
62A	10,247- 10,259	22.93 3.09	16.67 36.51	58.79	98.39	57.90	42.10	1.38	SILURIAN.
62B	10,259- 10,263	55.48 8.34	39.61 86.75	4.70	99.79	58.34	41.66	1.40	

62C	10,263- 10,267	52.39 13.43	32.74 71.70	13.40	98.53	61.54	38.46	1.60	
62D	10,267- 10,274	57.69 14.48	36.30 79.50	5.60	99.59	61.38	38.62	1.59	
Weighted avg, 62B-D		55.69	32.22	7.44					
62E	10,274- 10,289	76.47 53.30	19.46 42.62	4.20	100.13	79.71	20.29	3.93	
62F	10,289- 10,301	79.71 61.02	15.71 34.40	4.73	100.15	83.54	16.46	5.07	
62G	10,301- 10,310	78.56 60.98	14.77 32.35	6.31	99.64	84.17	15.83	5.32	
62H	10,310- 10,321	78.66 61.90	14.09 30.86	4.47	97.22	84.81	15.19	5.58	
Weighted avg, 62E-H		78.21	16.35	4.87					
Weighted avg, 62B-H		72.76	16.45	5.49					
GULF 1 STREETER 22A	6,954- 6,964	87.10 74.81	10.33 22.62	2.57	*100.00	89.40	10.60	8.43	EARLY DEVONIAN. FRISCO FORMATION.
22B	6,964- 6,974	91.44 90.15	1.08 2.37	7.48	*100.00	98.83	11.67	84.67	
22C	6,974- 6,984	No sample							
22D	6,984- 6,994	97.88 96.82	0.89 1.95	1.23	*100.00	99.10	0.90	109.98	
22E	6,994- 7,004	98.42 97.11	1.10 2.41	0.48	*100.00	98.89	1.11	89.47	
22F	7,004- 7,014	98.64 1.91	0.87 97.60	0.49	*100.00	99.13	0.87	113.38	
22G	7,014- 7,024	98.70 98.27	0.36 0.79	0.87	99.93	99.64	0.36	274.17	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

[*] Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
22H	7,024- 7,034	98.10 96.98	0.94 2.06	0.96	*100.00	99.05	0.95	104.36	
22I	7,034- 7,037	98.10 97.23	0.73 1.60	1.17	*100.00	99.26	0.74	134.38	
22J	7,037- 7,043.5	97.49 97.03	0.39 0.85	2.12	*100.00	99.60	0.40	249.97	
Weighted avg, 22B-J		97.40	1.99	1.99					
22K	7,043.5- 7,051	92.49 88.41	3.43 7.51	4.08	*100.00	96.42	3.58	26.97	SILURIAN. *KIRKIDIUM* BIOFACIES (oolite, 7,051-7,055 ft).
22L	7,051- 7,055	98.08 97.34	0.62 1.36	1.30	*100.00	99.37	0.63	158.19	
22M	7,055- 7,065	73.19 59.28	11.69 25.60	15.12	*100.00	86.23	13.77	6.26	
22N	7,065- 7,075	80.02 68.60	9.60 21.02	10.38	*100.00	89.29	10.71	8.34	
22O	7,075- 7,085	76.46 62.80	11.48 25.14	11.25	99.19	86.95	13.05	6.66	
Weighted avg, 22K-O		81.10	8.77	9.93					
	7,085- 7,104	No core							
22P	7,104- 7,114	64.28 48.56	13.21 28.93	22.51	*100.00	82.95	17.05	4.87	SILURIAN. *KIRKIDIUM* BIOFACIES.
22Q	7,114- 7,126	70.79 58.65	10.20 22.34	19.01	*100.00	87.41	12.59	6.94	
22R	7,126- 7,133	74.55 65.22	7.84 17.17	17.61	*100.00	90.48	9.52	9.51	
22S	7,138- 7,148	81.80 75.75	5.08 11.13	13.12	*100.00	94.15	5.85	16.10	
Weighted avg, 22K-S		72.61	9.24	18.15					

22T	7,148- 7,158	89.32 85.49	3.22 7.05	7.46	*100.00	96.52	3.48	27.74	SILURIAN. CHIMNEYHILL SUBGROUP(?).
22U	7,158- 7,168	91.97 88.79	2.67 5.85	5.36	*100.00	97.18	2.82	34.45	
22V	7,168- 7,178	97.06 95.87	1.00 2.19	1.94	*100.00	98.98	1.02	97.06	
	7,178- 7,185	No analysis							
Weighted avg, 22T-V		92.78	2.30	4.92					
22W	7,185- 7,191	79.53 63.20	13.72 30.05	6.75	*100.00	85.29	14.71	5.8	SILURIAN. CHIMNEYHILL SUBGROUP.
22X	7,191- 7,201	82.43 73.15	7.80 17.08	9.77	*100.00	91.36	8.64	10.57	
22Y	7,201- 7,211	76.91 66.47	8.77 19.21	12.87	98.55	89.76	10.24	8.77	
22Z	7,211- 7,221	82.80 75.73	5.94 13.01	11.26	*100.00	93.31	6.69	13.94	
22AA	7,221- 7,231	81.39 73.54	6.60 14.45	12.01	*100.00	92.50	7.5	12.33	
22BB	7,231- 7,241	78.07 67.20	9.14 20.02	12.78	*100.00	89.52	10.48	8.54	
	7,241- 7,248	No analysis							
Weighted avg, 22W-BB		80.23	8.30	11.20					
22CC	7,248- 7,252	56.54 32.70	20.03 43.87	21.85	98.42	73.84	26.16	2.82	
22DD	7,252- 7,262	80.05 69.52	8.85 19.38	10.24	99.14	90.04	9.96	9.05	
Weighted avg, 22CC-DD		73.33	12.04	13.56					

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		$CaCO_3$-$MgCO_3$ ratio	Age and unit
		$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)		
22EE	7,262- 7,272	84.18 82.65	7.17 8.70	8.65	*100.00	92.15	7.85	11.74	
22FF	7,272- 7,282	95.07 91.79	2.76 6.04	2.17	*100.00	97.18	2.82	34.45	
22GG	7,282- 7,292	71.49 59.52	10.06 22.03	18.45	*100.00	87.66	12.34	7.11	
22HH	7,292- 7,297	92.75 87.95	4.03 8.83	3.22	*100.00	92.84	4.16	23.01	
Weighted avg, 22EE-HH		84.89	6.29	8.82					
Weighted avg, 22T-HH		83.51	6.83	9.43					
Weighted avg, 22K-HH		80.88	7.49	10.42					
TEXACO 1 THEO THOMPSON									
P6A	8,869	56.27 7.20	42.08 92.16	0.41	99.76	57.21	42.79	1.34	SILURIAN. *KIRKIDIUM* BIOFACIES (P6A, 8,869 ft, oolite).
P6B	8,880	51.96 10.58	34.77 76.15	12.18	98.91	59.91	40.09	1.49	
RODEN 12-1 THRASHER									
16A	7,904- 7,914	70.52 55.60	12.54 27.46	16.94	*100.00	84.90	15.10	5.62	SILURIAN(?). *KIRKIDIUM* BIOFACIES(?).
16B	7,914- 7,924	66.19 52.73	11.31 24.77	21.78	99.28	85.41	14.59	5.85	
16C	7,924- 7,934	70.18 57.29	10.83 23.72	18.99	*100.00	86.63	13.37	6.48	
16D	7,934- 7,944	73.73 62.62	9.34 20.45	16.93	*100.00	88.76	11.24	7.89	
16E	7,944- 7,953	70.01 58.59	9.60 21.02	20.39	*100.00	87.94	12.06	7.29	
Weighted avg, 16A-E		70.13	10.75	18.98					

CALIFORNIA 1 TICER ET AL.									
46A	9,490-9,500	39.56 18.73	17.46 38.24	39.85	96.87	69.38	30.62	2.27	SILURIAN(?). HENRYHOUSE FORMATION(?).
46B	9,500-9,510	38.84 22.39	13.83 30.29	44.73	97.40	73.74	26.26	2.81	
46C	9,510-9,517	55.20 43.01	10.24 22.43	32.50	97.94	84.35	15.65	5.39	
Weighted avg, 46A-C		43.35	14.24	39.75					
46D	9,517-9,527	87.78 84.09	3.10 6.79	8.19	99.07	96.59	3.41	28.32	SILURIAN. CHIMNEYHILL SUBGROUP(?). CLARITA FORMATION(?).
46E	9,527-9,532	79.23 73.58	4.76 10.42	14.52	98.51	94.33	5.67	16.64	
Weighted avg, 46D-E		84.93	3.65	10.30					
Weighted avg, 46A-E		76.39	13.73	38.37					
KING 1 TIGER									
5A	3,921-3,931	89.28 79.99	7.38 16.16	2.95	99.61	92.36	7.64	12.10	SILURIAN. CHIMNEYHILL SUBGROUP.
5B	3,931-3,939	88.56 78.87	8.14 17.83	1.64	98.34	91.58	8.42	10.88	
5C	3,939-3,949	89.45 79.61	8.28 18.13	1.62	99.35	91.53	8.47	10.80	
5D	3,949-3,954	81.66 65.15	13.87 30.38	3.30	98.83	85.48	14.52	5.89	
Weighted avg, 5A-D		88.00	8.82	2.25					
5E	3,955-3,960	48.64 11.89	30.87 67.61	15.36	94.87	61.17	38.83	1.58	ORDOVICIAN. SYLVAN SHALE.
PAN AMERICAN 1 TSAUBY									
29A	5,361-5,369	67.31 63.66	3.07 6.72	29.62	*100.00	95.64	4.36	21.93	SILURIAN(?). CHIMNEYHILL SUBGROUP(?).

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		$CaCO_3$-$MgCO_3$ ratio	Age and unit
		$CaCO_3$ (%)[a]	$MgCO_3$ (%)[c]						
		Mineral calcite (%)[b]	Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)		
KIRKPATRICK 1 WICHERT									
24A	7,770- 7,780	54.32 3.77	42.47 93.01	1.53	98.32	56.12	43.88	1.28	SILURIAN(?).
24B	7,780- 7,784	55.44 6.53	41.10 90.01	1.66	98.20	57.43	42.57	1.35	
Weighted avg, 24A-B		54.64	42.08	1.57					
24C	7,788- 7,798	55.74 12.25	36.54 80.02	6.35	98.63	60.40	39.60	1.53	SILURIAN.
24D	7,798- 7,808	52.96 4.42	40.64 89.00	5.01	98.61	56.58	43.42	1.30	
24E	7,808- 7,810	52.34 0.27	44.21 96.82	4.38	100.93	54.21	45.79	1.18	
Weighted avg, 24C-E		54.16	39.10	5.56					
Weighted avg, 24A-E		54.35	40.26	4.01					
PAYNE 1 WILLIAMS									
39A	7,073- 7,083	50.58 18.59	26.88 58.87	21.76	99.22	65.30	34.70	1.88	EARLY DEVONIAN(?).
39B	7,083- 7,085	60.58 37.82	19.13 41.89	20.29	*100.00	76.00	24.00	3.17	
39C	7,085- 7,095	69.47 51.23	15.33 33.57	15.20	*100.00	81.92	18.08	4.53	
Weighted avg, 39A-C		60.07	20.92	18.64					
GULF 1 WILLIS									
Spot sample	5,414	98.48 97.67	0.68 1.49	0.19	99.35	99.31	0.69	144.82	EARLY DEVONIAN. FRISCO FORMATION.
FEDERAL 1 WOLLESON									
Spot sample	5,083	11.50 5.43	5.10 11.17	81.10	97.70	69.24	30.76	2.25	MIDDLE DEVONIAN. MISENER SANDSTONE.
Spot sample	5,086	48.50 24.94	19.80 43.36	33.0	101.30	71.01	28.99	2.45	

Spot sample	5,094	36.20 5.14	26.10 57.16	37.50	99.80	58.11	41.89	1.39	
Spot sample	5,103	46.20 6.81	33.10 72.49	20.60	99.90	58.26	41.74	1.40	
CONOCO 1 WOMAN GOING UP HILL									
37A	13,735- 13,745	66.87 56.15	9.01 19.73	24.12	*100.00	88.13	11.87	7.42	SILURIAN(?). HENRYHOUSE FORMATION(?) (may include some Early Devonian).
37B	13,745- 13,755	71.17 69.32	7.44 9.29	21.39	*100.00	90.54	9.46	9.57	
37C	13,755- 13,765	77.48 69.54	6.67 14.61	15.85	*100.00	92.07	7.93	11.62	
37D	13,765- 13,775	78.74 71.78	5.85 12.81	15.41	*100.00	93.08	6.92	13.46	
37E	13,775- 13,785	63.07 51.60	9.64 21.11	27.29	*100.00	86.74	13.26	6.54	
37F	13,785- 13,795	66.95 58.19	7.36 16.12	25.69	*100.00	90.10	9.90	9.10	
37G	13,795- 13,805	79.78 72.75	5.91 12.94	14.31	*100.00	93.10	6.90	13.50	
37H	13,805- 13,815	70.81 62.30	7.15 15.66	22.04	*100.00	90.83	9.17	9.90	
37I	13,815- 13,825	54.26 41.40	10.81 23.67	34.31	99.38	83.39	16.61	5.02	
37J	13,825- 13,831	70.25 62.19	6.77 14.83	22.98	*100.00	91.21	8.79	10.38	
Weighted avg, 37A-J		69.92	7.70	16.44					
37K	13,837- 13,849	64.05 53.95	8.49 18.59	27.46	*100.00	88.30	11.70	7.54	
37L	13,871- 13,877	64.73 56.42	6.98 15.29	28.29	*100.00	90.27	9.73	9.27	
Weighted avg, 37A-L		69.03	7.74	18.22					

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

[*] Analysis by X-ray fluorescence.

