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

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Title Page Illustration

Photomicrograph, ×5, of Tenkiller Formation (Lower Silurian), showing sediment-filled cavity with open cavity (arrow) and spar. For full explanation, see description of plate 2, figure 4.

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CONTENTS

ILLUSTRATIONS

Text-Figures

Plates

Panels

(Folded separately in pocket)

Type faces: Text in 10- and 8-pt. Century Schoolbook, with 1-pt. leading
Heads in 10-pt. Century Schoolbook bold, 8-pt. Century Schoolbook, and 10-pt. Century Schoolbook italic
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HUNTON GROUP (LATE ORDOVICIAN, SILURIAN AND EARLY DEVONIAN) IN THE ARKOMA BASIN OF OKLAHOMA

THOMAS W. AMSDEN [1]

Abstract—This report presents a sedimentary model of Late Ordovician to Early Mississippian strata (Welling Formation, Sylvan Shale, Hunton Group, Woodford Shale) in the Arkoma Basin of eastern Oklahoma. It is regional in scope and describes the lithostratigraphic-biostratigraphic and lithofacies-biofacies relationships of these strata. The area covered extends from R. 4 E. east to the Oklahoma border and includes information on the Bonanza Gas Field of western Arkansas. It extends from the eastern belt of outcrops in the Arbuckle Mountains to the Sylvan-Hunton-Woodford outcrops of northeastern Oklahoma, and is thus based on both surface and subsurface data; subsurface data are emphasized, however, as the surface geology has been covered in earlier reports. The subsurface study is based primarily on 11 cores and samples from 90 wells, supported by approximately 800 thin sections. The emphasis is on the Hunton Group, but stratigraphic information is provided on the Upper Ordovician Welling Formation and Sylvan Shale, and the Upper Devonian-Lower Mississippian Woodford (Chattanooga) Shale. Regional isopach and structure maps of the Sylvan Shale, Hunton Group, and Woodford (Chattanooga) Shale are included.

Hunton strata in the northeastern part of the Arbuckle Mountains comprise the Late Ordovician and Silurian (Llandoverian-Wenlockian) Chimneyhill Subgroup and Henryhouse Formation (Ludlovian, probably in part Pridolian), and the Lower Devonian Haragan-Bois d'Arc and Frisco Formations. A short distance to the north and east the Upper Silurian Henryhouse and Lower Devonian Haragan-Bois d'Arc Formations are truncated by the pre-Frisco unconformity, and throughout most of eastern Oklahoma Hunton rocks include only the Chimneyhill Subgroup rocks, in places unconformably overlain by the Lower Devonian Frisco and Sallisaw Formations.

In the Arkoma Basin Hunton strata dip to the south into the Choctaw Fault, the deepest penetration presently known being at about −14,000 feet. In the eastern part of the basin Hunton rocks comprise a thinly lenticular body of sediments that are truncated along most of the northern and southern parts of the basin. Hunton strata rest with apparent conformity on the Sylvan Shale and are separated from the overlying Woodford (Chattanooga) Shale by an unconformity during which time Hunton rocks were deeply dissected by eastward-flowing streams and subjected to much dissolution. The Middle Ordovician Simpson Group thickens into the southern, structurally deepest part of the Arkoma Basin; but the Welling Formation, Sylvan Shale, and Hunton Group do not thicken basinward, and it was not until Woodford time that such a depositional pattern was again developed.

Chimneyhill strata in the Arbuckle Mountains are represented by low-magnesium limestones. North and east of here these strata are dolomitized, and throughout the Arkoma Basin they comprise dolomitic limestones, calcitic dolomites, and crystalline dolomites, the latter concentrated mainly in two areas, one in eastern Oklahoma extending into western Arkansas and the other in the northwestern part of the area under study. The dolomite is believed to have originated largely as a penecontemporaneous replacement that took place at the depositional interface.

A number of Hunton oil and gas fields are present in the western part of the area investigated, from just east of the present Arbuckle Mountains and northward along the Hunton arch and on to the truncated margin of the Hunton. East of here, in the Arkoma Basin, only a few widely scattered gas fields are presently known. One of the largest is the Bonanza Gas Field of western Arkansas, which produces from Chimneyhill crystalline dolomites. Other fields occur in less heavily dolomitized Chimneyhill strata and may include Lower Devonian production.

INTRODUCTION

The goal of the present study is to provide an Arkoma Basin model for strata of Late Ordovician to Early Mississippian age. The area covered (text-fig. 1) extends from R. 4 E. eastward to the Arkansas border and including the Bonanza Gas Field of western Arkansas. The stratigraphic units comprise the Welling ("Fernvale") Formation, Sylvan Shale, Hunton Group, and Woodford Shale (ascending), but the study is most particularly concerned with Hunton strata (text-fig. 2). The investigation is regional in scope, with emphasis on the lithostratigraphic-biostratigraphic and lithofacies-

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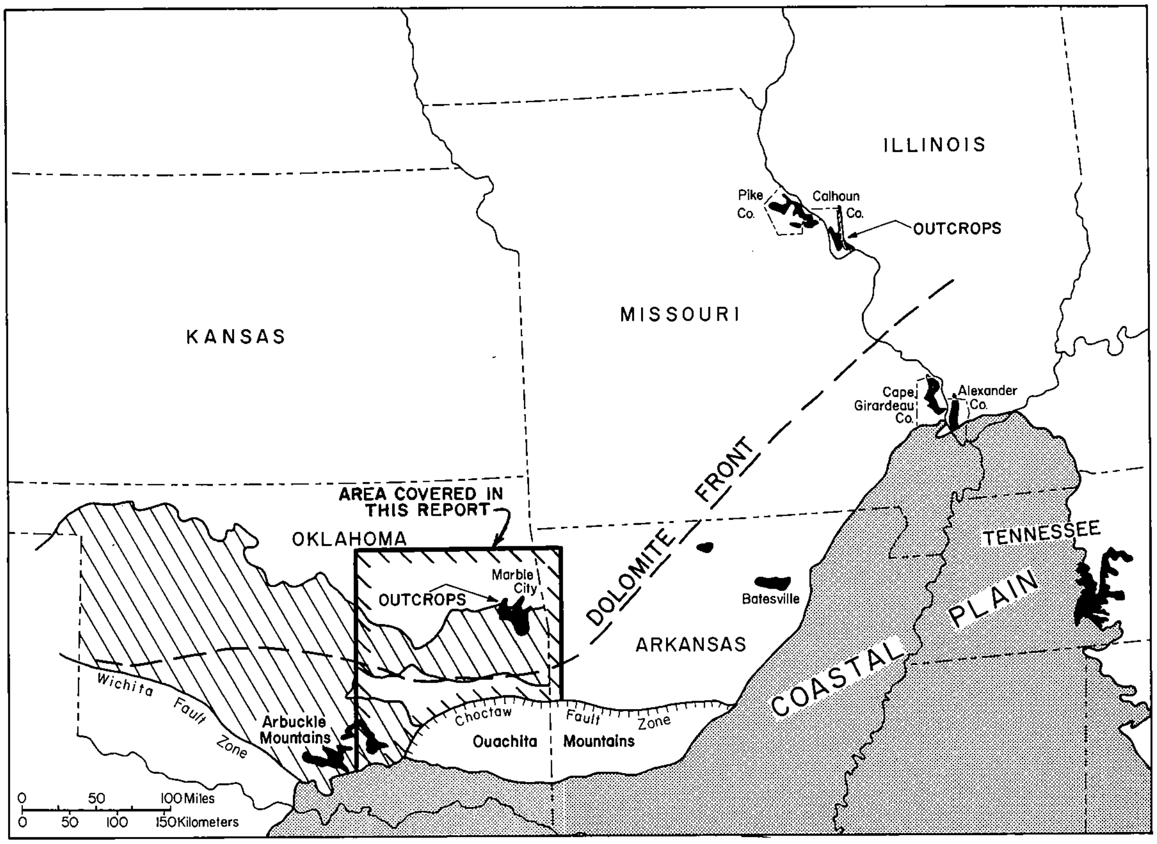


Text-figure 1. Map showing distribution of Late Ordovician-Silurian-Early Devonian outcrops (black) in central United States. Subsurface distribution of these strata in Oklahoma shown by diagonal lines.