		Percentage of total rock				Percentage of rock soluble in HCl			
Core sample	Depth (ft)	$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	$CaCO_3$-$MgCO_3$ ratio	Age and unit
GULF 1 WRIGHT HRS.									
58A	6,305- 6,315	95.23 93.21	1.69 3.70	2.42	99.34	98.26	1.74	56.35	EARLY DEVONIAN. FRISCO FORMATION.
58B	6,317- 6,325	81.47 72.07	7.90 17.30	9.04	98.41	91.16	8.84	10.31	SILURIAN. HENRYHOUSE FORMATION.
58C	6,325- 6,334	74.21 58.90	12.86 28.16	11.83	98.90	85.23	14.77	5.77	
58D	6,334- 6,342	78.28 66.80	9.65 21.13	9.43	97.36	89.03	10.97	8.11	
Weighted avg, 58B-D		82.73	7.81	8.01					
CHEVRON 1 ZELLERS									
45A	9,825- 9,835	49.29 35.69	11.43 25.03	37.87	98.59	81.18	18.82	4.31	SILURIAN. CHIMNEYHILL SUBGROUP(?). CLARITA FORMATION(?).
45B	9,835- 9,845	89.92 85.95	3.34 7.31	7.15	100.41	96.42	3.58	26.92	
45C	9,845- 9,851	70.94 65.13	4.88 10.69	23.54	99.36	93.56	6.44	14.54	
Weighted avg, 45A-C		69.91	6.81	22.75					
45D	9,851- 9,861	97.18 95.55	1.37 3.00	1.35	99.90	98.61	1.39	70.93	SILURIAN. CHIMNEYHILL SUBGROUP. COCHRANE FORMATION.
45E	9,861- 9,871	97.41 95.60	1.52 3.33	1.07	*100.00	98.46	1.54	64.09	
45F	9,871- 9,875	97.51 95.93	1.34 2.93	1.25	100.10	98.64	1.36	72.77	
Weighted avg, 45D-F		97.33	1.43	1.22					
Weighted avg, 45A-F		83.07	4.23	12.41					

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

*Analysis by X-ray fluorescence.

Part IV–Porosity and Permeability Tests

The following table comprises data on 150 core samples obtained from 23 wells that were tested for porosity and permeability. These core samples are arranged by well, alphabetized by farm name; locations are shown on panel 1, map A, and panels 5 and 6 (wells tested for porosity are shown in red). Thirty-seven samples representing 21 wells were tested in the laboratory of the School of Petroleum and Geological Engineering, The University of Oklahoma, under the direction of Prof. Arthur W. McCray (see chapter on Porosity and Permeability in Late Ordovician and Silurian Strata for a discussion of the sampling technique used). An additional 45 core samples from the Ferguson 1 Stinson were tested by Core Laboratories, Inc., Dallas, Texas, and 68 samples from the Sunray DX 10-A Rentie were prepared by Earlougher Engineering, Tulsa, Oklahoma. The chemical analyses accompanying these porosity tests were performed in the chemical laboratory of the Oklahoma Geological Survey under the direction of Mr. David Foster. These include analyses for $CaCO_3$, $MgCO_3$, and HCl-insoluble residues for all samples as well as whole-rock analyses for selected samples tested at The University of Oklahoma (appended at the end of this section). A thin section was made for each of the 21 samples prepared at The University of Oklahoma, and for most of the samples from the other two wells.

A brief description of the rock texture is given, along with the age and formation; additional information is given in parts I and III of the Appendix, Core Descriptions and Chemical Analyses of Cores (see also chapter, Porosity and Permeability in Late Ordovician and Silurian Strata).

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl		$CaCO_3$-$MgCO_3$ ratio	Porosity (%)	Permeability (md)	Brief description (see also other sections of Appendix)
		$CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)	$MgCO_3$ (%)				
CALVERT 1 BERTIE											
P10-A	8,339	57.71 13.80	36.55 80.04	4.94 4.94	99.20	61.22	38.77	1.58	0.42	0.00	*KIRKIDIUM* BIOFACIES. Crystalline dolomite; fossils preserved in spar. 6 ft below Woodford.
P10-B	8,568	57.51 11.72	38.48 84.27	3.46 3.46	99.45	59.61	40.08	3.46	6.08	0.00	CHIMNEYHILL(?). Crystalline dolomite; fossils preserved as molds and in spar; pl. 13, fig. *6*. 235 ft below Woodford.
P10-C	8,585	55.52 4.93	42.52 93.12	1.45 1.45	99.49	56.62	43.37	1.30	7.62	0.52	Same lithology as above; pl. 4, figs. *1a, 1b*. 252 ft below Woodford.
P10-D	8,614	56.37 7.60	40.98 89.74	2.25 2.25	99.60	57.90	42.10	1.37	16.66	22.17	Same lithology as above. 282 ft below Woodford.
CALVERT-MID-AMERICA 2 BLOYD											
P11-A	6,211	61.13 20.85	33.85 74.13	4.40 4.40	99.38	64.36	35.64	1.81	(1) 9.07 (2) 6.13 (3)11.52 avg 8.90	(1) 19.74 (2) 5.96 (3) 14.41 avg 13.37	COCHRANE. Porous crystalline dolomite. 2 ft below Woodford.
GETTY 1-B COFFMAN											
P13-A	11,236	91.39 91.05	0.29 0.64	7.73 7.73	99.41	99.68	0.32	315.00	0.30	0.00	*KIRKIDIUM* BIOFACIES. Organo-detrital limestone. 144 ft below Woodford.
KIRKPATRICK 1 CRONKITE											
P19-A	7,109	53.18 52.54	0.54 1.18	46.12 46.12	99.84	98.99	1.00	98.40	2.15	0.00	LOWER DEVONIAN (SALLISAW?). Oolite with quartz crystals in matrix. 11 ft below Woodford.
SHELL 1-15 DILL											
P21-A	8,535	55.89 6.47	41.53 90.95	2.30 2.30	99.72	57.37	42.63	1.34	16.07	53.90	*KIRKIDIUM* BIOFACIES. Dolomitized oolite. 4 ft below Woodford.
P21-B	8,537	54.52 5.47	41.22 90.27	4.12 4.12	99.86	56.95	43.05	1.32	16.87	108.29	*KIRKIDIUM* BIOFACIES. Dolomitized oolite. 6 ft below Woodford.

P21-C	8,559	58.21 16.81	34.79 76.19	6.36 6.36	99.36	63.87	37.41	1.67	0.45	0.00	*KIRKIDIUM* BIOFACIES. Crystalline dolomite; fossils preserved in spar. 28 ft below Woodford.
JONES & PELLOW 1 FARRELL											
14-A	7,775	59.03 22.75	30.48 66.75	10.05 10.05	99.56	65.94	34.05	1.94	6.51	0.00	*KIRKIDIUM* BIOFACIES. Dolomitic limestone. 23 ft below Woodford.
14-B	7,784	98.83 98.40	0.37 0.81	0.58 0.58	99.78	99.63	0.38	267.10	0.35	0.00	*KIRKIDIUM* BIOFACIES. Organo-detrital limestone; most of this interval is oolite. 32 ft below Woodford.
TENNECO 1-11 FISHER UNIT											
P3-A	8,136	58.29 36.44	18.35 40.19	22.26 22.25	98.90	76.05	23.94	3.18	0.10	0.00	SILURIAN(?). Dolomitic limestone; pl. 6, fig. *2*. 7 ft below Woodford.
P3-B	8,157	35.43 5.55	25.11 54.99	38.12 38.12	98.66	58.52	41.47	1.42	0.10	0.00	SILURIAN(?). Dolomitic and silty limestone. 28 ft below Woodford.
P3-C	8,174	55.20 4.57	42.54 93.16	1.34 1.34	99.08	56.47	43.52	1.30	12.9	31.71	SILURIAN(?). Crystalline dolomite with leached fossils; pl. 6, figs. *5a*, *5b*. 45 ft below Woodford.
SUNRAY DX 1 FRANS											
P15-A	**14,524**	**47.07** **10.22**	**30.97** **67.82**	**21.69** **21.69**	**99.73**	**60.31**	**39.68**	**1.52**	**0.14**	**0.00**	***KIRKIDIUM*** **BIOFACIES. Crystalline dolomite; most fossils replaced with spar. 20 ft below Woodford.**
LONE STAR 1 HANNAN UNIT											
P12-A	**14,361**	**50.63** **5.68**	**37.78** **82.74**	**11.71** **11.71**	**100.12**	**57.26**	**42.73**	**1.34**	**0.36**	**0.00**	***KIRKIDIUM*** **BIOFACIES(?). Crystalline dolomite with subrounded detrital quartz grains. 19 ft below Woodford.**

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

Core sample	Depth (ft)	Percentage of total rock				Percentage of rock soluble in HCl					
		CaCO$_3$ (%)^a Mineral calcite (%)^b	MgCO$_3$ (%)^c Mineral dolomite (%)^d	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)	CaCO$_3$-MgCO$_3$ ratio	Porosity (%)	Permeability (md)	Brief description (see also other sections of Appendix)
P12-B	14,384	44.97 17.02	20.97 45.92	36.47 36.47	102.41	68.19	31.80	2.14	0.20	0.00	*KIRKIDIUM* BIOFACIES(?). Dolomitic limestone; high percentage of insoluble residue indicates inclusion of chert. 42 ft below Woodford.
P12-C	14,387	81.56 68.91	10.64 23.30	7.34 7.34	99.54	88.46	11.54	7.69	0.10	0.00	*KIRKIDIUM* BIOFACIES(?). Organo-detrital limestone with scattered euhedral dolomite crystals. 45 ft below Woodford.
GLOVER HEFNER KENNEDY 1-1 HOFFMAN											
P16-A	14,269	52.81 9.11	36.72 80.42	9.94 9.94	99.47	58.98	41.01	1.44	0.32	0.00	*KIRKIDIUM* BIOFACIES(?). Crystalline dolomite with fine subangular quartz grains; fossils preserved in spar; pl. 13, fig. 5. 2 ft below Woodford.
MOBIL 1 HORTON											
P1-A	14,265	79.63 59.74	16.71 36.60	3.34 3.34	99.68	82.96	17.41	4.76	0.00	0.00	*KIRKIDIUM* BIOFACIES. Organo-detrital limestone. 23 ft below Woodford.
P1-B	14,315	49.61 10.35	32.99 72.24	16.53 16.53	99.13	60.06	39.93	1.50	0.00	0.00	*KIRKIDIUM* BIOFACIES. Crystalline dolomite; fossils preserved in spar. 73 ft below Woodford.
MIDWEST 1 HUGHES UNIT											
P18-A	8,063	81.00 73.71	6.12 13.40	12.34 12.34	99.46	92.97	7.02	13.23	0.04	0.00	*KIRKIDIUM* BIOFACIES. Fossiliferous marlstone with silt-size subangular quartz detritus. 43 ft below Woodford.
TENNECO 1-A JORDAN UNIT											
P2-A	8,501	53.25 4.80	40.72 89.17	5.37 5.37	99.34	56.67	43.32	1.31	18.49	154.31	*KIRKIDIUM* BIOFACIES. Crystalline dolomite. 12 ft below Woodford.

P2-B	8,523	49.98 4.03	38.62 84.57	10.55 10.55	99.16	56.41	43.58	1.29	15.63	7.27	*KIRKIDIUM* BIOFACIES. Crystalline dolomite. 34 ft below Woodford.
TENNECO 2-34 JORDAN UNIT P4-A	8,477	53.02 7.83	37.98 83.17	8.45 8.45	99.45	58.26	41.73	1.39	2.50	0.00	SILURIAN(?). Crystalline dolomite; pl. 13, fig. 4. 12 ft below top of core.
P4-B	8,562	52.60 4.25	40.63 88.97	6.22 6.22	99.45	56.42	43.57	1.28	19.0	70.24	SILURIAN(?). Crystalline dolomite; fossils preserved mainly as molds. 98 ft below top of core.
CLEARY 1-24 KRAMP-COBB P9-A	8,512	55.91 4.66	43.07 94.32	0.39 0.39	99.37	56.48	43.51	1.29	13.6	174.89	*KIRKIDIUM* BIOFACIES. Strongly dolomitized oolite. 24 ft below Woodford.
P9-B	8,515	49.49 12.89	30.76 67.37	18.96 18.96	99.21	61.66	38.33	1.61	0.16	0.00	*KIRKIDIUM* BIOFACIES. Partly crystalline dolomite; fossils preserved in spar. 27 ft below Woodford.
GETTY 1 LUETKEMEYER UNIT P8-A	8,842	55.09 3.87	43.04 94.26	0.89 0.89	99.02	56.1	43.8	1.30	14.3	211.28	*KIRKIDIUM* BIOFACIES. Strongly dolomitized oolite; fossiliferous; fossils preserved as molds. 22 ft below Woodford.
SUNRAY DX 10-A RENTIE 1,2	4,030.5- 4,035	90.73 82.69	6.76 14.80	2.05	99.54	93.07	6.93	13.42	(1) 8.4 (2) 8.9 (3) 8.9 (4) 7.1 (5) 7.1 (6) 3.8 avg 7.37	(1) 0.3 (2) 0.5 (3) 1.2 (4) 3.2 (5) 1.0 (6) 0.0 avg 1.03	CHIMNEYHILL. Low-magnesium, organo-detrital limestone with very little insoluble detritus. Considerable visual porosity, much in the form of small, elongate vugs arranged in linear fashion

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

Core sample	Depth (ft)	Percentage of total rock: $CaCO_3$ (%)[a] Mineral calcite (%)[b]	$MgCO_3$ (%)[c] Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	Percentage of rock soluble in HCl: $CaCO_3$ (%)[3]	$MgCO_3$ (%)[3]	$CaCO_3$-$MgCO_3$ ratio	Porosity (%)	Permeability (md)	Brief description (see also other sections of Appendix)
3,4	4,035- 4,039	91.07 83.11	6.69 14.65	1.90	99.66	93.16	6.84	13.61	(1) 5.4 (2) 9.6 (3) 5.9 avg 6.96	(1) 0.0 (2) 1.0 (3) 0.1 avg 0.36	and suggesting solution along fractures. Also, some intergranular porosity.
5,6,7	4,039- 4,046	93.52 87.50	5.06 11.08	1.38	99.96	94.87	5.13	18.48	(1)10.0 (2) 9.8 (3)15.2 (4)13.6 (5) 6.4 (6) 4.6 avg 9.93	(1) 3.0 (2) 2.2 (3) 7.8 (4) 4.6 (5) 1.0 (6) 0.2 avg 3.13	
8,9	4,046- 4,050	97.80 95.91	1.59 3.48	0.39	99.78	98.40	1.60	61.50	(1) 4.9 (2) 6.4 (3) 7.0 (4) 6.1 avg 6.1	(1) 0.2 (2) 1.0 (3) 1.2 (4) 0.5 avg 0.73	
10,11	4,050- 4,055	96.07 93.24	2.38 5.21	1.29	99.74	97.58	2.42	40.36	(1)12.0 (2)12.4 (3) 9.7 (4) 3.9 (5) 7.1 avg 9.02	(1) 2.9 (2) 1.2 (3) 1.8 (4) 0.0 (5) 0.5 avg 1.28	
12,13	4,055- 4,059	88.09 77.43	8.96 19.62	2.70	99.75	90.77	9.23	9.83	(1) 5.9 (2)10.4 (3) 9.2 (4) 9.2 avg 8.68	(1) 0.5 (2) 13.0 (3) 9.7 (4) 15.0 avg 9.55	
14,15	4,059- 4,065	85.07 71.24	11.62 25.45	2.89	99.58	87.98	12.02	7.32	(1) 4.3 (2) 4.3 (3) 7.6 (4) 9.2 (5) 3.7 avg 5.82	(1) 0.2 (2) 0.2 (3) 0.3 (4) 5.6 (5) 0.0 avg 1.26	
16,17,18	4,065- 4,070	71.59 45.48	21.94 48.05	6.19	99.72	76.54	23.46	3.26	(1) 2.6 (2) 4.5 (3) 7.4 (4) 8.2 (5) 2.4 avg 5.02	(1) 0.0 (2) 0.0 (3) 0.5 (4) 0.3 (5) 0.1 avg 0.18	