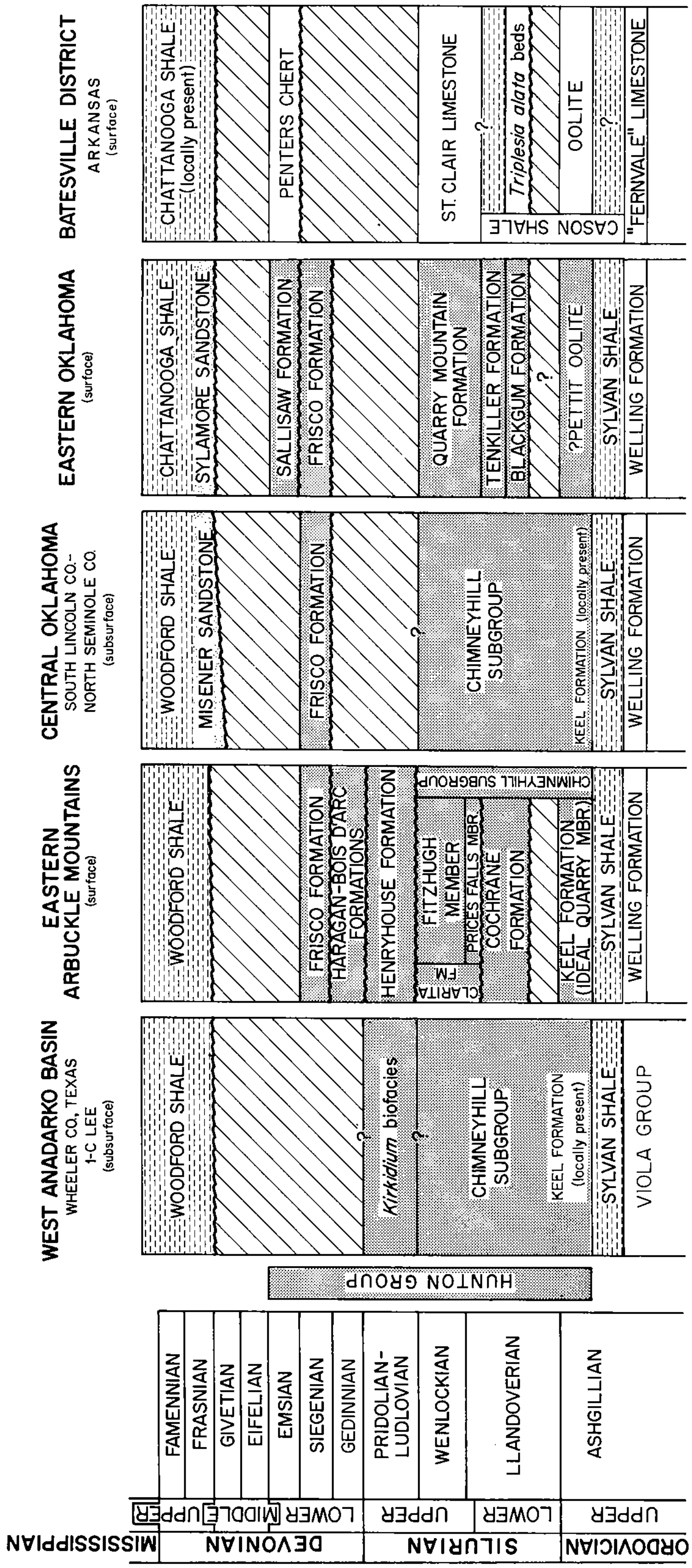
biofacies relationships. Some information is provided on the stratigraphic distribution and porosity of Hunton oil- and gas-producing zones, but this bulletin is not meant to be a report on Hunton production as such although I hope it will provide useful background information of interest to petroleum geologists.

The area covered overlaps the western part of my Anadarko Basin investigation (Amsden, 1975b, Oklahoma Geological Survey Bulletin 121) by six townships (R. 4 E. to R. 9 E.) and gives new data on one well providing a core (1 McElvaney) and on a number of wells providing samples (panel 2). The strata embraced in the present report are essentially the same as reported on in Bulletin 121, and the goals of the two reports are the same. This study relies more heavily on well samples, partly because of the lack of cores and partly because of a desire to acquire more detailed lithostratigraphic information from the subsurface.

The Ouachita Mountain clastic province is excluded from this report. The lithofacies, biofacies, and structural conditions of the Ouachitas are so different from those of the carbonate platform that they require different techniques and methods of study (see Ouachita Mountain Clastic Province).

Data Sources

Surface.—Hunton strata crop out in the Arbuckle Mountains near the southwestern edge of the area covered in this report and in the vicinity of Marble City near the northeastern corner (text-fig. 1; panel 2). Fossiliferous Late Ordovician, Silurian, and Early Devonian strata are well exposed in both areas, and much information is now available through a number of detailed stratigraphic and paleontologic investigations, the more important being Reeds (1911), Maxwell (1931), Christian (1953), Amsden (1958a, 1958b, 1960, 1961, 1963a, 1963b,



Text-figure 2. Stratigraphic chart showing inferred relationship of Late Ordovician to Early Mississippian strata. Stratigraphic units included in Hunton Group are stippled. Chart not to scale in terms of stratigraphic thickness or time.

1968, 1974, 1978), Amsden and Rowland (1965), Amsden and Ventress (1963), Barrick and Klapper (1976), Campbell (1967, 1977), Lundin (1965, 1968), Sutherland (1965). The information in these studies provides the basic lithostratigraphic and biostratigraphic framework for the present subsurface investigation of eastern Oklahoma.

Subsurface.—I am familiar with only 11 wells that cored some part of the Hunton Group. Eight of these were drilled in the region north of the Arbuckle Mountains, extending onto the Hunton arch, and only the 1 Fargo, 1 Farmers Flag, and 1 Western Coal and Mining Co. cores are from the Arkoma Basin in eastern Oklahoma and western Arkansas (Appendix; panel 2). Mechanical logs have been heavily relied on for locating the Woodford (Chattanooga)-Hunton, Hunton-Sylvan, and Sylvan-Viola boundaries, but almost all other lithostratigraphic information has been derived from a study of well samples by means of thin sections. Many eastern Oklahoma wells have been air drilled and provide samples that are too fine to be used in this type of investigation. Of the available wells providing conventional samples, those have been selected that were thought to give maximum stratigraphic and geographic information. Samples from 90 wells, including four from western Arkansas, were examined with the aid of approximately 800 thin sections (Appendix). The thin sections are most useful in making estimates of dolomite content as well as in providing information on terrigenous detritus, fossils, character of the cement, and other textural features that are useful in a lithostratigraphic and lithofacies study such as this one. I have also examined the mechanical logs, where available, for all wells in which the samples were studied; these are mainly spontaneous-potential logs, as relatively few wells drilled in this area provide gamma-ray logs (see Amsden, 1975b, p. 4–5). This subsurface investigation, with its heavy reliance on samples, provides very little biostratigraphic control. Nevertheless, it does supply considerable lithostratigraphic data, and this information, combined with the biostratigraphic and lithostratigraphic control, furnished by the surface exposures and the cores, is believed to provide a reasonable view of Hunton stratigraphic relations.

Maps

This report includes isopach and structure maps of the Woodford Shale, Hunton Group, and Sylvan Shale (panels 1–3). These maps are based primarily on data obtained from well-completion cards issued by Petroleum Information Corp. and Research Oil Reports as well as from files of the Oklahoma Corporation Commission, supplemented where possible by information obtained in my study of mechanical logs, cores, and samples. The method used is essentially the same as that of the Anadarko Basin study (Amsden 1975b, p. 6, panels 3–8); the data were first plotted at a scale of 3 inches to the mile and then reduced to a printing scale of 1:500,000. For the eastern part of the area studied, from R. 10 E. to the Arkansas border, where well spacing is diffuse, I have tried to incorporate most of the available well information; however, in parts of the western region (R. 4 E. to R. 9 E.), where drilling has been intense, it has been necessary to restrict the control points to one per section. The maps show the structure and isopach data with reasonable precision except in the vicinity of the Arbuckle Mountains, where the structural complexity increases to such a degree that considerable generalization is necessary (see Structure). The purpose of these maps is to present a *regional* view of the structure and thickness, which should be useful in studying such relationships as (1) thickness to structure, (2) dolomitization to structure and (or) thickness, and (3) distribution and thickness of the Sylvan Shale with respect to the overlying Hunton. I believe that the degree of precision represented in these maps is adequate for this purpose, and the maps have been so utilized in reaching the various conclusions of the present report.

This report also includes a pre-Woodford geologic map; a lithofacies and isopach map of the Chimneyhill Subgroup; and two stratigraphic sections, one extending from the Arbuckle Mountains to the eastern Oklahoma outcrops and the other from the eastern Oklahoma outcrops southward to the Choctaw Fault (panel 4).