19,20	4,070- 4,074	91.38 83.23	6.85 15.00	1.96	100.19	93.03	6.97	13.40	(1) 3.5 (2) 6.0 (3) 4.6 (4) 9.6 avg 5.93	(1) 0.1 (2) 0.1 (3) 0.6 (4) 1.6 avg 0.6	
21,22	4,074- 4,079	91.85 84.70	6.01 13.16	1.46	99.32	93.86	6.14	15.28	(1) 5.0 (2) 4.6 (3) 5.7 (4) 9.1 (5)11.7 avg 7.22	(1) 0.1 (2) 0.2 (3) 1.2 (4) 0.9 (5) 3.5 avg 1.18	
23,24	4,079- 4,084	93.17 86.85	5.31 11.63	1.04	99.52	94.61	5.39	17.54	(1)11.9 (2)11.2 (3) 7.2 (4)10.2 (5) 1.0 avg 8.3	(1) 2.8 (2) 2.7 (3) 0.5 (4) 1.2 (5) 7.2 avg 2.88	
25,26	4,084- 4,088	92.81 86.17	5.58 12.22	0.95	99.34	94.23	5.67	16.63	(1) 9.0 (2) 9.1 (3) 9.3 (4)12.0 avg 9.85	(1) 1.1 (2) 1.3 (3) 1.6 (4) 5.1 avg 2.28	
27,28	4,088- 4,093	91.84 84.44	6.22 13.62	1.46	99.52	93.66	6.34	14.75	(1) 7.4 (2) 9.1 (3) 9.7 (4) 2.2 (5) 9.1 avg 7.5	(1) 1.1 (2) 1.9 (3) 2.3 (4) 0.0 (5) 1.0 avg 1.26	
29,30	4,093- 4,097	89.58 79.92	8.12 17.78	1.52	99.22	91.69	8.31	11.03	(1) 8.2 (2) 3.9 (3) 3.9 avg 5.3	(1) 0.9 (2) 0.1 (3) 0.1 avg 0.36	
31,32,33	4,097- 4,104	78.57 60.17	15.46 33.86	3.81	97.84	83.56	16.44	5.08	(1)10.6 (2) 2.5 (3) 6.1 (4) 5.0 (5) 6.6 (6) 7.1 avg 6.32	(1) 7.5 (2) 0.0 (3) 0.2 (4) 0.2 (5) 0.1 (6) 0.2 avg 1.36	
34,35	4,104- 4,110	24.19 6.21	15.11 33.09	57.20	96.50	61.55	38.45	1.60	-	-	ORDOVICIAN; SYLVAN SHALE.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

		Percentage of total rock				Percentage of rock soluble in HCl					
		CaCO$_3$ (%)^a	MgCO$_3$ (%)^c								
Core sample	Depth (ft)	Mineral calcite (%)^b	Mineral dolomite (%)^d	Insoluble residue (%)	Recovery (%)	CaCO$_3$ (%)	MgCO$_3$ (%)	CaCO$_3$-MgCO$_3$ ratio	Porosity (%)	Permeability (md)	Brief description (see also other sections of Appendix)
PAN AMERICAN 1-B ROETZAL UNIT P20-A	8,435	52.44 10.32	35.40 77.53	11.73 11.73	99.57	59.70	40.30	1.48	0.20	0.00	*KIRKIDIUM* BIOFACIES. Crystalline dolomite; fossils preserved in spar. 1 ft below Woodford.
KIRKPATRICK 1 SHEWEY UNIT P7-A	7,906	53.23 4.46	40.98 89.74	4.40 4.40	98.61	56.6	43.4	1.27	15.6	5.00	SILURIAN. Crystalline dolomite; fossils preserved partly in spar. 16 ft below Woodford.
KIRKPATRICK 1-A SHEWEY P5-A	7,856	50.67 3.06	40.28 88.21	9.20 9.20	100.15	55.7	44.3	1.26	12.8	0.00	SILURIAN. Crystalline dolomite; fossils preserved partly as molds, partly in spar. 38 ft below Woodford.
HUMBLE 1 STATE HUNTON P17-A	7,905	56.35 10.08	38.88 85.15	4.26 4.26	99.49	59.17	40.82	1.45	2.29	0.18	*KIRKIDIUM* BIOFACIES(?). Crystalline dolomite; a few fossils preserved in spar. 1 ft below Woodford.
P17-B	7,919	58.78 13.81	37.78 82.74	3.54 3.54	100.10	60.87	39.13	1.55	2.90	2.90	*KIRKIDIUM* BIOFACIES(?). Crystalline dolomite; fossils preserved in spar. 15 ft below Woodford.
FERGUSON 1 STINSON 1	7,822-7,823	52.46 12.61	33.49 73.34	12.85	98.80	61.04	38.96	1.57	7.9	2.6	*KIRKIDIUM* BIOFACIES(?). Crystalline dolomite with chert nodules and silicification; HCl-insoluble residues probably include much silicified material. Considerable fossil debris preserved mainly in spar and silica. Much of visual porosity is in form of small vugs associated with small colonial corals and bryozoans; pl. 13, figs. *1-3*.
2	7,823-7,824	51.12 15.52	29.92 65.52	17.46	98.50	63.08	36.92	1.71	8.2	1.2	
3	7,824-7,825	46.57 7.26	33.03 72.34	19.21	98.81	58.51	41.49	1.41	9.0	0.5	
4	7,825-7,826	50.54 13.73	30.93 67.74	17.84	99.31	62.04	37.96	1.63	8.5	<0.1	
5	7,826-7.827	46.99 6.63	33.92 74.28	17.62	98.53	58.08	41.92	1.39	9.4	1.6	

6	7,827– 7,828	45.06 7.40	31.65 69.31	22.22	98.93	58.74	41.26	1.42	8.7	9.1	
7	7,828– 7,829	46.14 6.91	32.89 72.12	19.99	99.02	58.38	41.62	1.40	8.2	0.8	
8	7,829– 7,830	45.27 7.93	31.38 68.72	21.02	97.67	59.06	40.94	1.44	8.8	0.1	
9	7,830– 7,831	47.07 8.15	32.71 71.63	19.35	99.13	59.00	41.00	1.44	7.6	<0.1	
10	7,831– 7,832	45.16 2.38	31.55 69.09	21.37	98.08	58.87	41.14	1.43	8.7	<0.1	
11	7,832– 7,833	46.06 8.43	31.62 69.25	21.45	99.13	59.29	40.71	1.46	9.1	<0.1	
12	7,833– 7,834	46.89 8.66	32.13 70.36	20.07	99.09	59.34	40.66	1.51	8.3	<0.1	
13	7,834– 7,835	45.87 8.40	31.49 68.96	21.73	99.09	59.29	40.71	1.46	9.1	0.8	
14	7,835– 7,836	41.99 8.23	28.37 62.13	26.99	97.35	59.68	40.32	1.48	9.3	0.2	
15	7,836– 7,837	51.16 22.50	24.08 52.74	23.79	99.03	68.00	32.00	2.12	4.3	<0.1	*KIRKIDIUM* BIOFACIES(?). Dolomitic marlstone with scattered fossils; minor visual porosity, mostly associated with small colonial organisms.
16	7,837– 7,838	57.17 30.17	22.69 49.69	18.46	98.32	71.59	28.41	2.52	3.4	<0.1	
17	7,838– 7,839	59.21 34.53	20.74 45.42	19.58	99.53	74.06	25.94	2.85	2.7	0.3	
18	7,839– 7,840	59.51 35.96	19.79 43.34	17.88	97.18	75.04	24.96	3.01	3.0	<0.1	
19	7,840– 7,841	63.33 42.77	17.28 37.84	18.60	99.21	78.56	21.44	3.66	1.8	<0.1	
20	7,841– 7,842	64.87 51.13	11.55 25.29	23.00	99.42	84.89	15.11	5.62	1.7	<0.1	SILURIAN. Marlstone with scattered fossils; very little visual porosity.
21	7,842– 7,843	72.02 66.53	4.61 10.10	22.85	99.48	93.98	6.02	15.62	1.4	<0.1	

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

		Percentage of total rock				Percentage of rock soluble in HCl					
		$CaCO_3$ (%)[a]	$MgCO_3$ (%)[c]								
Core sample	Depth (ft)	Mineral calcite (%)[b]	Mineral dolomite (%)[d]	Insoluble residue (%)	Recovery (%)	$CaCO_3$ (%)3	$MgCO_3$ (%)3	$CaCO_3$-$MgCO_3$ ratio	Porosity (%)	Permeability (md)	Brief description (see also other sections of Appendix)
22	7,843- 7,844	76.86 70.07	5.71 12.50	17.85	100.42	93.08	6.92	13.46	1.5	<0.1	
23	7,844- 7,845	58.49 33.76	20.78 45.51	18.34	97.61	73.79	26.21	2.81	1.5	<0.1	
24	7,847- 7,848	59.54 42.15	14.61 32.00	24.65	98.80	80.30	19.70	4.08	2.5	<0.1	
25	7,850- 7,851	64.51 50.88	11.45 25.08	20.83	96.79	84.93	15.07	5.63	1.2	<0.1	
26	7,853- 7,854	67.13 54.96	10.23 22.40	21.52	98.88	86.78	13.22	6.56	1.6	<0.1	
27	7,856- 7,857	66.37 57.13	7.73 16.93	24.00	98.10	89.57	10.43	8.59	1.6	<0.1	
28	7,859- 7,860	70.88 62.20	7.29 15.97	20.71	98.88	90.67	9.33	9.72	1.4	<0.1	
29	7,862- 7,863	71.85 60.03	9.93 21.75	19.28	101.06	87.86	12.14	7.24	1.1	<0.1	
30	7,865- 7,866	73.99 66.37	6.40 14.02	17.77	98.16	92.04	7.96	11.56	1.3	<0.1	
31	7,868- 7,869	73.55 68.60	4.16 9.11	21.85	99.56	94.65	5.35	17.68	0.9	0.5	
32	7,871- 7,872	65.75 60.63	4.30 9.42	28.70	98.75	93.86	6.14	15.29	1.1	2.2	
33	7,873- 7,874	72.69 67.63	4.25 9.31	21.86	98.80	94.48	5.52	17.10	1.0	1.0	
34	7,898- 7,899	70.48 59.02	9.63 21.09	17.02	97.13	87.98	12.02	7.32	2.4	<0.1	
35	7,903- 7,904	70.76 60.28	8.81 19.29	18.26	97.83	88.93	11.07	8.03	2.4	<0.1	
36	7,908- 7,909	75.56 66.48	7.63 16.71	17.47	100.66	90.83	9.17	9.90	1.6	<0.1	
37	7,913- 7,914	79.72 73.66	5.09 11.15	13.74	98.55	94.00	6.00	15.66	2.4	<0.1	
38	7,918- 7,919	69.72 56.80	10.86 23.78	17.50	98.08	86.52	13.48	6.42	1.6	<0.1	

39	7,923- 7,924	81.23 76.29	4.15 9.09	13.00	98.38	95.14	4.86	19.57	1.6	<0.1	
40	7,928- 7,929	75.32 66.95	7.03 15.40	16.24	98.59	91.46	8.54	10.71	2.1	<0.1	
41	7,933- 7,934	77.19 70.18	5.89 12.90	15.78	98.86	92.91	7.09	13.11	1.5	<0.1	
42	7,938- 7,939	76.72 68.00	7.33 16.05	14.94	98.99	91.28	8.72	10.47	1.5	<0.1	
43	7,943- 7,944	71.72 66.00	4.81 10.53	20.26	96.79	93.71	6.29	14.91	1.4	<0.1	
44	7,948- 7,949	45.26 24.98	17.04 37.32	35.06	97.36	72.65	27.35	2.66	3.4	<0.1	
45	7,953- 7,954	64.48 50.88	11.43 25.03	23.62	99.53	84.94	15.06	5.64	1.5	<0.1	
TEXACO 1 THOMPSON											
P6-A	8,869	56.28 5.02	43.08 94.35	0.42	99.78	56.63	43.36	1.31	13.7	38.48	*KIRKIDIUM* BIOFACIES. Strongly dolomitized oolite. 2 ft below top of core.
P6-B	8,880	51.97 10.59	34.77 76.15	12.18	98.92	59.91	40.08	1.49	1.3	0.00	*KIRKIDIUM* BIOFACIES. Crystalline dolomite with considerable silt-size quartz detritus. 13 ft below top of core.

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[a] Upper figure given for each sample represents percentage of $CaCO_3$.

[b] Lower figure given for each sample represents percentage of the mineral calcite.

[c] Upper figure given for each sample represents percentage of $MgCO_3$.

[d] Lower figure given for each sample represents percentage of the mineral dolomite (assuming that all the $MgCO_3$ present is in the mineral dolomite).

Whole-Rock Analyses for Selected Carbonates
Porosity-Permeability Group
(All values given as percentages)

Sample number	$CaCO_3$	$MgCO_3$	Al_2O_3	Fe_2O_3	SiO_2	P_2O_5	S	Na_2O	K_2O	H_2O	Recovery	Insols.	CO_2
P1-A	79.62	16.71	0.17	0.18	2.75	0.01	0.06	0.09	0.40	0.01	100.00	3.34	43.15
P1-B	49.61	32.98	1.90	0.58	11.74	0.01	0.23	0.23	1.89	0.02	99.19	16.53	38.51
P3-B	35.43	25.11	5.32	0.87	29.99	0.02	0.35	0.91	1.76	0.24	100.00	36.12	27.32
P3-C	55.20	42.54	0.36	0.40	0.73	0.01	0.06	0.06	0.42	--	99.78	1.34	45.11
P6-A	56.28	43.08	0.61	0.21	0.05	--	0.04	0.04	0.40	--	100.71	0.42	45.56
P10-A	57.71	36.55	0.56	0.26	3.33	--	0.17	0.31	0.26	0.05	99.20	4.94	43.70
P11-A	61.13	33.85	1.21	1.04	2.33	0.34	0.48	0.10	0.32	--	100.80	4.40	42.38
P13-A	91.39	0.29	1.72	0.29	5.74	0.01	0.06	0.08	0.37	0.05	100.00	7.73	40.33
P14-A	59.03	30.48	0.79	0.22	7.82	0.01	0.12	0.06	0.45	0.08	99.06	10.05	39.59
P14-B	98.83	0.37	0.21	0.03	0.28	--	0.04	0.07	0.60	--	100.43	0.58	43.31

PLATES

(Descriptions and locations of cores given in Appendix; locations also shown on panel 1, map A)

Plate 1

Frisco Formation

Figs. *1a, 1b*.—Photomicrograph, ×12, and enlarged detail, ×30, showing fractured and broken shelly debris; darker areas represent recrystallized (?) spar. Gulf 1 Streeter; depth, 6,996 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *2a, 2b*.—Photomicrograph, ×12, and enlarged detail, ×30, showing pelmatozoan plates, fractured shelly debris, and solution; matrix is largely spar with some minor recrystallization (dark areas). Jones and Pellow 1 Boyd; depth, 6,491 feet. Thin section, Oklahoma Geological Survey collections.