Lithologic Terminology

For descriptive purposes, the carbonate rocks discussed in this report can be categorized as follows: (1) organo-detrital limestones including oolites, (2) marlstones, and (3) dolomites. No reefs or boundstones have been observed, and calcareous algae are an insignificant part of the organic material in Hunton strata.

1. Organo-detrital limestones are abundant and widespread in the middle Paleozoic carbonates of the Midcontinent region. These are grain-supported rocks, with the clasts composed almost exclusively of organic debris little if any of which appears to be in growth position. The grain size ranges widely, being dependent upon the available biota plus the amount of fragmentation to which the material was subjected before burial. Because of this wide variation in the size of the clasts, I prefer to avoid size terms such as calcarenite (size variation illustrated on pl. 1, fig. 3; pl. 2, fig. 3; pl. 10, figs. 3–5; also Amsden, 1978, pls. 12, 13). The most common clasts in the organo-detrital rocks here studied are disarticulated pelmatozoan plates, most of which are presumed to represent crinoids. Other common clasts are bryozoans, brachiopods, trilobites, ostracodes, and mollusks; corals are generally a minor part of the shelly material. (Some limestones include substantial faunas of conodonts and arenaceous forms.) The degree of disarticulation and fragmentation ranges widely, but the most common texture appears to represent modest disarticulation by wave and (or) current action, and the shelly material in most of these limestones probably is composed of life assemblages or fossil communities (Amsden, 1978, p. 4–5). The organic debris is cemented by either spar (organo-detrital sparite; pl. 10, fig. 2) or micrite (organo-detrital micrite; pl. 10, fig. 5), with the two rather closely intermingled in some beds. Point counting of thin sections from the Clarita and Quarry Mountain Formations demonstrates that in the organo-detrital sparites the matrix usually makes up some 25 to 35 percent of the total rock volume, and for the organo-detrital micrite, some 40 to 50 percent (Amsden, 1978, p. 6; this report, Clarita Formation). The percentage of insoluble terrigenous detritus is mostly low, generally less than 10 percent and almost entirely confined to silt and finer particles. In places the insoluble terrigenous detritus increases significantly, the fossil content decreases, and the organo-detrital micrites grade into mud-supported marlstones (see Amsden and Ventress, 1963, p. 20–22; this report, Clarita Formation).

Oolites are present in some of the Late Ordovician, Silurian, and Early Devonian strata in Oklahoma. The individual ooids commonly show well-marked radial and concentric structure and a fossil nucleus (Amsden, 1960, pl. 10). Cementing material is either spar or micrite, and the two are commonly intimately interbedded. Fossils are commonly present in the oolites, and as the fossil content increases and the ooids decrease, the oolites grade into organo-detrital limestones.

2. The marlstones have a mud-supported fabric, the mud being composed of a mixture of finely divided carbonate and clay- and silt-size insoluble detritus (Amsden, 1975b, pl. 8, figs. 1, 2). The insoluble material ranges widely, averaging about 20 percent in the Henryhouse Formation. Fossils are scattered through this matrix somewhat like plums in a pudding. Crinoids are common in the Henryhouse marlstones, but the marlstones also include many brachiopods, trilobites, ostracodes, bryozoans, corals, and mollusks. As the percentage of fossil debris increases and the insoluble detritus decreases, the marlstones grade into organo-detrital limestones.

3. Hunton rocks in eastern Oklahoma show a complete gradation from high-calcium limestone (parts of the Marble City Member analyze over 99 percent $CaCO_3$ and are mined for chemical-grade limestone) to high-magnesium dolomites (some beds in the Bonanza Field analyze over 41 percent $MgCO_3$). The character of this gradation is discussed in the section Hunton Dolomite and will not be repeated here except to stress two features: First, the magnesium carbonate in Hunton rocks occurs in well-formed crystals that are readily identified in unstained thin section (staining is especially helpful in distinguishing calcspar from dolospar). Second, when the $MgCO_3$ exceeds 28–29 percent, the texture invariably appears as interlocking crystals of dolomite and any fossils present are preserved either as molds or in spar. Recognition of this *crystalline-dolomite* texture is thus quite useful, because it indicates a rock with about 28 percent or more $MgCO_3$ (about 61 percent

or more of the mineral dolomite). The gradation from limestone to dolomite takes place entirely within a sequence of marine limestones; note the presence of marine fossils in the moderately dolomitized limestone (11.28 percent $MgCO_3$) illustrated on plate 1, fig. 3, and in the heavily dolomitized limestones (36 to more than 40 percent $MgCO_3$) illustrated on plate 1, figs. 1, 5, 6.

Ouachita Mountain Clastic Province

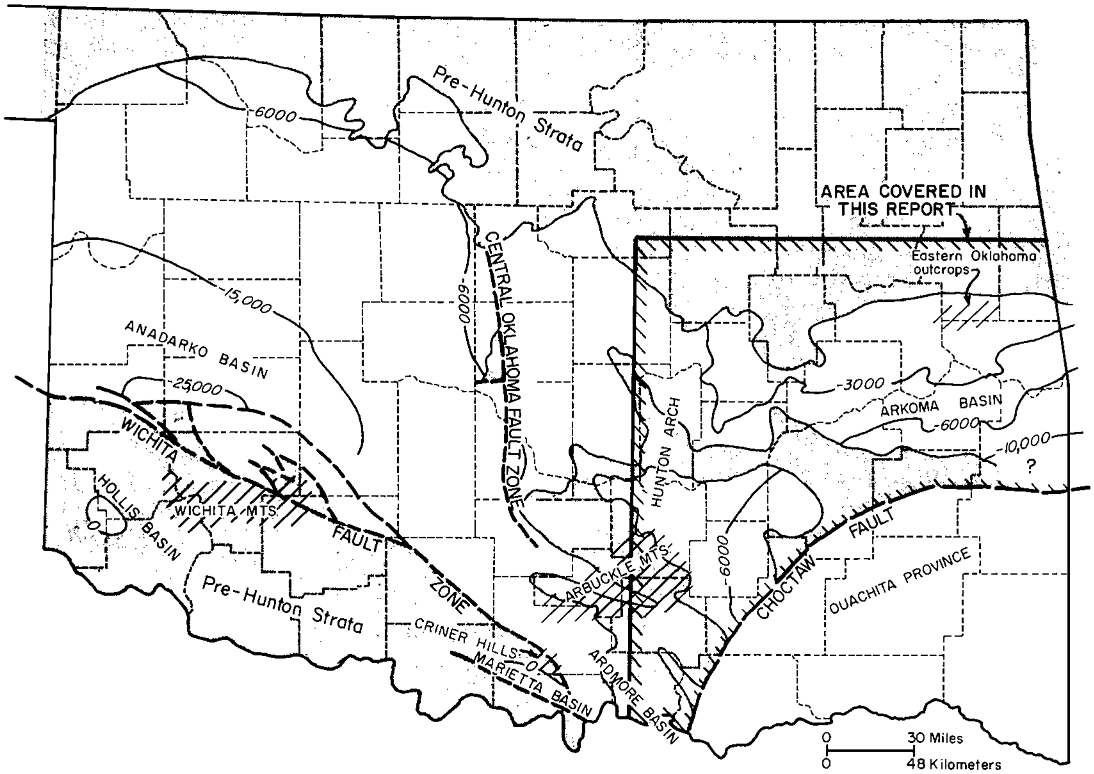
Strata in this province mainly comprise terrigenous clastic sediments whose biostratigraphy is poorly understood. The Choctaw Fault is here used as the boundary separating the Ouachita clastic province on the south from the shales and shallow-water carbonates lying to the north and west (text-fig. 1). Hunton strata are generally absent in the region north of the Choctaw Fault, and presumably this area of truncated Late Ordovician, Silurian, and Early Devonian rocks extends for some distance south of the Choctaw Fault. Hunton equivalents are known to be present in the Blalock Sandstone at Caddo Gap, Arkansas, which yields Early Silurian (Llandoverian) graptolites. The only other significant Silurian-Devonian fossils known to me are Late Devonian conodonts from the middle division of the Arkansas Novaculite at Caddo Gap (Amsden and others, 1967, p. 928) and Late Devonian-Mississippian conodonts from the upper Middle Division of the Arkansas Novaculite in McCurtain County, Oklahoma, north of Broken Bow (Stone, 1978, p. 115). Hunton rocks are present in close proximity to the southwestern part of the Choctaw Fault in Atoka, Coal, and Pittsburg Counties (panel 2). The closest well examined by me is the 1 Lewis (Appendix), located within a mile or so of the fault, and which is clearly a part of the Arbuckle carbonate-platform facies. Nevertheless, the Ouachita clastic facies is reflected to some extent in both the Chimneyhill and Henryhouse lithofacies, where it forms a southern, clastic halo of fine terrigenous detritus and mudstones (Amsden, 1969, p. 971; Amsden, 1975; Amsden, 1975b, p. 41; this report, Chimneyhill, Arbuckle Mountains-Criner Hills).