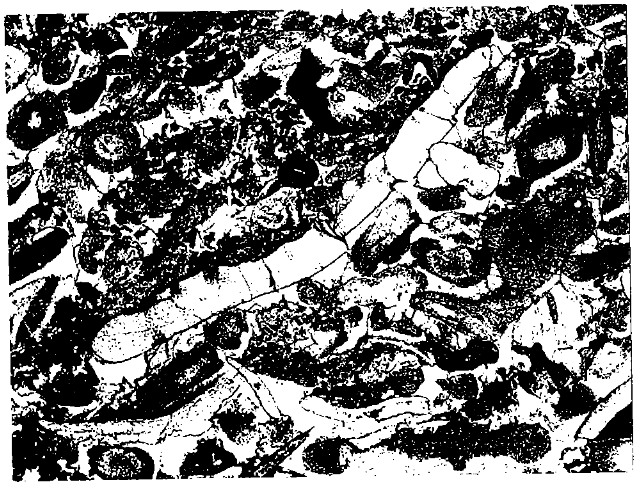
Figs. *3a, 3b*.—Photomicrograph, ×12, and enlarged detail, ×30, showing solution and recrystallization (?). Gulf 1 Shaddix; depth, 9,248 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *4a*. —Photomicrograph, ×40, showing pelmatozoan debris set in a largely recrystallized (?) matrix. Sinclair 1 Horlivy; depth, 8,790 feet. Thin section, Oklahoma Geological Survey collections.

Plate 1

1a

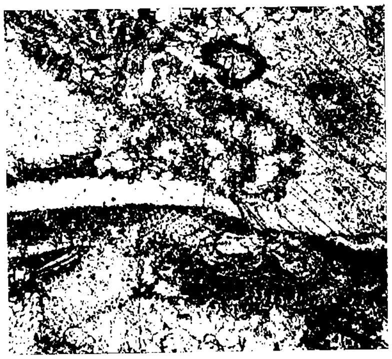
1b



2a

2b

3a



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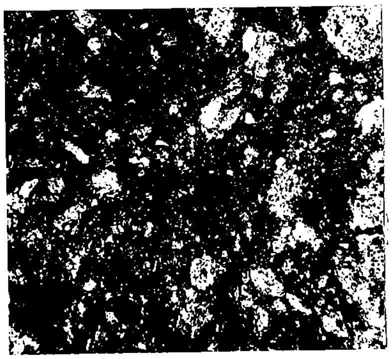


4a

Plate 2

Frisco Formation

Fig. *1*.—Photomicrograph, ×12, showing a mixture of shelly debris and pelmatozoan plates; clear areas are spar, and dark areas are recrystallized (?) spar. Gulf 1 Streeter; depth, 6,977 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *2*.—Photomicrograph, ×12, showing pelmatozoan debris set in a matrix of mostly recrystallized (?) spar (dark areas). Sinclair 1 Horlivy; depth, 8,781 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *3*.—Photomicrograph, ×12; rock composed largely of broken and abraded shell debris set in a spar matrix. Gulf 1 Streeter; depth, 7,037 feet. Thin section, Oklahoma Geological Survey collections.

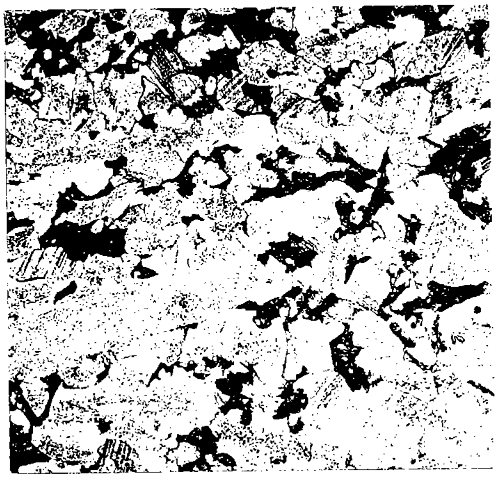
Fig. *4*.—Photomicrograph, ×12, showing organo-detrital sparite composed mostly of fine shell debris. Jones and Pellow 1 Boyd; depth, 6,533 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *5*.—Photomicrograph, ×12, showing organo-detrital sparite with many bryozoan fragments; some recrystallization (?) (dark areas). Gulf 1 Willis; depth, 5,457 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *6*.—Photomicrograph, ×12, showing scattered oolites. Gulf 1 Holtzschue; depth, 6,474 feet. Thin section, Oklahoma Geological Survey collections.

Plate 2

1



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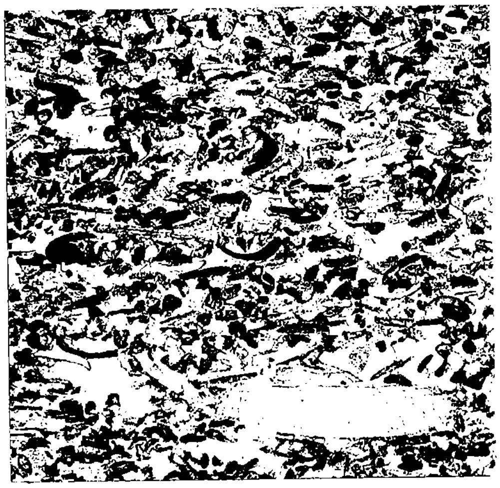

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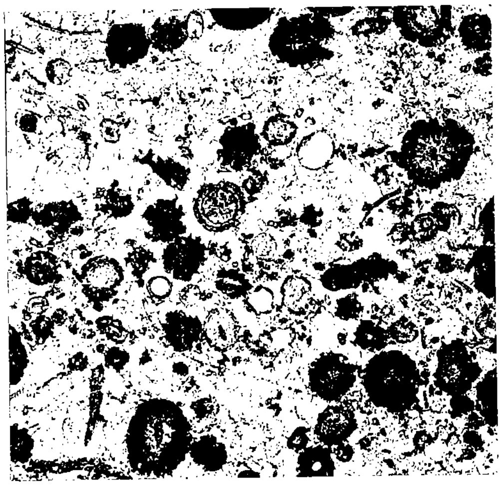

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Plate 3

Kirkidium Biofacies; Chimneyhill Subgroup

Fig. *1*.—Cut surface, ×3, Chimneyhill Subgroup (25 feet above Sylvan Shale), showing fossil molds, mostly pelmatozoan plates, some of which are partly filled with spar. Note well-formed dolomite and quartz crystals in mold in center of picture. Calvert 1 Bertie; depth, 8,615 feet.

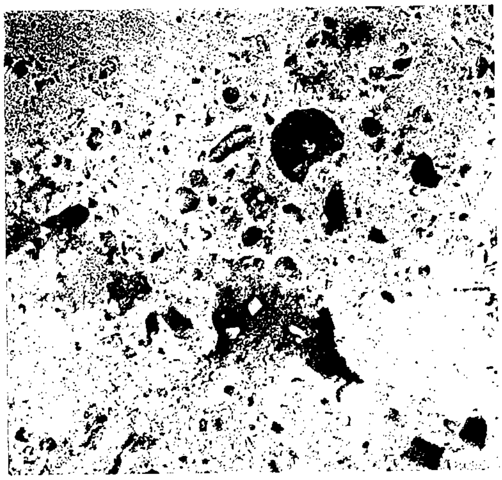
Fig. *2*.—Broken core surface, ×2, showing molds of *Kirkidium* sp. Note oolitic texture with some pore space in the strongly dolomitized matrix. Shell 1-15 Dill; depth, 8,534 feet.

Fig. *3*.—Broken core surface, ×2, showing molds of *Kirkidium* sp. Note oolitic texture preserved in crystalline dolomite. Cleary 1-24 Kramp-Cobb; depth, 8,505 feet.

Fig. *4*.—Broken core surface, ×3, showing mold of *Kirkidium* sp. Note oolitic texture (preserved in crystalline dolomite) and large, well-formed dolomite crystal in center of picture at upper right of fossil. Getty 1 Luetkemeyer Unit; depth, 8,842 feet.

Fig. *5*.—Photomicrograph, ×10, of *Kirkidium* biofacies, showing oolites preserved in crystalline dolomite. Most of clear areas in this picture are voids. Shell 1-15 Dill; depth, 8,537 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *6*.—Photomicrograph, ×10, showing cross section of ventral valve of mold of *Kirkidium* sp. Enclosing matrix is crystalline dolomite. Shell 1-15 Dill; depth, 8,548 feet. Thin section, Oklahoma Geological Survey collections.



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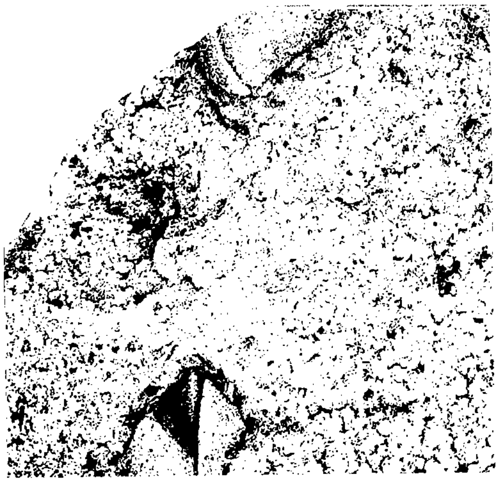

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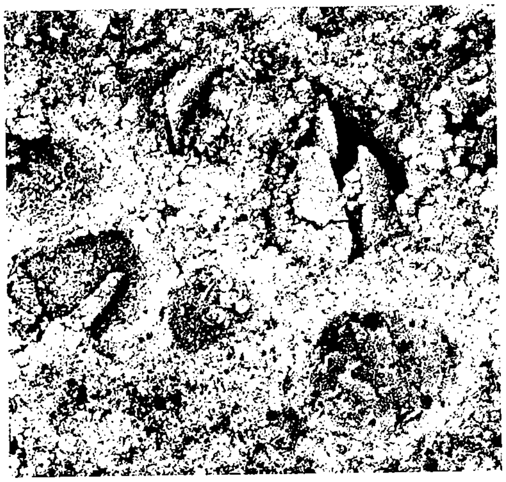

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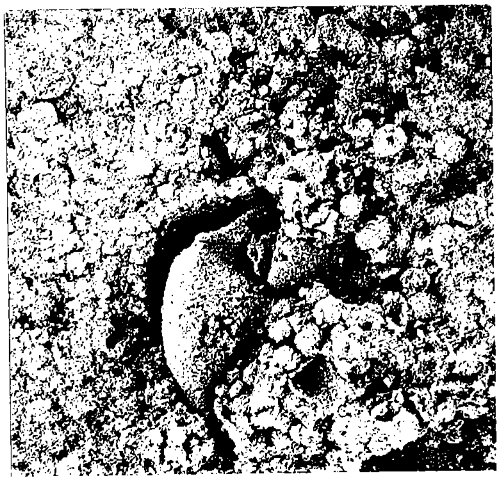

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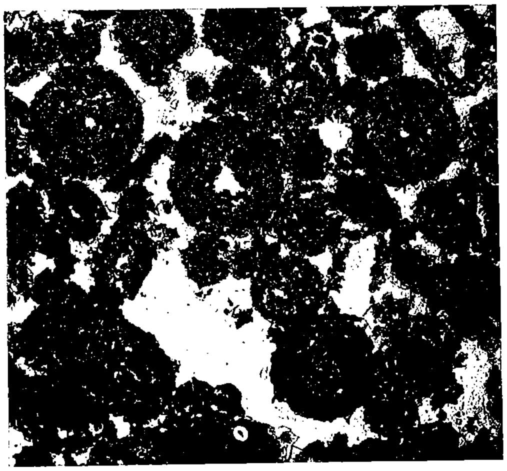

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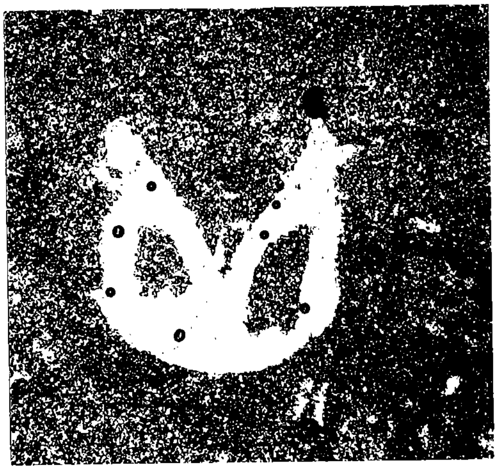


6

Plate 4

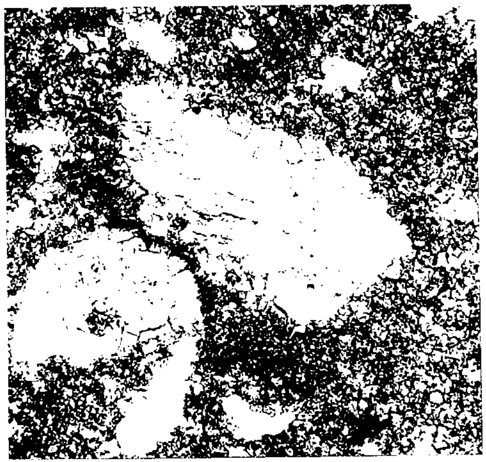
Kirkidium Biofacies; Chimneyhill Subgroup

Figs. *1a, 1b.*—Photomicrographs, ×40, uncrossed and crossed nicols, from a Silurian bed, probably Chimneyhill Subgroup (55 feet above Hunton-Sylvan contact), showing pelmatozoan plates preserved partly as molds and partly in coarse spar. Matrix is crystalline dolomite. This is one of porosity-permeability samples (P10-C), which analyzed: $CaCO_3$, 55.52 percent; $MgCO_3$, 42.52 percent; HCl-insoluble residue, 1.44 percent. Porosity, 7.62 percent; permeability, 0.52 md. Calvert 1 Bertie; depth, 8,585 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *2a, 2b.*—Photomicrographs, ×40, uncrossed and crossed nicols, from *Kirkidium* biofacies, showing dolomitized oolite with pore space in surrounding matrix. View of another specimen from this same core about 7 feet higher shown on pl. 3, fig. *3*. This is one of porosity-permeability samples (P9-A), which analyzed: $CaCO_3$, 55.97 percent; $MgCO_3$, 43.07 percent; HCl-insoluble residue, 0.39 percent. Porosity, 13.6 percent; permeability, 174.89 md. Cleary 1-24 Kramp-Cobb; depth, 8,512 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *3a, 3b.*—Photomicrographs, ×40, uncrossed and crossed nicols, from *Kirkidium* biofacies, showing hinge plate of brachiopod preserved in coarse dolospar; matrix is largely crystalline dolomite. This is one of porosity-permeability samples (P1-B), which analyzed: $CaCO_3$, 60.06 percent; $MgCO_3$, 32.98 percent; HCl-insoluble residue, 16.53 percent. Porosity, 0.00 percent (virtually all fossils are filled with spar); permeability, 0.00 md. Mobil 1 Horton; depth, 14,315 feet. Thin section, Oklahoma Geological Survey collections.