Structure

The Arkoma Basin is generally defined to include the region extending from east of the Arbuckle Mountains, in eastern Coal and southeastern Hughes Counties, across eastern Oklahoma and into western Arkansas (Koinm and Dickey, 1967, p. 710); the Oklahoma portion of the Arkoma Basin has been called the McAlester basin. This sedimentary-structural basin is depressed to the south, with Hunton rocks attaining depths greater than −14,000 feet near the Arkansas border (see Humble 1 Kerr, Appendix). The Choctaw Fault forms the southern margin of the basin, and, for this report, the northern margin is placed in the vicinity of the eastern Hunton outcrops on the flanks of the Ozark Uplift. The Arkoma Basin is separated from the Anadarko Basin by a structural complex that includes the Criner Hills, Arbuckle Mountains, Hunton Arch, and Central Oklahoma Fault Zone (text-figs. 1, 3; panels 1–3). Structural complexities increase sharply in the region centering around the Arbuckle Mountains, necessitating considerable simplification and generalization of the structure maps.

Within this basin, Sylvan, Hunton, and Woodford strata form a broadly arcuate east-, southeast-, and south-dipping basin that wraps around the Choctaw Fault and the Ouachita province. The dips are by no means uniform, and there are many subsidiary folds, especially in the eastern part. Between the eastern outcrops and the 1 Kerr the average dip of Hunton rocks is about 4°, although locally much steeper dips prevail along the flanks of the subsidiary folds. Very few faults are shown on the Sylvan, Hunton, and Woodford structure maps, although quite possibly some of the steep dips would be mapped as faults on a larger scale map with a more closely spaced contour interval.

Several geologists have investigated the regional stratigraphy and structure of the Arkoma Basin, one of the earliest being Disney (1960), who examined the Cambrian-Ordovician to Quaternary strata. In 1967 Koinm and Dickey presented a paper on growth faulting in the McAlester (Arkoma) Basin, including regional structure maps of the Hartshorne and Wapanucka Formations. Recently McQuillan (1977) studied growth



Text-figure 3. Map showing major structural features of area covered in this report. Structure contours (in feet) of top of Hunton Group.

faulting in Pennsylvanian sandstones in the Arkoma Basin in eastern Oklahoma; he prepared structure maps on the basal Atokan and basal "C" marker in the Morrowan. According to these investigators, Pennsylvanian strata are cut by numerous faults, the major ones having displacements of several thousand feet. This is in marked contrast to the Sylvan-Hunton-Woodford structure maps of the present report, in which faulting appears to be minimal. To some extent this could be an artifact of the data base, since wells penetrating Pennsylvanian strata are much more abundant than those cutting the Hunton. The three major fault systems affecting upper Paleozoic strata are the Mulberry, Kinton, and San Bois, all with displacements generally exceeding 2,000 feet (Koinm and Dickey, 1967, figs. 2, 3; McQuillan, 1977, fig. 1, pls. 7, 8). When these faults are plotted on the Hunton structure maps it can be seen that minor portions, notably the southern extension of the San Bois Fault, do fall in areas of meager Hunton control. However, the northeastern extension of this fault, and most of the Kinta and Mulberry Faults, are in areas with some Hunton control, probably enough to reveal faulting of this magnitude. In part, these Pennsylvanian faults do coincide with areas where Sylvan-Hunton-Woodford strata have steep dips, but elsewhere they do not, and thus there appears to be a considerable difference between the structural pattern of the younger Paleozoic strata and that of the older rocks, as shown on the maps in this report. Koinm and Dickey (1967, fig. 4) proposed growth faulting, with the southern, downthrown side receiving increased sedimentation. McQuillan (1977, figs. 2, 3, 6–10), following the mechanism proposed by Koinm and Dickey (1967), Buchanan and Johnson (1968, figs. 6, 7), and others, shows these as shallow-rooted faults that flatten with depth, passing into bedding-plane faults. Faulting that developed in this manner would be compatible with the stratigraphic distribution of faults in the Arkoma Basin, according to the present report. However, Gary W. Hart (Oklahoma City, letter, Aug. 8, 1978) believes that most of the normal faults in the Arkoma Basin are also growth faults that cut all of the sedimentary section and that in only a few areas do these growth faults die out in shale of the lower Atoka. This question cannot be resolved with the data available to me, and I can only emphasize that the Sylvan-Hunton-Woodford contour maps of this report are in accord with the data base and the contour interval and scale employed on these panels.

Unconformities

Throughout Oklahoma and adjacent areas, deposition was probably continuous from the Late Ordovician Sylvan Shale into earliest Hunton (Keel) time (see Ordovician-Silurian Boundary). At some time after the close of Hunton deposition this region was, with the possible exception of the deep Anadarko Basin, uplifted and exposed to a long period of erosion, followed by deposition of the Woodford (Chattanooga) strata. There is lithostratigraphic and biostratigraphic evidence in Hunton strata exposed in the Arbuckle Mountains–Criner Hills and eastern Oklahoma for at least local development of pre-Cochrane-Blackgum, pre-Clarita, pre-Henryhouse, pre-Haragan-Bois d'Arc, pre-Frisco, and pre-Sallisaw unconformities (see discussions in Amsden, 1960, 1961, 1963b, 1975b; see also discussions of various formations in this report). Of these unconformities, the only ones for which I can demonstrate truncation of regional dimensions in both the surface and subsurface are the pre-Woodford (Chattanooga) (panel 4; text-fig. 23), pre-Sallisaw, and pre-Frisco (text-fig. 18) unconformities. (Haragan–Bois d'Arc strata have such restricted geographic distribution that it is impossible to assess their regional relations, as noted in Amsden, 1975b, panels 9, 10, 11, and this report, panel 4, and Silurian-Devonian Boundary.) This is not to imply that other unconformities are unrepresented in the subsurface, but present information indicates that, if present, they affect relatively small geographic areas. In the structurally deepest part of the Anadarko Basin, in the region bordering the Wichita Mountain Fault Zone, the lithostratigraphic and thickness-structure relationships suggest that deposition was continuous from Late Ordovician into Early Mississippian time.

Hunton Group

The Hunton Formation was named by Taff in 1902 for Silurian to Early Devonian carbonate strata that crop out in the Arbuckle Mountains and Criner Hills of south-central Oklahoma. The Hunton was later elevated to group status, and in 1975 I expanded the Hunton Group to include all Late Ordovician (Keel Formation) through Early Devonian (Sallisaw Formation) carbonate strata (text-fig. 2; Amsden, 1975b, p. 7). These strata overlie the Sylvan Shale (Late Ordovician) and underlie the Woodford Shale (=Chattanooga Shale; Late Devonian to Early Mississippian), thus making a distinctive shale-carbonate-shale sequence that is readily recognized in the subsurface (locally the basal Misener Sandstone is as old as Middle Devonian; see Woodford (Chattanooga) Shale and Misener (Sylamore) Sandstone). In the deep part of the Anadarko Basin, present information suggests that deposition was continuous from the Late Ordovician Sylvan Shale through the Early Mississippian Woodford Shale, and the Hunton Group probably includes Middle Devonian carbonate rocks in this region. This usage represents an expansion from the strata included in the type area near old Hunton townsite (Amsden, 1960, p. 182–188), where the Hunton Group comprises strata ranging in age from the Late Ordovician (Keel Formation) into the middle Early Devonian (Frisco Formation). However, this addition of late Early and, probably, Middle Devonian strata appears to be a relatively straightforward expansion that does not deviate enough from that of the type locality to be confusing. I can see no merit in further categorizing these strata into a Hunton megagroup.

The lithostratigraphic and biostratigraphic character of Hunton strata has been studied in detail for the outcrop area in the Arbuckle Mountains and Criner Hills, in the subsurface of western Oklahoma, and in the surface exposures of eastern Oklahoma. References to the various papers on Hunton stratigraphy and paleontology are given previously in the Introduction and in my Anadarko Basin study (Amsden, 1975b, p. 7, 76–78), and the reader is referred to these publications for additional background information on the strata covered in this report.

Silurian-Devonian Boundary

Throughout much of the Arbuckle Mountains–Criner Hills outcrop area the Silurian-Devonian boundary lies at the contact of the Henryhouse and Haragan Formations. This brings Upper Silurian (Ludlovian, probably including Pridolian) Henryhouse strata into contact with Lower Devonian (Helderbergian-Gedinnian) Haragan strata. This contact has been the subject of much discussion, and it is certainly troublesome insofar as lithostratigraphic investigations are concerned, because both formations are composed of marlstones, which, for all practical purposes, cannot be distinguished. Henryhouse and Haragan strata are, however, readily distinguished on the basis of their megafaunas and can be identified throughout the Arbuckle Mountains and Criner Hills. A formidable body of megafaunal evidence is now available for separating these two formations. Major studies include Reeds (1911), Maxwell (1931, 1936), Strimple (1963; crinoids), Amsden (1951, 1958a, 1960; brachiopods), Sutherland (1965; corals), Lundin (1965, 1968; ostracodes), Campbell (1967, 1977; trilobites). In essence, these investigators find two distinct megafaunas, one of Late Silurian and the other of Late Devonian age. Neither fauna shows any clear evidence of zonation, nor does there appear to be any transitional fauna connecting these two biostratigraphic units; the biostratigraphic definition of the Henryhouse and Haragan Formations given by Reeds in 1911 is essentially the same as that used today. The Henryhouse and Haragan are mappable biostratigraphic units and have been mapped throughout the outcrop area (Amsden, 1960, panels 1–3). Such mapping shows that in the southeastern part of the Arbuckle Mountains the Henryhouse biostratigraphic unit wedges out beneath the Haragan and Bois d'Arc biostratigraphic units, allowing Helderbergian-age strata to rest directly on Chimneyhill and older strata. Of particular significance is the fact that the geographic and stratigraphic distribution of these formations given by Maxwell in 1931 is almost identical to that worked out some years later by me and others, again demonstrating that the biostratigraphic definition of these units has remained remarkably constant over the years. According to my interpretation, these relations are the result of pre-Devonian (pre-Helderbergian) uplift and erosion, although it should be noted that there is only one locality in the outcrop area (stratigraphic section P8, Amsden, 1960, p. 277; 1962a, p. 1512) that shows physical evidence for an unconformity at the Henryhouse-Haragan boundary. Whatever explanation is proposed to explain Henryhouse-Haragan relations must accord with these basic biostratigraphic data.

Unfortunately, the regional relationship of Henryhouse-Haragan strata cannot be satisfactorily studied because of the restricted distribution of Helderbergian-age beds (text-fig. 17). To the north, northeast, and northwest, Haragan–Bois d'Arc strata are truncated by the pre-Frisco unconformity, and throughout most of this region Silurian strata are overlain by the Frisco or, where that formation has been removed by pre-Woodford erosion, by the Woodford (Chattanooga) Shale. Haragan–Bois d'Arc strata appear to extend into the deep part of the Anadarko Basin, where deposition is inferred to have been more or less continuous throughout Silurian and Devonian time. However, the evidence for this is entirely lithostratigraphic, as no biostratigraphic data are presently available.

Silurian strata were extensively eroded during the period of uplift preceding deposition of the Frisco Formation (text-fig. 18), and throughout most of eastern Oklahoma the Henryhouse Formation has been removed, allowing Devonian strata to rest on the Chimneyhill Subgroup. Some erosion also preceded deposition of the late Early Devonian Sallisaw Formation, because that unit is known to rest on strata as old as Ordovician; however, this unconformity is not well understood because of the restricted distribution of Emsian-age strata.

A long period of erosion preceded deposition of the Woodford (Chattanooga) Shale, resulting in extensive dissection of the pre-Frisco surface, the Frisco Formation, the pre-Sallisaw surface, and the Sallisaw Formation (panel 4; text-fig. 23). This unconformity also truncated the Silurian, allowing the Woodford (Chattanooga) to rest on the Sylvan Shale, the Viola Limestone, or older Ordovician rocks. These relationships make for a complicated Silurian-Devonian relationship, and Silurian strata may be overlain by rocks ranging in age from Early Devonian (Helderbergian, Gedinnian) to Late Devonian; conversely, Devonian strata may rest on Silurian strata of any age or on Ordovician rocks. I believe that the pre-Frisco and pre-Woodford (Chattanooga) unconformities (and probably some of the other erosional surfaces as well) are the result of subaerial erosion. There is widespread evidence that these old erosion surfaces were subjected to much dissolution, an event that is certainly significant in the development of Hunton porosity and permeability. The unconformities are discussed in Amsden (1975b, p. 9, 27, 70, 73, panel 9) and in this report, Chimneyhill Subgroup, Henryhouse Formation, Frisco Formation, Woodford Shale.

Sylvan Shale

The Sylvan Shale was named from exposures near the town of Sylvan, Johnston County, in south-central Oklahoma. In the Arbuckle Mountains-Criner Hills outcrop area the Sylvan consists of a lower, brown to dark-gray fissile shale, commonly with graptolites, overlain by a thinner, greenish-gray calcareous shale (Ham, 1969, p. 11; Jenkins, 1970, p. 263). This twofold division can be recognized in well samples throughout most of eastern Oklahoma and extending into western Arkansas, where the Shell 1 Western Coal and Mining Co. well cored the upper 4 feet of the Sylvan, which consisted of 2 feet of greenish-gray argillaceous dolomite (27 percent $MgCO_3$, 31 percent acid insolubles) underlain by dark-gray dolomitic shale (19 percent $MgCO_3$, 51 percent acid insolubles) (Appendix). The Sylvan Shale is overlain by the Keel Oolite in the eastern Arbuckle Mountain outcrops, extending into the subsurface for some distance, and by the presumably correlative Pettit Oolite in the eastern outcrops and adjacent subsurface areas; elsewhere it is generally overlain by organo-detrital limestones of the Chimneyhill Subgroup (text-fig. 11). Although the upper part of the Sylvan is strongly calcareous, in places grading into an argillaceous dolomite, it is readily distinguished from the overlying Hunton carbonates in surface exposures (Amsden, 1960, pl. 1) and in well samples throughout most of eastern Oklahoma. This contrasts with some parts of western Oklahoma, where it is difficult to distinguish the Sylvan Shale from the Hunton. Jenkins (1971, p. 490) suggested that deposition in the Texas Panhandle was probably continuous from Sylvan into Hunton time, and my own study of the stratigraphic relations in the Anadarko Basin is in accord with this conclusion (Amsden, 1975b, p. 42–143). Even in eastern Oklahoma, where the Sylvan-Hunton contact is well defined, there is no evidence for a disconformity at this boundary, and deposition may well have continued from Late Ordovician into Early Silurian time with only minor interruptions.

In the eastern part of the Arkoma Basin the Sylvan thickness is less than 50 feet. It is about 25 feet near the Arkansas border, thickening from here toward the southwest and attaining a thickness greater than 300 feet in the western part of the Arbuckle Mountains (Ham, 1969, p. 11; panel 1, this report).

The Sylvan Shale is underlain by the Late Ordovician organo-detrital sparites of the Welling ("Fernvale") Formation. Subsurface investigators have generally included these pre-Sylvan limestones in the Viola (sometimes the Fernvale), but in this report I am assigning them to the Welling Formation. The Welling-Sylvan relations are discussed in the next section.

Decker (1935, p. 698) assigned the Sylvan Shale to the Late Ordovician on the basis of graptolites, and Jenkins (1970, p. 284–285) recovered late Ordovician (Ashgillian)-age chitinozoans from this formation. The Sylvan rests on the Late Ordovician Welling ("Fernvale") Formation (Jenkins, 1969, p. 32; Alberstadt, 1973, p. 13) and is in places overlain by the Keel Formation of Late Ordovician (Hirnantian) age (Amsden, 1974, p. 26–29). The Ordovician-Silurian boundary, at the Keel-Cochrane contact in the Arbuckle Mountains, in places transgresses the shale-carbonate contact and extends down into the shale sequence (see Ordovician-Silurian Boundary).