Plate 4



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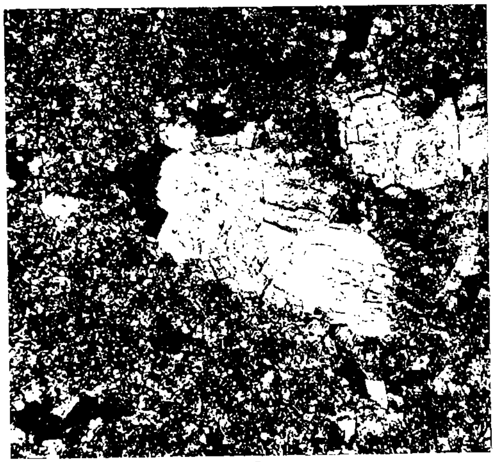

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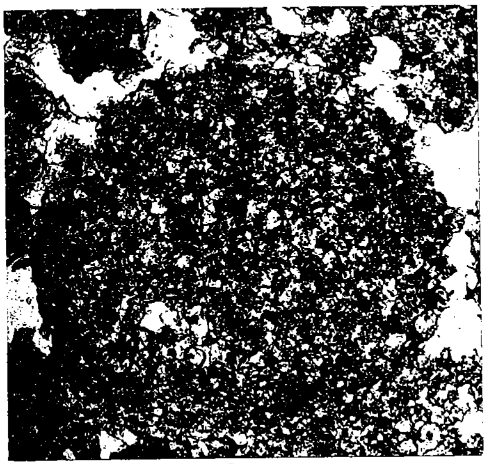

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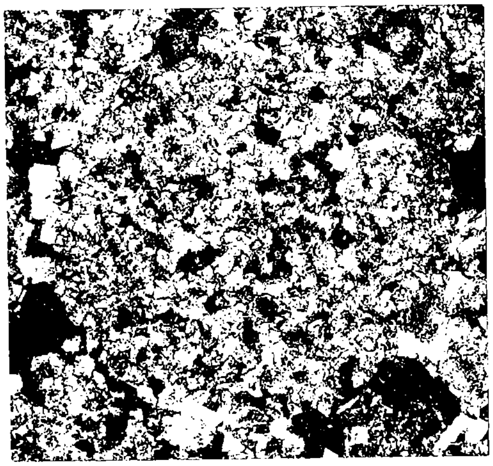

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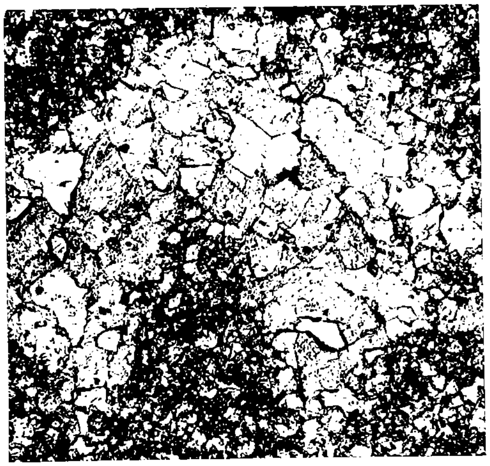

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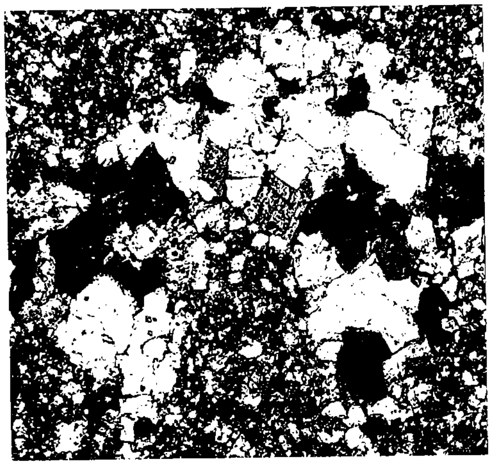


3b

Plate 5

Kirkidium Biofacies

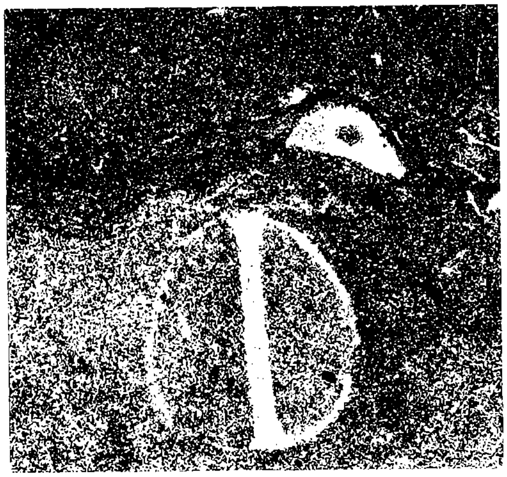
Fig. *1*.—Photomicrograph, ×6, of ventral valve with median septum of *Kirkidium* sp. Median septum is largely calcspar, and outer shell margins are partly calcspar, partly dolospar. Matrix is mostly crystalline dolomite with relatively high percentage of insoluble detritus. This is one of porosity-permeability samples (P15-A), which analyzed: $CaCO_3$, 47.07 percent; $MgCO_3$, 30.97 percent; HCl-insoluble residue, 21.69 percent. Porosity, 0.14 percent; permeability, 0.00 md. Sunray DX 1 Frans; depth, 14,524 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *2*.—Photomicrograph, ×5, of two dorsal valves of *Kirkidium* sp. These shells are preserved in calcspar, and surrounding matrix is mostly crystalline dolomite with substantial insoluble detritus. Sunray DX 1 Frans; depth, 14,524 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *3a, 3b*.—Photomicrographs, ×2, ×15, of ventral valve (with spondylium) of *Kirkidium* sp. Shell is preserved largely in dolospar, and surrounding matrix is mainly crystalline dolomite. Sunray DX 1 Frans; depth, 14,552 feet. Thin section, Oklahoma Geological Survey collections. Enlarged photomicrograph shown on pl. 9, fig. *3*.

Figs. *4a, 4b*.—Photomicrographs, ×3, ×20, of ventral valve (spondylium) of *Kirkidium* sp. Shell is preserved mainly in dolospar, and matrix is crystalline dolomite. Note that dolomitization has partly replaced and obliterated shell outline. Sunray DX 1 Frans; depth, 14,552 feet, same thin section as figs. *3a, 3b*. Thin section, Oklahoma Geological Survey collections. Enlarged view shown on pl. 9, fig. *2*.

Plate 5



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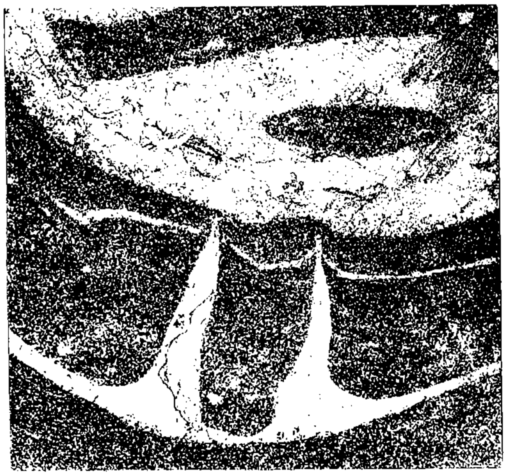

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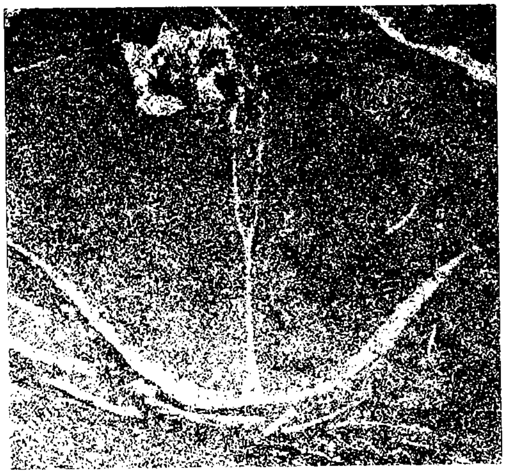
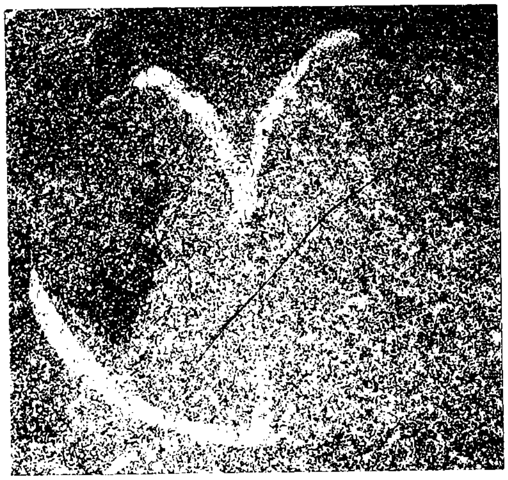
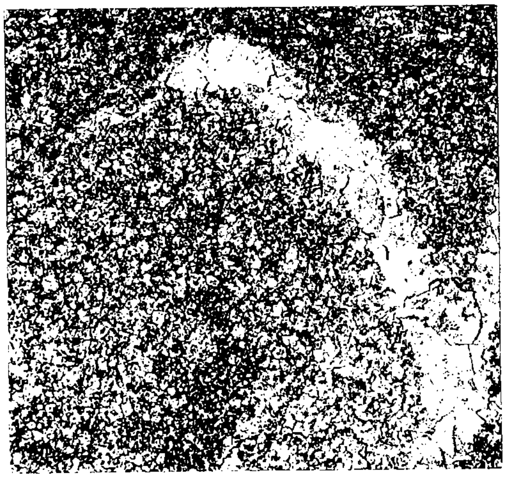


3a

3b



4a



4b

Plate 6

Kirkidium Biofacies; Chimneyhill Subgroup

Fig. *1*.—Photomicrograph, ×8, *Kirkidium* biofacies, showing interbedded organo-detrital limestone with very little dolomite (below) and organo-detrital carbonate with much euhedral dolomite replacing matrix (above). Both layers are composed largely of broken shelly debris; dolomite crystals corrode and partly replace fossil boundaries. Shelly debris retains its microtexture. This rock has little or no visible porosity. Mobil 1 Horton; depth, 14,304 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *2*.—Photomicrograph, ×30, upper part of Silurian (7 feet below Woodford contact), showing dolomitized mudstone texture. Dolomite crystals are well formed and are interspersed with considerable subangular silt-size quartz detritus. Fossils, mostly pelmatozoan plates, retain their original microtexture and are slightly corroded on outer margins by dolomite. This is one of porosity-permeability samples (P3-A), which analyzed: $CaCO_3$, 58.28 percent; $MgCO_3$, 18.35 percent; HCl-insoluble residue, 22.25 percent. Porosity, 0.10 percent; permeability, 0.00 md. Tenneco 1-11 Fisher Unit; depth, 8,136 feet. Thin section, Oklahoma Geological Survey collections.

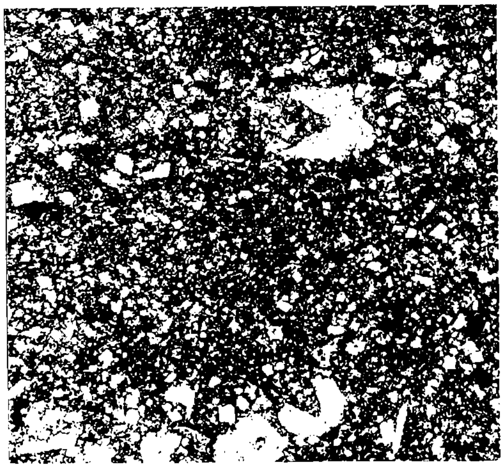
Fig. *3*.—Photomicrograph, ×6, *Kirkidium* biofacies, showing dolomitized mudstone texture with scattered fossil debris. Euhedral dolomite crystals are uniform in size and corrode outer margins of fossils, which retain their original microtexture. Considerable subangular silt-size quartz detritus is present, as well as some pyrite (black areas). Atlantic 1 Choate; depth, 8,347 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *4*.—Photomicrograph, ×6, Chimneyhill Subgroup (25 feet above Sylvan Shale), showing crystalline dolomite with fossils, mostly pelmatozoan plates, mainly preserved as molds, although a few are in calcspar (two in upper right are calcspar). Very little insoluble detritus present. Calvert 1 Bertie; depth, 8,615 feet (cut surface of this core illustrated on pl. 3, fig. *1*). Thin section, Oklahoma Geological Survey collections.

Figs. *5a*, *5b*.—Photomicrograph, uncrossed and crossed nicols, ×40, Silurian beds (43 feet below Woodford), showing crystalline dolomite with fossil molds, mostly pelmatozoan plates. This is one of porosity-permeability samples (P3-C), which analyzed: $CaCO_3$, 55.19 percent; $MgCO_3$, 42.54 percent; HCl-insoluble residue, 1.33 percent. Porosity, 12.9 percent; permeability, 31.71 md. Tenneco 1-11 Fisher Unit; depth, 8,174 feet. Thin section, Oklahoma Geological Survey collections.