Welling Formation (="Fernvale" Limestone)

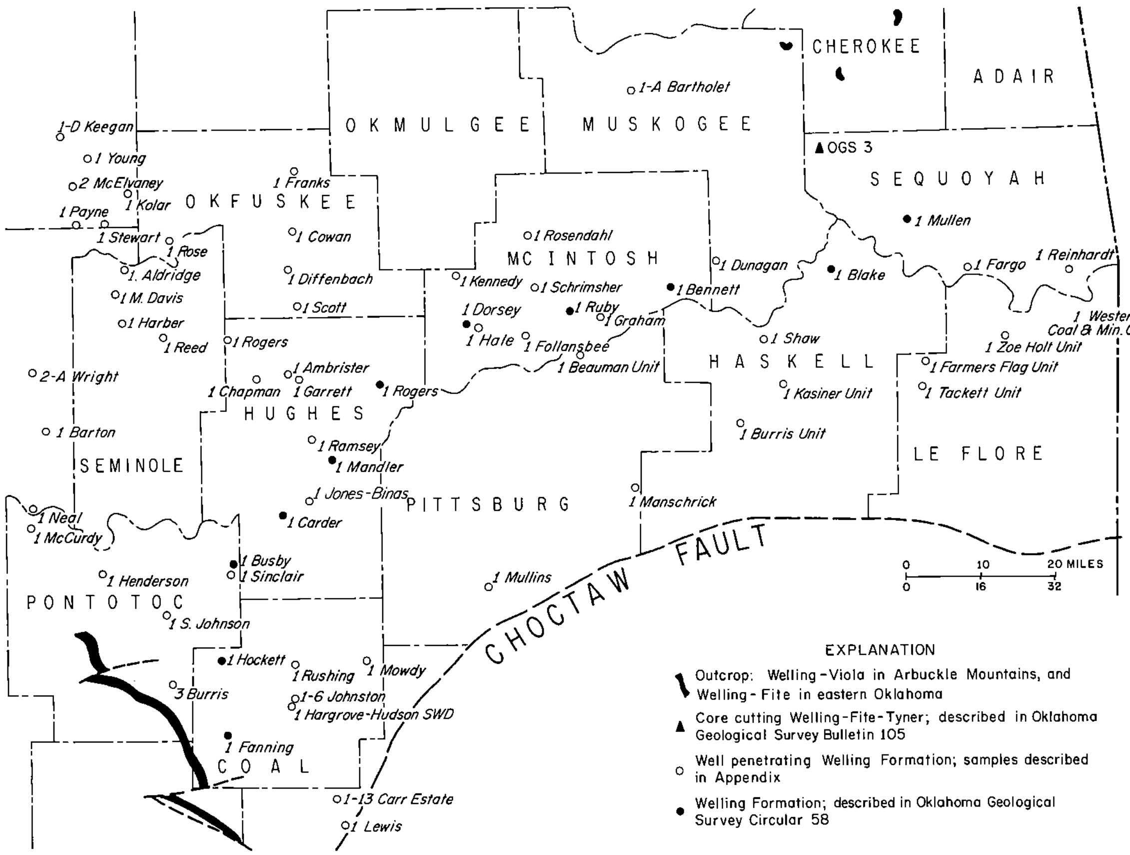
The Sylvan Shale rests on the Welling Formation throughout the area covered in this report. These strata comprise a distinctive sequence of organo-detrital limestones, mainly sparites, that can be readily recognized from the eastern Arbuckle Mountains to the outcrops in eastern Oklahoma and into western Arkansas. This is the formation that has been commonly called the Fernvale, a formation originally based on exposures in central Tennessee. The name Fernvale has been applied widely in the central United States. However, later studies have shown that over much of this region, including Oklahoma, these strata are older than those of the type area, and the name is now commonly placed in quotation marks as "Fernvale." In Oklahoma some stratigraphers include the "Fernvale" in the Viola Limestone, whereas others treat the Viola and "Fernvale" as distinct formations. Glaser (1965) and Alberstadt (1973, p. 3–6), in a recent detailed study of these strata in the Arbuckle Mountains, proposed to abandon the name "Fernvale" and to include these strata in the Viola Limestone as stratigraphic "unit 3." In 1979 I proposed to replace the name "Fernvale" in eastern Oklahoma with Welling Formation (Amsden, 1979). The type locality is on the Illinois River near the town of Welling, Cherokee County, where the formation comprises a distinctive sequence of organo-detrital limestones that are easily distinguished from the overlying Sylvan Shale and the underlying dense, pellet-type limestones of the Fite Limestone. Frezon (1962), in an excellent subsurface study of Paleozoic strata in the Arkoma Basin, traced the "Fernvale" (=Welling) from the Arbuckle Mountains eastward across Oklahoma into western Arkansas. My own investigation of Late Ordovician strata in the Arkoma Basin, based primarily on samples studied by means of thin sections, fully confirms Frezon's findings (text-fig. 4). Throughout this region the Sylvan Shale is underlain by the Welling Formation, which probably does not exceed 50 feet in thickness.

This report includes some discussion of pre-Hunton rocks in the Anadarko Basin. In this western region the Welling Formation is not readily distinguishable from the underlying Viola Limestone, and I have used the term Viola Group for all the strata between the Simpson Group and the Sylvan Shale. The upper part of the Viola Group probably includes the biostratigraphic correlatives of the Welling Formation.

Woodford (Chattanooga) Shale and Misener (Sylamore) Sandstone

The Woodford Shale (originally Woodford Chert) was named from exposures near the town of Woodford, Carter County, in the western Arbuckle Mountains. This name has been widely used by subsurface stratigraphers for the dark shales, containing chert in places, overlying Hunton strata in the area centering around the Arbuckle Mountains and extending westward throughout the Anadarko Basin (Amsden, 1975b, p. 9–11, panels 3, 4). The Chattanooga Shale was named from exposures near Chattanooga, Tennessee, and this name has been subsequently applied to a sequence of Devonian-Mississippian dark shales over a large area in the central and eastern part of the United States. In Oklahoma the term Chattanooga has been used for similar dark shales exposed in the northeastern part of the State, and also in the subsurface over much of eastern Oklahoma, extending into Arkansas. The Woodford (Chattanooga) dark shales bear conodont faunas of Late Devonian to Early Mississippian age.

The Sylamore Sandstone was named for exposures on Sylamore Creek in north central Arkansas, and this name has been used for the sandstone in eastern Oklahoma that overlies Hunton and older strata and which grades upward into the black shales of the Chattanooga. The Sylamore Sandstone has commonly been treated as the basal member of the Chattanooga Shale (Huffman, 1958, p. 38; Huffman and Starke, 1960; Amsden, 1961, p. 60). The name Misener was first applied to a sandstone in the subsurface of Creek County that occupies the same stratigraphic position as the Sylamore Sandstone and with which it is correlative (Amsden and Klapper, 1972, p. 2323–2324). It is the basal sand lithofacies of the Woodford black



Text-figure 4. Map showing location of some wells penetrating Welling Formation. Samples from these wells are described in Appendix and in Frezon (1962); Oklahoma Geological Survey core 3 is described in Amsden and Rowland (1965).

shale and extends over a large area in the central and western part of the State (Amsden, 1975b, panel 11); it extends into the eastern areas, where it is called the Sylamore Sandstone. These sands are generally thin, mostly less than 20 feet, and although widely scattered over the State their distribution is erratic and they are absent in many areas (Amsden and Klapper, 1972, fig. 2; Amsden, 1975b, panel 11). They are mostly of Late Devonian age but locally are as old as late Middle Devonian.

All available lithostratigraphic and biostratigraphic evidence indicates that the Woodford Shale, including the Misener Sandstone, and the Chattanooga Shale, including the Sylamore Sandstone, are essentially correlative, although the lower boundary is known to be diachronous (Freeman and Schumacher, 1969; Amsden and Klapper, 1972, p. 2330–2331). For convenience I am using the following terminology: Woodford (Chattanooga) Shale, except for the surface exposures in eastern Oklahoma, where, following long-accepted practice, Chattanooga Shale will be employed; and Misener Sandstone throughout the subsurface, using Sylamore Sandstone only in the eastern outcrop area. The Misener Sandstone and Sylamore Sandstone are basal facies of the overlying black shales with which they are intimately related, and logically these sands should be treated as a basal member of the Woodford (Chattanooga) Shale. This relationship could perhaps be expressed by recognizing a Woodford Formation divisible into an upper Woodford Shale Member and a lower Misener Sandstone Member. (The Chattanooga and Sylamore could be similarly categorized.) However, in the interest of brevity I am omitting the member designation from the Woodford Shale and the Misener Sandstone. (In 1960 Huffman and Starke proposed to recognize a Chattanooga

Formation, divided into a Sylamore Sandstone Member and a Noel Black Shale Member, the latter imported from Missouri, but the long continued usage of Chattanooga Shale and Sylamore Sandstone virtually precludes the successful introduction of a new name, even were such terminology considered useful.) The reader should be alerted to the fact that the Woodford isopach map (panel 4, in pocket) includes the Misener Sandstone, and thus the Woodford Shale here equals the Woodford Formation in the aforementioned terminology. Where present the Misener is generally very thin, and its contribution to the total thickness of the Woodford Shale is minimal.