Plate 6

1



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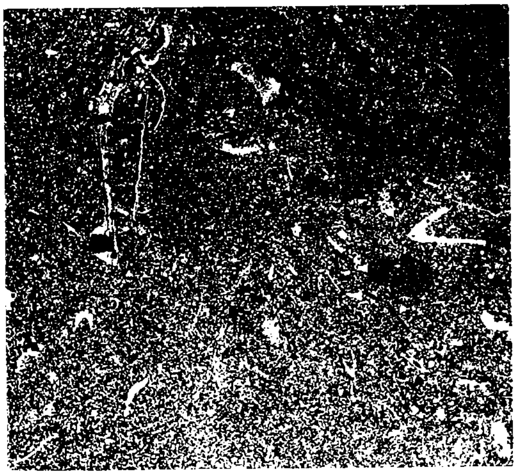

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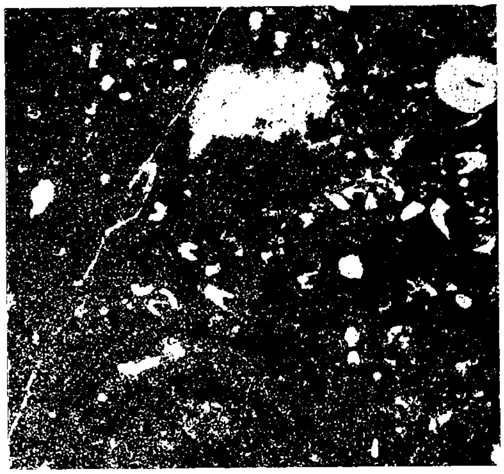

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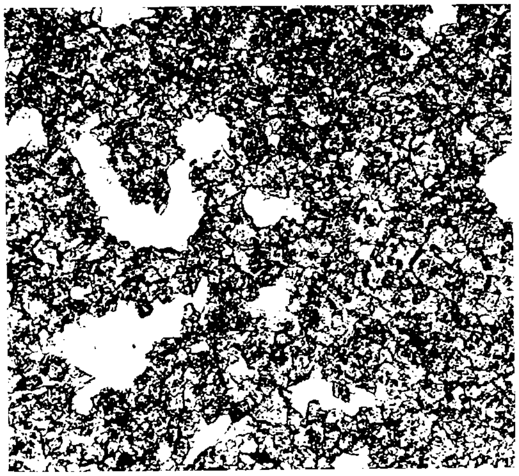

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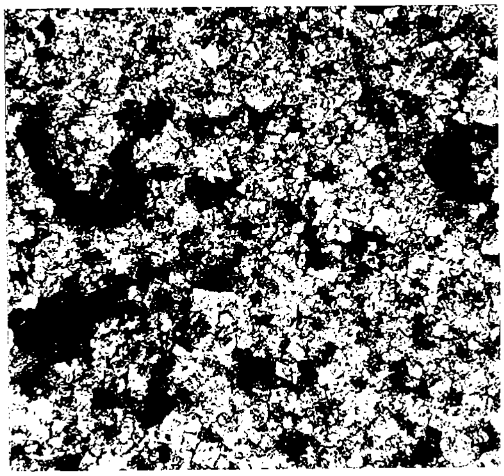


5b

Plate 7

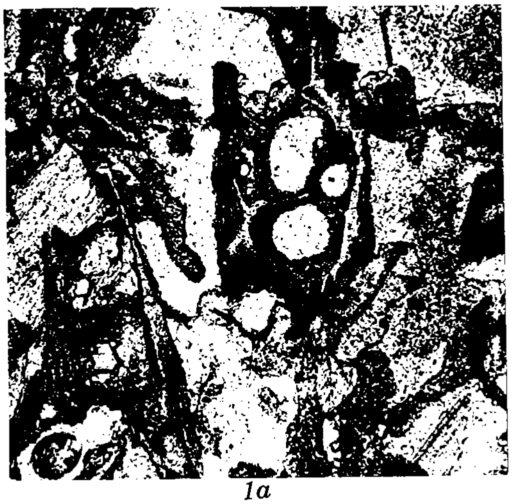
Frisco Formation

Figs. *1a, 1b*.—Photomicrograph, ×40, uncrossed and crossed nicols, showing pore space (light areas in uncrossed nicols, dark areas in crossed). Note porosity in the interior of bryozoan (upper center), as well as porosity partly surrounding it. Gulf 1 Streeter; depth, 7,034 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *2a, 2b*.—Photomicrographs, ×50, uncrossed and crossed nicols, showing pore space (light areas in uncrossed nicols, dark areas in crossed). Note irregular pore space in area surrounding elongate bryozoan fragment extending from lower right to upper left. Gulf 1 Wright Hrs.; depth, 6,310 feet. Thin section, Oklahoma Geological Survey collections.

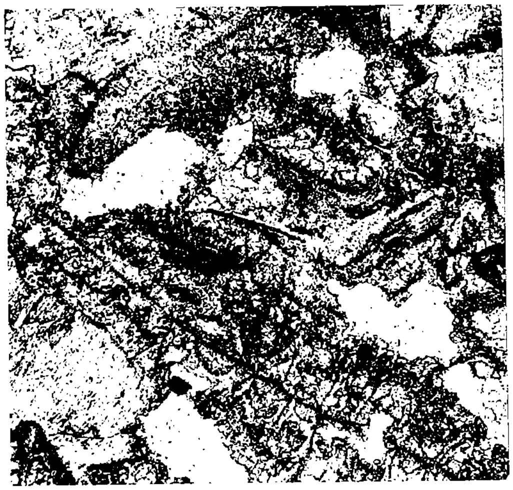
Figs. *3a, 3b*.—Photomicrographs, ×45, uncrossed and crossed nicols, showing porosity developed along a solution cavity. Jones and Pellow 1 Boyd; depth, 6,522 feet. Thin section, Oklahoma Geological Survey collections.

Other illustrations of Frisco porosity shown on pl. 14.



1a

1b



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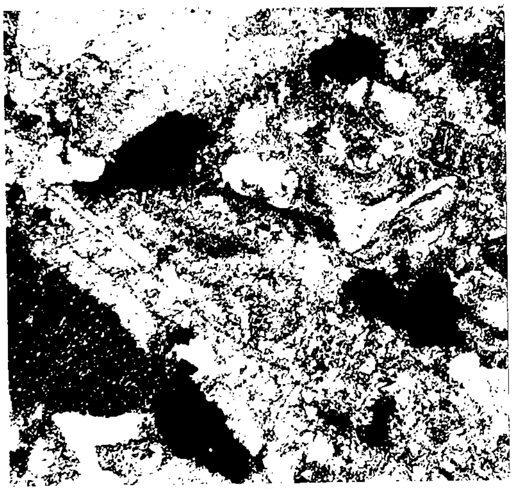

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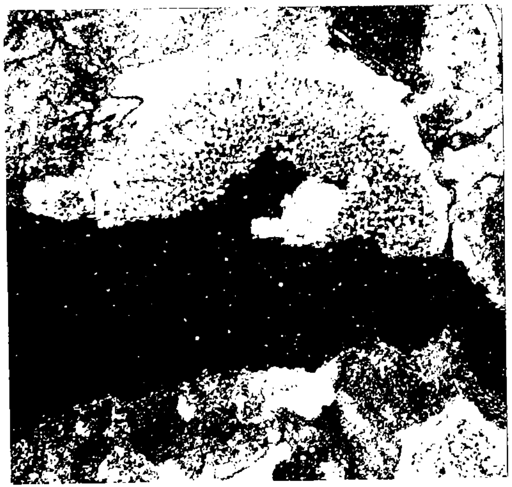


3b

Plate 8

Henryhouse Formation; Chimneyhill Subgroup

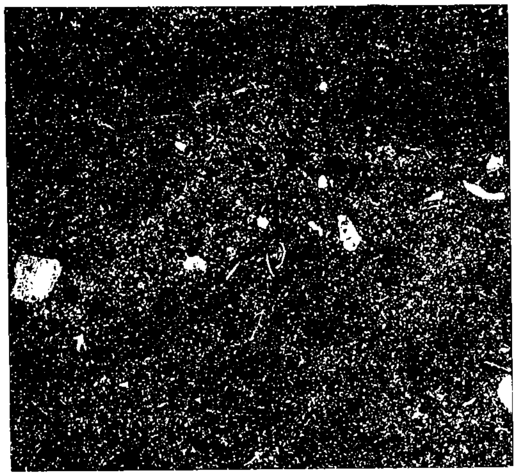
Fig. *1*.—Henryhouse Formation, photomicrograph, ×6, showing typical mud-supported (marlstone) texture with scattered fossils. From bed 77 feet above Henryhouse-Clarita contact; 29.56 percent HCl-insoluble residue, 8.43 percent $MgCO_3$. Thin section, Oklahoma Geological Survey collections (stratigraphic section M17, new cut, Amsden, 1960, p. 256).

Fig. *2*.—Henryhouse Formation, photomicrograph, ×35, showing mud-supported texture with cross section of pelmatozoan plate. Note well-preserved microtexture. From bed about 65 feet below top of formation; Henryhouse Creek, SW¼SE¼ sec. 30, T. 2 S., R. 1 E. Thin section, W. E. Ham collection.

Figs. *3a, 3b*.—Henryhouse Formation, photomicrographs, ×6, ×35, showing typical texture, although with somewhat more fossil debris than in fig. *1*. Note preservation of fossil microtexture. From bed 10 feet below Henryhouse-Haragan contact; 19.48 percent HCl-insoluble residue, 5.50 percent $MgCO_3$. Thin section, Oklahoma Geological Survey collections (stratigraphic section M17, new cut, Amsden, 1960, p. 256).

Fig. *4a*.—Contact (arrow) of Henryhouse Formation (above) and Clarita Formation (below), photomicrograph, ×6, showing lithostratigraphic boundary. Insoluble detritus increases abruptly at contact (from 25 to 33 percent), and fossil content decreases correspondingly. Note numerous ostracodes in Clarita. Thin section, Oklahoma Geological Survey collections (stratigraphic section M17, new cut, Amsden, 1960, p. 256).

Fig. *4b*.—Sawed surface showing welded contact between Henryhouse Formation (above) and Clarita Formation (below), ×3. There is an abrupt change in insoluble detritus at this contact, upper 1 inch of Clarita having 23.34 percent HCl-insoluble residue and lower 1 inch of Henryhouse having 36.88 percent HCl-insoluble residue. Stratigraphic section M2, near White Mound (Amsden, 1960, p. 235-236).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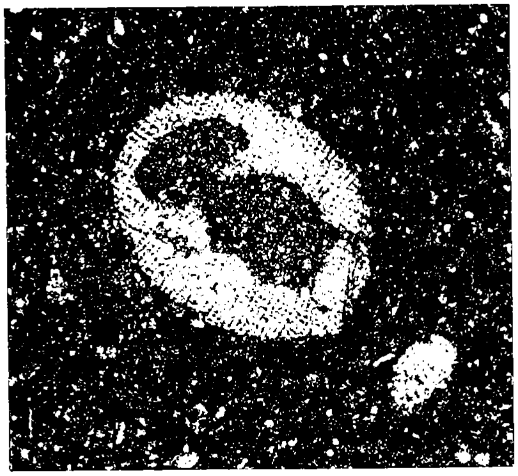
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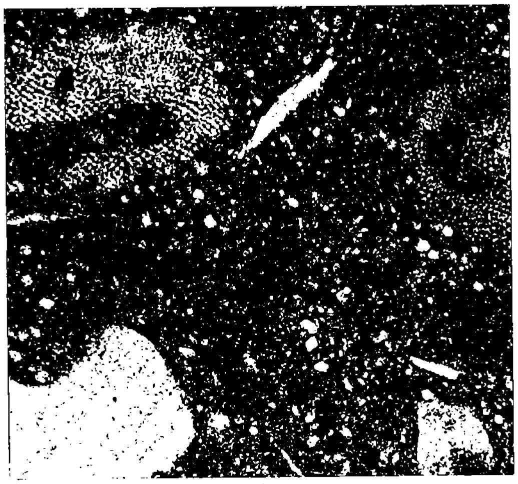
3a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4a

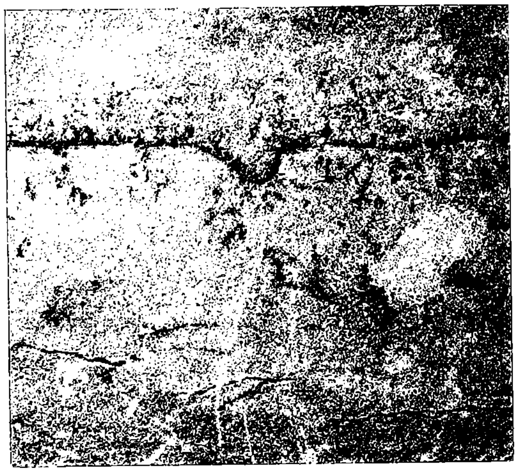

4b

Plate 9

Kirkidium Biofacies; Henryhouse Formation

Figs. *1a, 1b*.–Silurian, *Kirkidium* biofacies, photomicrographs, ×5, ×30, showing complete transverse section of pedicle valve of *Kirkidium* sp. with spondylium, and enlarged view of latter. Note unaltered microtexture of shell, which is characteristic of limestone facies. Rock has a low $MgCO_3$ content (2.61 percent) and a low HCl-insoluble-residue content (1.54 percent) (Amsden, 1969, text-figs. 5, 6). Phillips 1-C Lee; depth, 15,058 feet; Wheeler County, Texas. Thin section, Oklahoma Geological Survey collections.

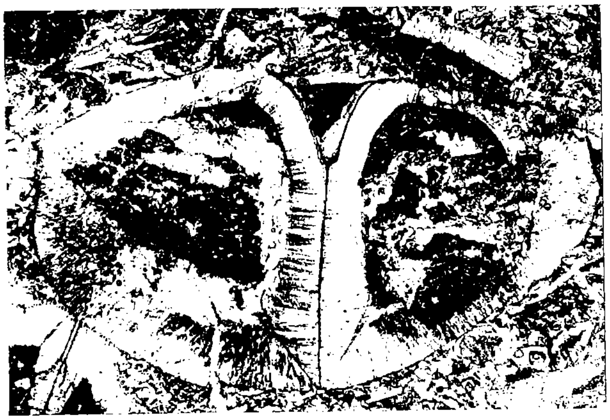
Fig. *2*.–Silurian, *Kirkidium* biofacies, photomicrograph, ×40, showing portion of ventral spondylium of *Kirkidium* sp. Brachiopod shell is here completely replaced by dolospar, surrounding matrix being finely crystalline dolomite (rock analysis, 38.6 percent $MgCO_3$). Same shell shown on pl. 5, figs. *4a, 4b*. Compare to microtexture preserved in limestone facies, figs. *1a, 1b*, above. Sunray DX 1 Frans; depth, 14,552 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *3*.–Silurian, *Kirkidium* biofacies, photomicrograph, ×40, showing portion of plate in brachial valve of *Kirkidium* sp. Shell is largely replaced with calcspar and is embedded in matrix of finely crystalline dolomite (35.4 percent $MgCO_3$). Complete view of shell shown on pl. 5, figs. *3a, 3b*. Sunray DX 1 Frans; depth, 14,524 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *4*.–Henryhouse Formation, photomicrograph, ×40, showing mud-supported texture (marlstone) with scattered fossils. Note fossil-microtexture preservation (ostracode cross section filled with spar); this has very little dolomite. About 65 feet below top of Henryhouse Formation, Henryhouse Creek, SW¼SE¼ sec. 30, T. 2 S., R. 1 E., Carter County, Oklahoma. Thin section, W. E. Ham collection.

Fig. *5*.–Henryhouse Formation, photomicrograph, much enlarged, to show texture of matrix and fossil fragment (pelmatozoan plate). Note dolomite rhomb and subangular to angular quartz fragments; only a few scattered dolomite crystals are present. From bed about 77 feet above Henryhouse-Clarita contact. Thin section, Oklahoma Geological Survey collections (stratigraphic section M17, new cut, Amsden, 1960, p. 256). Another view of this thin section shown on pl. 8, fig. *1*.

Plate 9



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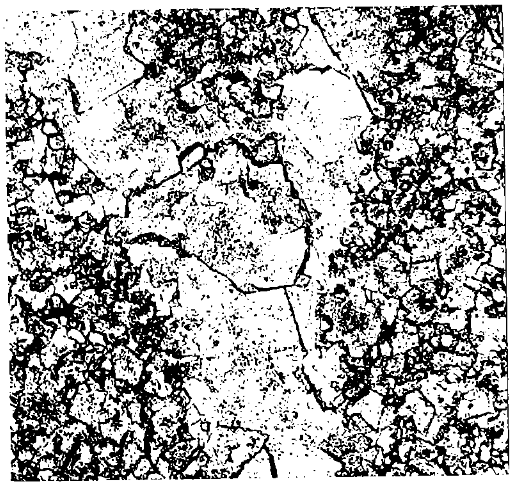

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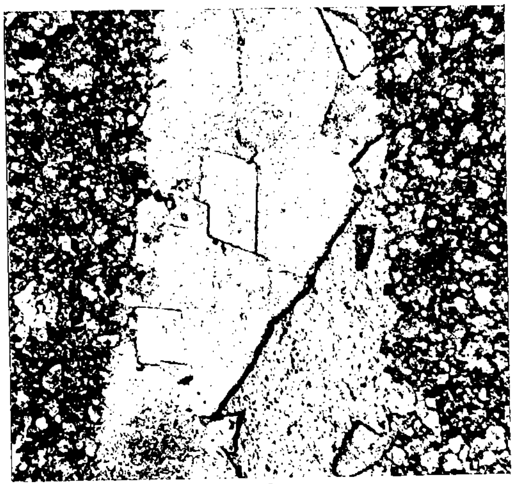

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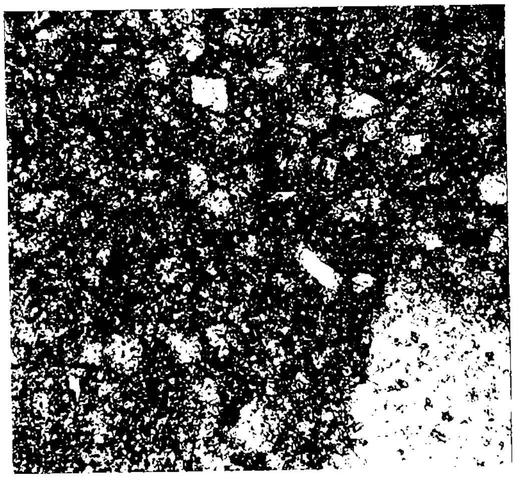

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Plate 10

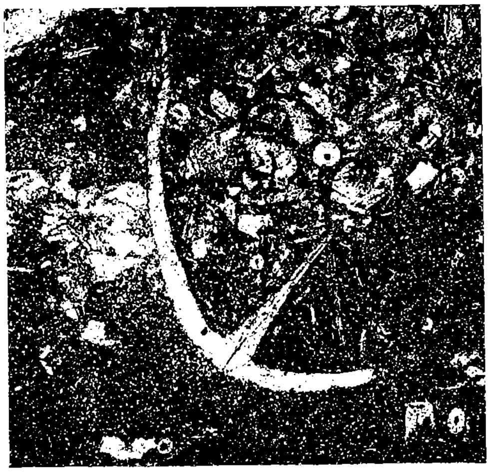
Kirkidium Biofacies

Fig. *1*.—Photomicrograph, ×5, showing cross section of pedicle valve of *Kirkidium* sp. with much crinoidal debris; note that *Kirkidium* shell retains its microtexture and that it was broken before deposition. Matrix has many euhedral dolomite crystals; $MgCO_3$ content averages 18.3 percent. Calvert 1 Bertie; depth, 8,351 feet. Thin section, Oklahoma Geological Survey collections. Enlarged view shown on pl. 11, fig. *2*.

Figs. *2a-2c*.—*Kirkidium* biofacies; photomicrographs of thin sections from Getty 1-B Coffman. Figs. *2a, 2c*: same thin section, ×10, showing broken shell debris and effects of solution; depth, 11,236 feet; $MgCO_3$ averages 1.46 percent. Fig. *2b*: thin section, ×10, showing tabulate coral enclosed in micrite with much fossil debris; depth, 11,205 feet. Oklahoma Geological Survey collections.

Fig. *3*.—Core surface showing articulated specimens of *Kirkidium pingue pingue* (Amsden), ×1. From well cored by Pure Oil Company, depth and location unknown. University of Oklahoma repository, OU 6229.

Fig. *4*.—Core showing specimens of *Kirkidium pingue pingue* (Amsden) that were disarticulated and partially broken before deposition, ×1. Jones and Pellow 1 Farrell; depth, 7,801½ feet. University of Oklahoma repository, OU 5672.



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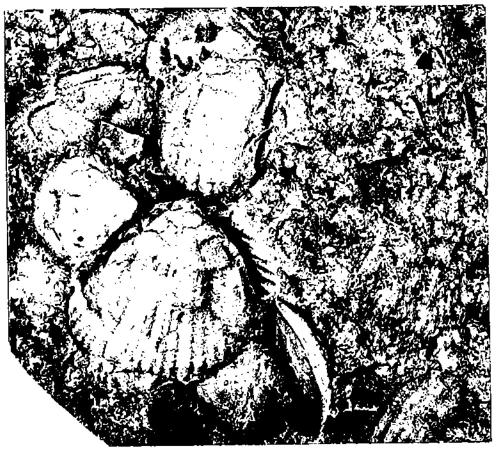

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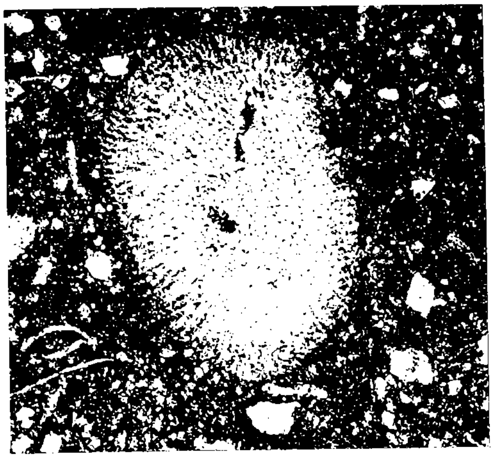
Plate 11

Kirkidium Biofacies; ?Chimneyhill Subgroup

Fig. *1*.–Photomicrograph, ×40, ?Chimneyhill Subgroup showing crinoid plate and matrix with only a few scattered dolomite crystals; $MgCO_3$, 9.10 percent; HCl-insoluble residue, 18.05 percent. Calvert 1 Bertie; depth, 8,521 feet. Thin section, Oklahoma Geological Survey collections.

Figs. *2a-2c*.–Photomicrographs, ×40, *Kirkidium* biofacies, Calvert 1 Bertie; depth, 8,351 feet. Analyzed interval (8,343-8,353 feet) showed: $MgCO_3$, 18.30 percent; HCl-insoluble residue, 5.84 percent; $CaCO_3/MgCO_3$ ratio, 3.90. Fig. *2a* is enlarged view of brachiopod shell illustrated in pl. 10, fig. *1*, showing dolomitized matrix partly corroding *Kirkidium* shell. Fig. *2b* shows dolomitized matrix and shell fragment with its original microtexture. Fig. *2c* shows crinoid plate partly corroded by dolomite crystals. Thin sections, Oklahoma Geological Survey collections.

Figs. *3a, 3b*.–Photomicrographs, ×40, *Kirkidium* biofacies, showing dolomitized matrix partly corroding fossil fragments. Jones and Pellow 1 Farrell; depth, 7,795 feet. $MgCO_3$, 20.5 percent; HCl-insoluble residue, 19.5 percent. Thin sections, Oklahoma Geological Survey collections.



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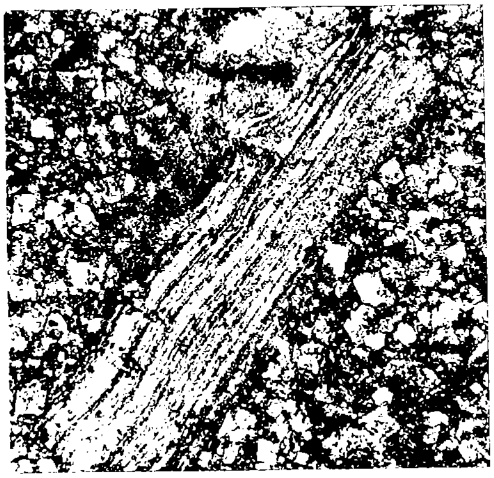

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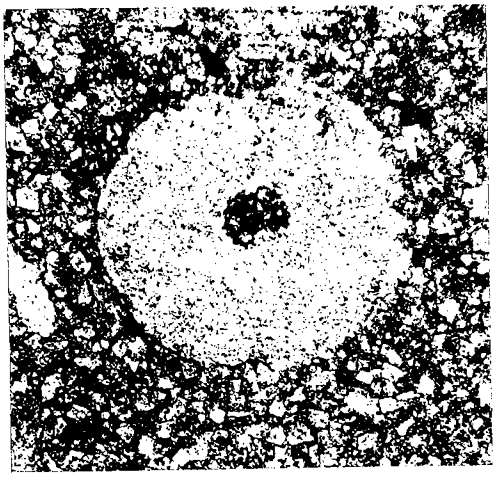

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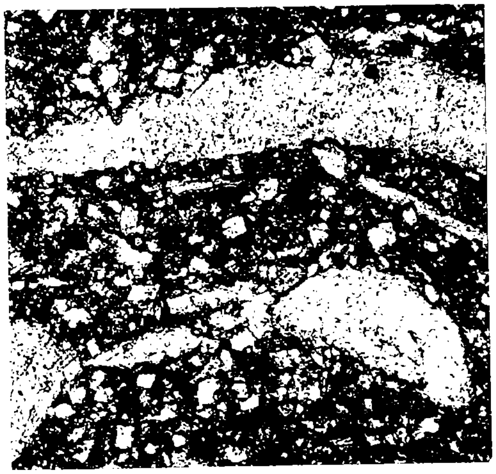

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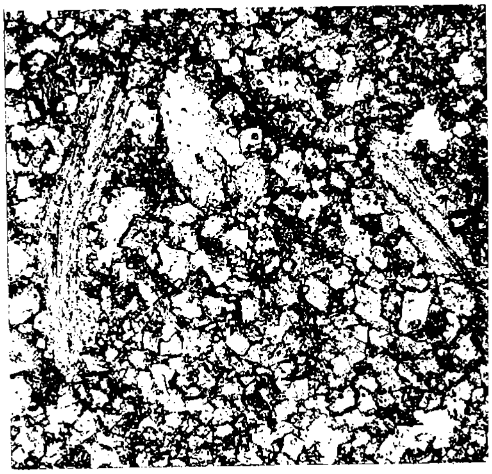

3b

Plate 12

Kirkidium Biofacies; Chimneyhill Subgroup (Keel Formation)

Fig. *1*.–Core from *Kirkidium* biofacies (slightly reduced), showing large solution cavity lined with dolospar; light-colored bands are crevices filled with dolospar. Humble 1 State Hunton; depth, 7,932 feet. Oklahoma Geological Survey collections.

Fig. *2*.–Photomicrograph (stained with Alizarin Red-S), ×10, from *Kirkidium* biofacies, showing part of solution cavity filled with spar, outer rim being dolospar (d) and inner part calcspar (c). Sunray DX 1 Frans; depth, 14,552 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *3*.–Photomicrograph (stained with Alizarin Red-S), ×35, showing part of *Kirkidium* shell preserved in spar; this shell has outer, discontinuous rim of dolospar (d) and inner filling of calcspar (c). *Kirkidium* biofacies, Sunray DX 1 Frans; depth, 14,524 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *4*.–Photomicrograph, ×10, of undolomitized oolite (1.30 percent $MgCO_3$) in *Kirkidium* biofacies. Compare to dolomitized oolites illustrated on pl. 3, figs. *2-5*, and pl. 4, figs. *2a*, *2b*. Gulf 1 Streeter; depth, 7,053 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *5*.–Photomicrograph, ×12, of partly dolomitized oolite (11.9 percent $MgCO_3$), Keel Formation. Getty 1 Luetkemeyer Unit; depth, 9,245 feet. Undolomitized Keel oolite illustrated in Amsden (1960, pl. 10, figs. *4-6*, pl. 11, figs. *1-6*); strongly dolomitized oolite illustrated in fig. *6*, this plate. Thin section, Oklahoma Geological Survey collections.

Fig. *6*.–Photomicrograph, ×25, of strongly dolomitized oolite (stained with Alizarin Red-S). Most of clear areas are voids in thin section. This bed of oolite, which directly overlies Sylvan Shale, is referred to Keel Formation. Compare to fig. *5*, this plate. Phillips 1-C Lee, 15,320-15,330 feet, Wheeler County, Texas. Thin section, Oklahoma Geological Survey collections.