Misener (Sylamore) Sandstone.—The Misener Sandstone (including the Sylamore Sandstone) is fairly well developed in a broad belt extending from east to west across the northern part of the area under study (from T. 8 N. northward). It is thin, mostly well under 20 feet, and absent at a number of places, but many of the wells studied in this belt do show at least some Misener (Appendix). The Misener (Sylamore) Sandstone is underlain by the Sallisaw Formation in the Marble City outcrop area, and this relationship continues south into the subsurface. There is some difficulty in distinguishing the Misener from the Sallisaw on the basis of well samples, and in places the two formations have probably been confused (see discussion under Sallisaw Formation). The Misener and Sallisaw are largely absent south of T. 8 N., and throughout the Arbuckle Mountains-Criner Hills outcrops the Woodford Shale incorporates at most only a few inches of basal clastic material. South of the outcrop area, in Marshall County, the Misener Sandstone is again present and in places attains thicknesses of 50 feet or more (Amsden and Klapper, 1972, p. 2332–2334).

The Misener Sandstone in the northern belt is composed mostly of well-rounded quartz grains, commonly with prominent crystal overgrowths, cemented with varying amounts of dolomite (Amsden and Klapper, 1972, p. 2324–2326, fig. 4a–4d). In the eastern exposures the Sylamore Sandstone incorporates conglomeratic material including some fairly large chert blocks, all of which were locally derived (Amsden, 1961, p. 61–68). In fact, the quartz detritus throughout this northern area appears to be a secondary sand derived in part from Simpson sands exposed by pre-Woodford erosion (Amsden and Klapper, 1972, p. 2331–2332). The Marshall County Misener is a different type of sandstone, being composed of a fine, angular quartz detritus with substantial mica, glauconite, and chert. These clastics are believed to represent a primary sand derived from a southern Ouachita source (Amsden and Klapper, 1972, p. 2333; Amsden, 1975b, p. 11).

The Misener Sandstone in the northern belt includes some linguloid brachiopods and numerous conodonts, the latter indicating an age ranging from late Middle into Late Devonian (Amsden and Klapper, 1972, p. 2326–2330).

Woodford (Chattanooga) Shale.—The Woodford (Chattanooga) Shale covers a large part of Oklahoma, burying the older strata under a blanket of dark shale ranging from a feather edge up to thicknesses greater than 700 feet (Amsden, 1975b, panel 4; this report, panel 3). In the area under study the Woodford (Chattanooga) thickens to the south and west from less than 25 feet along the northern margin to more than 250 feet in the Arkoma Basin and more than 500 feet in the eastern Arbuckle Mountains. This regional thickening appears to be related to the sedimentary pattern associated with the development of a sedimentary basin. In addition, there are local variations in thickness, some of which appear to be related to variations in the thickness of the underlying Hunton rocks, with the shale (and basal sand) filling depressions on the old pre-Woodford surface. In the eastern outcrops the Chattanooga (Woodford) is a dark, fissile shale, and this lithofacies extends westward into Lincoln and Pottawatomie Counties and southward into the northern Arbuckle Mountains in Pontotoc County. However, in the central and western part of the Arbuckle Mountains thin beds of blocky chert (novaculite?) are fairly common. Such beds can be observed in the Woodford exposures on the I-35 interchange leading to Prices Falls; Taff (1902), in his original description of this formation, based on exposures near Woodford, Carter County, described the Woodford as consisting of fissile black shale and thin-bedded chert. The precise nature of these changes requires further study, but undoubtedly they reflect the gradation toward the chert lithofacies present in the Ouachita Mountain province, as seen in the Arkansas Novaculite with which it is certainly at least in part correlative (Amsden and others, 1967, p. 917, 926).

The Woodford (Chattanooga) is separated from the underlying strata by an erosional unconformity, during which time period the older rocks were uplifted and exposed to subaerial erosion (text-fig. 23). Dissolution of the pre-Woodford surface produced a network of relatively deep crevices and even small caverns (Amsden, 1961, p. 63–65) as well as a well-developed surface-drainage system (text-fig. 26). The Woodford Shale contains numerous conodonts and spores along with some fish, crustaceans, and fairly large tree trunks. The latter presumably were washed in from some land area, or they may have been derived from the old land surface over which the Woodford (Chattanooga) was deposited (see Middle Paleozoic History of Arkoma and Anadarko Basins).

Conodonts from the Woodford (Chattanooga) indicate an age range from early Late Devonian (Frasnian) into Early Mississippian (Kinderhookian) time (Hass and Huddle, 1965, p. D128–129; Amsden and others, 1967, p. 926).

Acknowledgments

In 1965 Tom L. Rowland, then of the Oklahoma Geological Survey, and I collaborated in an investigation of Silurian strata in eastern Oklahoma, and since then we have conferred on various problems concerned with the present study. H. W. Peace II, Union Oil Co. of California, Norton R. Perry, Global Gas Corp., and Edward D. Pittman, Amoco Production Co., reviewed the maps, and Gary W. Hart and Edward D. Pittman reviewed the manuscript. These reviewers offered a number of suggestions and emendations that have been incorporated into this report. Professor Gilbert Klapper and Dr. James Barrick, The University of Iowa, processed, identified, and discussed the age of a number of conodont samples used in this investigation. Orville A. Wise, Arkansas Geological Commission, furnished information on the Bonanza Gas Field and lent well samples from this field. Hubert Collins, Shell Oil Co., lent me the Shell 1 Western Coal & Mining Co. core from Shell's Midland Office. David G. Campbell, Tenneco Oil Co., provided information on the Tenneco 1-5 Biller core described in the Appendix.

LATE ORDOVICIAN-SILURIAN STRATIGRAPHY

The most complete surface exposures of Late Ordovician to Silurian carbonate rocks are in the Arbuckle Mountains-Criner Hills region, where the strata range in age from the Late Ordovician (Ashgillian-Hirnantian) through the Late Silurian (Ludlovian and probably into the Pridolian) (text-fig. 2). This sequence comprises two major rock units, a lower Chimneyhill Subgroup, composed mainly of grain-supported organo-detrital limestones, and an upper Henryhouse Formation, composed almost entirely of fossiliferous mud-supported marlstones averaging about 20 percent terrigenous detritus (text-fig. 2). The maximum measured thickness for the Chimneyhill-Henryhouse beds in the Arbuckle Mountains-Criner Hills is 309 feet (Amsden, 1960, p. 25), and the total combined maximum thickness of each of the stratigraphic units assigned to these divisions is approximately 364 feet (Amsden, 1975b, p. 8). Strata of Late Ordovician-Silurian age are also present in the eastern Oklahoma outcrop area, although here the Henryhouse correlatives are absent, the Chimneyhill strata being directly overlain by the Lower Devonian Frisco Formation (text-fig. 2).

Strata of this age are widely distributed in the subsurface of Oklahoma, being well represented in the Anadarko Basin (Amsden, 1975b) and in the Arkoma Basin as discussed in the present report. In thickness they range from a feather edge near the northern truncated margin of Hunton rocks to possibly as much as 700 or 800 feet in the deep part of the Anadarko Basin. They are almost exclusively fossiliferous carbonates, varying widely in their texture and composition.

Chimneyhill Subgroup

The Chimneyhill comprises a sequence of Late Ordovician to early Late Silurian (Late Ashgillian, Llandoverian, and Wenlockian) limestones whose type locality is on the South Fork of Jackfork Creek (formerly Chimneyhill Creek) at the northeastern end of the Arbuckle Mountains region (Amsden, 1960, p. 27–30; Amsden, 1967). Three formations are included, a basal Keel Formation, a middle Cochrane Formation, and an upper Clarita Formation. These formations are mappable units that maintain their lithologic identity throughout almost all of the Arbuckle Mountains and Criner Hills. Collectively, Chimneyhill strata in the outcrop area comprise a sequence of oolites and organo-detrital limestones that are readily distinguished from the underlying Sylvan Shale and the overlying marlstones of the Henryhouse Formation, or, where that formation has been removed by pre-Devonian erosion, from the Haragan or Bois d'Arc Formation (see discussion of Chimneyhill, Arbuckle Mountains-Criner Hills). Correlative strata are represented in the eastern Oklahoma outcrops, and in the present report I propose to include the Quarry Mountain, Tenkiller, Blackgum, and Pettit Formations in the Chimneyhill Subgroup (see discussion of Chimneyhill, Eastern Outcrops).