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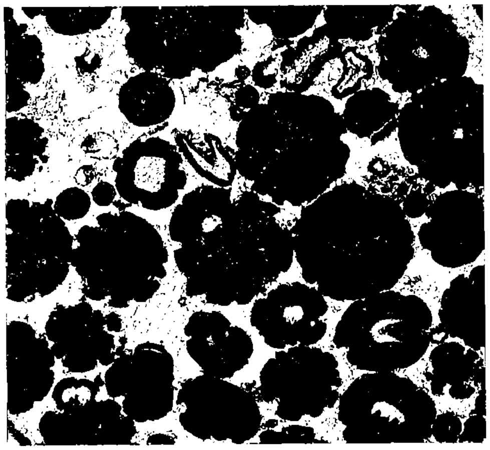

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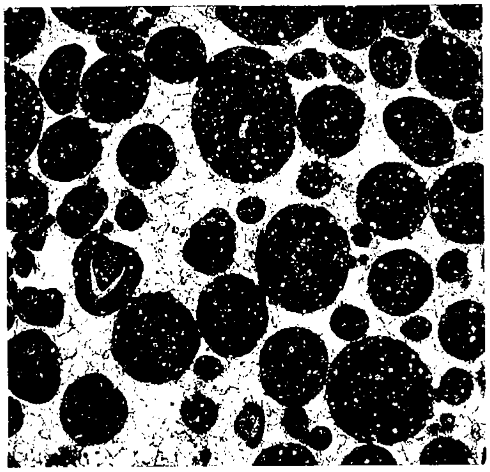

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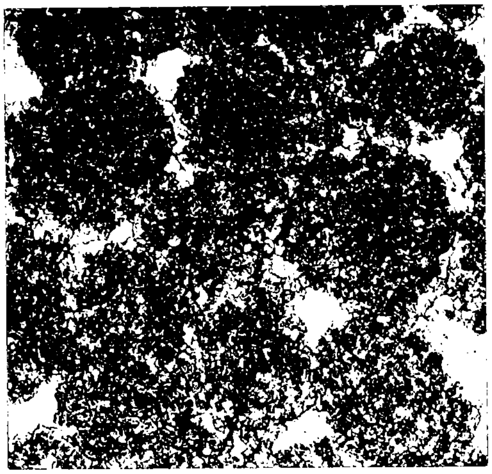

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Plate 13

Kirkidium Biofacies; Chimneyhill Subgroup

Fig. *1*.—Core showing silicified tabulate coral (s), ×3.5, enclosing central cavity (c) lined with quartz crystals; crystalline-dolomite matrix (d). Ferguson 1 Stinson; depth, 7,826-7,827 feet (?*Kirkidium* biofacies). Oklahoma Geological Survey collections. (Porosity-permeability tests and chemical analyses given in Appendix.)

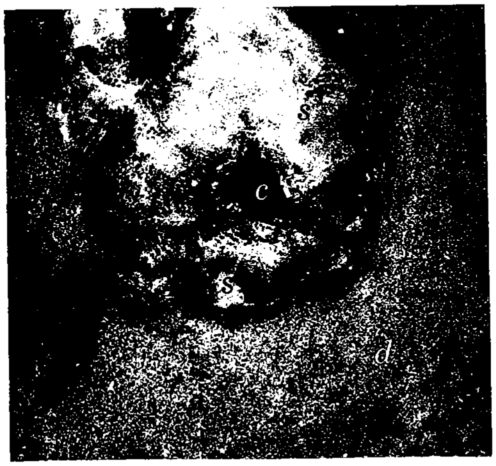
Fig. *2*.—Core showing silicified tabulate coral (s), ×3.5, enclosing central cavity (c), set in crystalline-dolomite matrix (d). Ferguson 1 Stinson; depth, 7,827-7,828 feet (?*Kirkidium* biofacies). Oklahoma Geological Survey collections. (Porosity-permeability tests and chemical analyses given in Appendix.)

Fig. *3*.—Core showing silicified coral (s), ×1.5, with cavity (c), set in crystalline-dolomite matrix (d). Ferguson 1 Stinson; depth, 7,835-7,836 feet (?*Kirkidium* biofacies). Oklahoma Geological Survey collections. (Porosity-permeability tests and chemical analyses given in Appendix.)

Fig. *4*.—Photomicrograph, ×10, of crystalline dolomite with irregular solution channel (c). Tenneco 2-34 Jordan Unit; depth, 8,477 feet. Thin section, Oklahoma Geological Survey collections. (Specimen P4-A, porosity-permeability tests and chemical analyses given in Appendix.)

Fig. *5*.—Photomicrograph, ×12, of crystalline dolomite with small fracture cavities (c). Glover Hefner Kennedy 1-1 Hoffman; depth, 14,269 feet (*Kirkidium* biofacies). Thin section, Oklahoma Geological Survey collections. (Specimen P16-A, porosity-permeability tests and chemical analyses given in Appendix.)

Fig. *6*.—Photomicrograph, ×8, of crystalline dolomite with a stylolite including some small cavities (c). Calvert 1 Bertie; depth, 8,568 feet (?Chimneyhill Subgroup). Thin section, Oklahoma Geological Survey collections. (Specimen P10-B, porosity-permeability tests and chemical analyses given in Appendix.)



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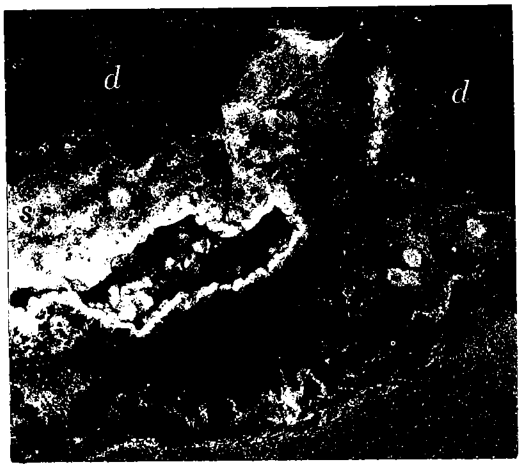

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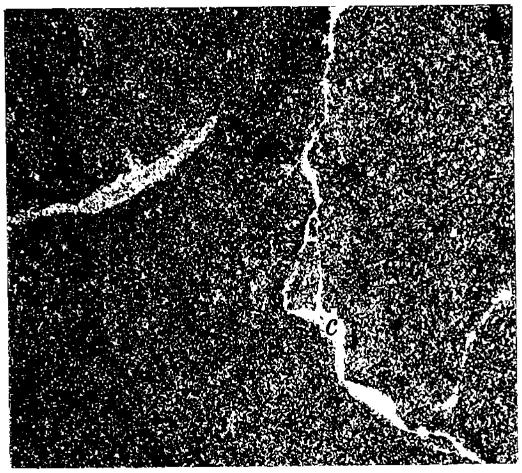

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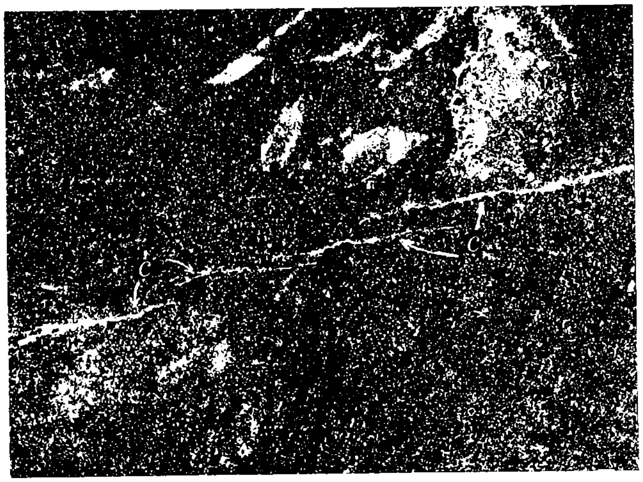

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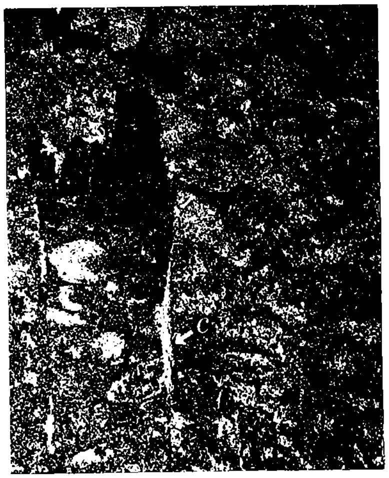

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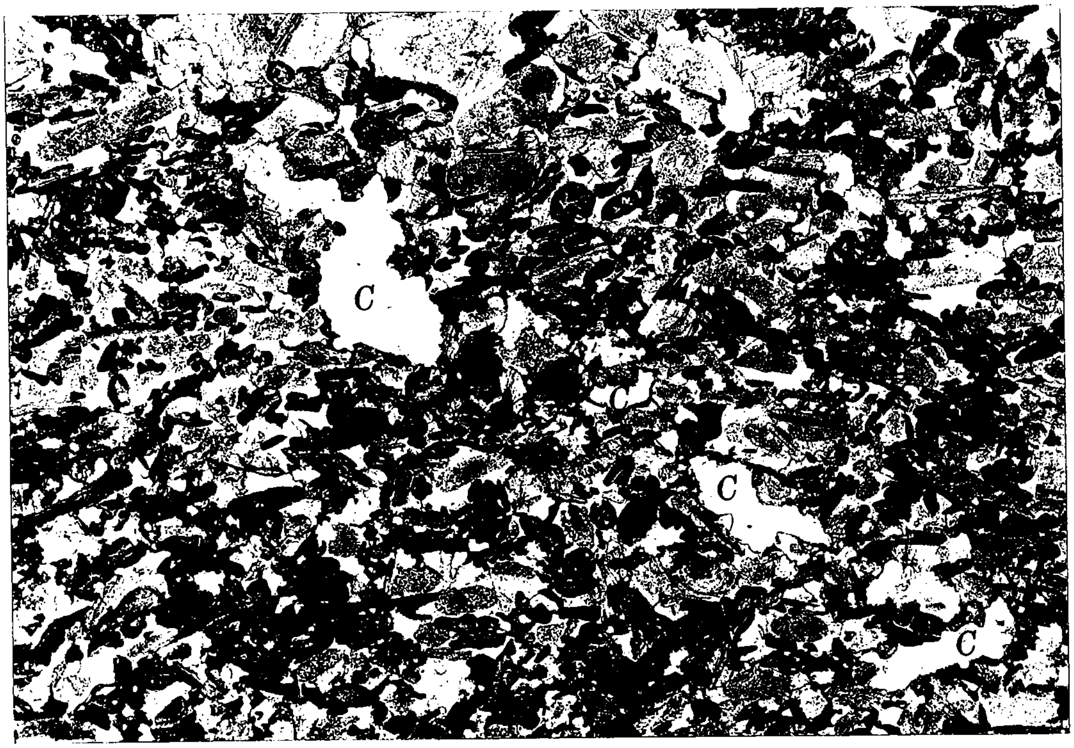
Plate 14

Frisco Formation

Fig. *1*.—Photomicrograph, ×10, Frisco Formation, showing solution cavities (C) with a linear distribution, suggesting fracture control. Gulf 1 Streeter; depth, 7,040 feet. Thin section, Oklahoma Geological Survey collections.

Fig. *2*.—Photomicrograph, ×10, showing quartz sandstone (S; Misener Sandstone?) penetrating Frisco limestone (L). This appears to represent an overlying sand that was washed into solution cavities in upper part of Frisco Formation; note cavity (C) to lower right of sandstone. Gulf 1 Streeter; depth, 6,954 (about 15 feet below base of Woodford). Thin section, Oklahoma Geological Survey collections.

Other illustrations of Frisco porosity shown on pl. 7.



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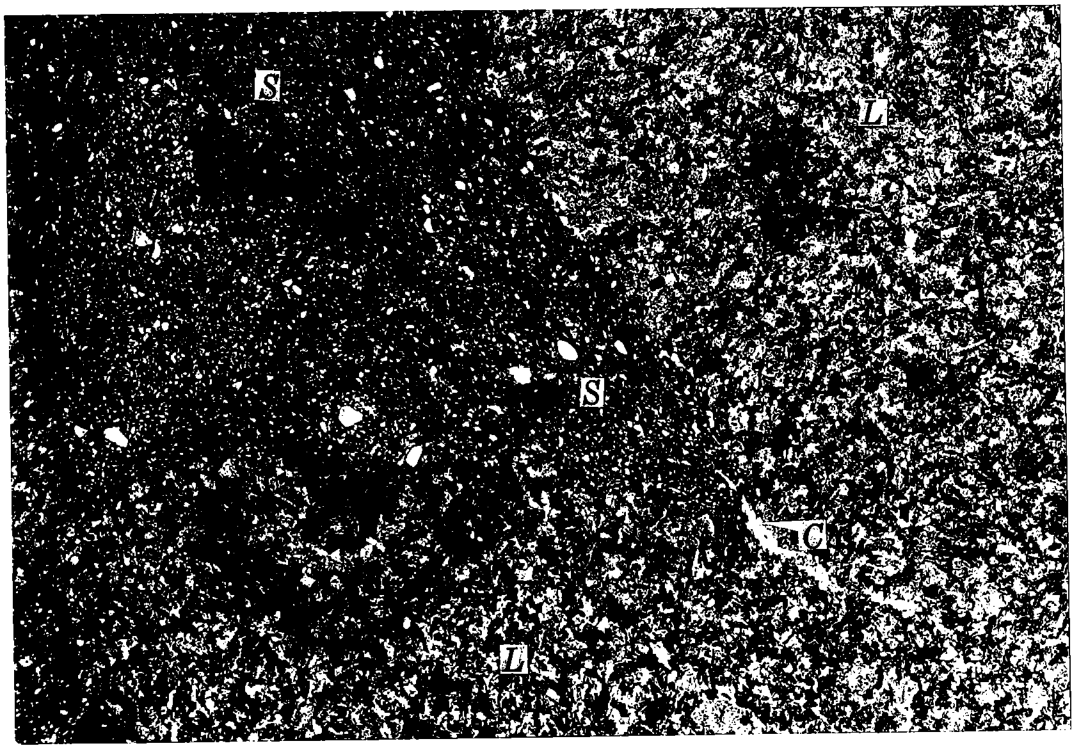

2

Plate 15

Contact of Frisco Formation and *Kirkidium* Biofacies

Figs. *1, 2.*—Photomicrographs showing the boundary (C) between Frisco Formation (above) and *Kirkidium* biofacies (below) in Gulf 1 Streeter, depth, 7,043½ feet. Fig. *1* is enlarged view (×20) of portion of fig. *2* (×7). Shell on left (K) is cross section of articulated *Kirkidium* shell. Compare to Frisco-Silurian contact in eastern Oklahoma, illustrated in Amsden (1961, pls. 4, 5, frontispiece). Thin section, Oklahoma Geological Survey collections.

1

2

INDEX

(**Boldface** numbers indicate main reference; parentheses indicate text-figure numbers; brackets indicate plate numbers)