Chimneyhill strata have been widely identified in the subsurface, the name generally being used for "lower" Hunton beds, commonly having a "pink-crinoidal," glauconitic, or oolitic character. In those areas lying just north of the Arbuckle Mountains (panel 4, this report) and extending westward into the deep part of the Anadarko Basin (Amsden, 1975b, p. 17, panels 9, 10), lower Hunton strata are composed of organo-detrital limestones, commonly with a basal oolite, which overlie the Sylvan Shale and underlie the Hunton marlstones. These are similar in general lithologic character and lithostratigraphic position to the Chimneyhill strata in the type region, with which they are almost certainly at least in part correlative (see discussion, Chimneyhill, Subsurface). However, throughout much of the Oklahoma subsurface the middle marlstone beds of the Hunton Group (Henryhouse, Haragan, Bois d'Arc-Cravatt Formations) disappear, either by facies changes (Amsden, 1975b, p. 38–42, panels 1, 2, 10) or through removal by subsequent erosion (see Henryhouse Formation, panels 2, 4, this report), and the Chimneyhill beds are overlain by organo-detrital limestones of Late Silurian (*Kirkidium* biofacies) or Early Devonian (Frisco Formation) age, causing the subgroup to lose its lithologic identity. In these areas the Chimneyhill can be identified with certainty only by means of fossil evidence, and where such biostratigraphic evidence is absent the use of the term Chimneyhill for a poorly defined set of "lower" Hunton beds is of questionable value. In this report I have tried to restrict the name to those strata for which there is some reasonable lithostratigraphic and (or) biostratigraphic evidence tying them to correlative beds in the type area (see Chimneyhill, Subsurface).

In the Arbuckle Mountain-Criner Hills outcrop area the Chimneyhill Subgroup has a maximum thickness of 75 feet, with a maximum combined thickness for each its three formations of about 100 feet. Excluding the Chimneyhill feather edge near the Hunton zero isopach, this is one of the thinnest sections known. Chimneyhill strata are about 200 feet thick at the outcrop area in eastern Oklahoma (panel 4) and have an estimated thickness of approximately 200 feet along the structurally deepest part of the Anadarko Basin (Amsden, 1975b, panel 10, stratigraphic section *C–C'*). Brachiopods indicating a Blackgum-Cochrane age (*Microcardinalia protriplesiana* Amsden) were recovered from a core 180 feet above the Sylvan Shale in the Phillips 1-D Franklin, Gray County, Texas (Amsden, 1975b, p. 20, 86). Biostratigraphic and lithostratigraphic data from the Midwest 1 Hughes Unit in Major County (Amsden, 1975b, p. 91, panel 10, section *A–A'*) indicate a thickness of about 170 feet for the Chimneyhill Subgroup.

CHIMNEYHILL, ARBUCKLE MOUNTAINS AND CRINER HILLS

Chimneyhill strata in this region are divided into three formations (in ascending order): Keel Formation, Cochrane Formation, and Clarita Formation (text-fig. 2). These are discrete lithostratigraphic and biostratigraphic units that are at least locally separated from one another and from the overlying beds by unconformities. Thus one or more of these formations can be absent, a deletion which I have interpreted as the result of uplift and erosion (Amsden, 1960, p. 27–65; Amsden, 1962a, p. 1504–1505; Amsden, 1963b, p. 631–635). I believe that a better understanding of Chimneyhill correlation in both the surface and subsurface can be obtained by considering each of the formations separately.

Keel Formation

The type locality for the Keel Formation is the Lawrence quarry, Ideal Cement Co., near the northeastern end of the Arbuckle Mountains. The formation does not exceed 15 feet in thickness and is irregular, being present along the eastern margin of the Arbuckles, generally absent in the central part, and again present in the western area and extending south into the Criner Hills (Amsden, 1960, p. 34, fig. 12). Within the outcrop area there does not appear to be any relationship between the distribution of this formation and the Sylvan Shale thickness, as the Keel is present in the eastern region where the Sylvan is generally a hundred feet or less in thickness and extends into areas where the Sylvan is 300 feet or more in thickness (Amsden, 1975b, panel 8; see also this report, Chimneyhill, Subsurface). The Keel is almost everywhere a low-magnesium oolite, which is also low in HCl-insoluble detritus. Many of the oolites are nearly spherical, and most have well-developed radial and concentric internal structure (Amsden, 1960, pl. 10, figs. 4–6). The oolites are mostly less than 2 mm in diameter, but the size is variable and the bedding may be defined by different-size ooids. Most if not all have an organic nucleus, and in places, especially in the lower part, the Keel grades into an organo-detrital limestone in which the fossils are only lightly coated (oncolite; Ideal Quarry Member; Amsden, 1960, pl. 10, figs. 1–3). The matrix is either spar or micrite, and in places sparites and micrites are intimately interbedded. Some irregular bedding and subdued cross bedding is present. The Keel Formation maintains a rather uniform lithologic character throughout most of its outcrop area; however, in a small area in the eastern part of the Arbuckles, a nonoolitic calcilutite is intercalated (Amsden, 1957, p. 13). It should be noted that oolites are not confined to the basal beds of the Hunton Group. They are known to be present in the Late Silurian *Kirkidium* biofacies in central Oklahoma (Amsden, 1975b, p. 29–30, panel 11) and in the Early Devonian Frisco Formation (Amsden, 1975b, p. 69–70, pl. 2, fig. 6).

The Keel Formation rests on the Sylvan Shale throughout the Arbuckle Mountains and the Criner Hills (Ham and others, 1954). This boundary is well exposed in the Lawrence quarry (Amsden, 1960, pl. 11, figs. 1, 2), where it is a sharply defined contact between a low-insoluble oolite and a calcareous shale. Elsewhere in this region it is poorly exposed, because the Sylvan readily weathers into a soil profile (see Chimneyhill, Subsurface).

The Keel Formation is generally overlain by the Cochrane Formation, or, locally where that formation has been removed by post-Cochrane erosion, by the Clarita Formation or the Henryhouse Formation. There is physical evidence for an erosional surface separating the Keel from the Cochrane (Amsden, 1960, p. 43; Amsden, 1963b).

Megafossils are present in some beds, especially the Ideal Quarry facies, although they are commonly difficult to extract from the rock. Ten species of brachiopods have been collected, and this fauna, which is similar to that of the Noix Limestone and the Leemon Formation (Edgewood Group) of eastern Missouri and southwestern Illinois, is assigned a Late Ordovician (late Ashgillian) age (Amsden, 1974, p. 26).

Cochrane Formation

The type locality for the Cochrane Formation is on the South Fork of Jackfork Creek (formerly Chimneyhill Creek) and is a part of the type section for the Chimneyhill Subgroup. This is the most widely distributed formation in the Chimneyhill Subgroup and is absent in only a few local areas (Amsden, 1960, p. 49–50, fig. 15). The Cochrane ranges up to 60 feet in thickness, although it averages about 20 feet or less. It is a light- to medium-gray, low-magnesium, organo-detrital micrite with some sparite. Pelmatozoan plates are the dominant element in the detritus, but brachiopods, trilobites, and other fossils are common in some beds. Chert is a common, although not universal, constituent. The acid-insoluble content is mostly less than 4 percent, of which a considerable part is glauconite. Megascopic grains of glauconite are common, and this rock was called the glauconitic limestone by early investigators (Amsden, 1960, p. 44–48). However, glauconite is not everywhere present, and the Cochrane is best distinguished in the field by its irregular bedding, this character plus the common occurrence of chert being the most reliable means of distinguishing the Cochrane from the overlying Clarita Formation (Amsden, 1960, p. 59–60; Amsden, 1962a, p. 1505, fig. 3). Although glauconite is common in the Cochrane, and in the correlative Blackgum Formation of eastern Oklahoma (Amsden and Rowland, 1965, p. 20), its exclusive use as a means of identifying this unit in the subsurface is at best unreliable and can be misleading. In the first place, glauconite is not confined to the Cochrane, being also present in the Clarita, Bois d'Arc, and Frisco Formations (Amsden, 1960, p. 58, 108, 117, 126, 128, 131). Moreover, there are places in the Arbuckle Mountains, such as the outcrops southwest of Wapanucka, where the Cochrane loses its glauconitic character and grades into a pink crinoidal limestone closely resembling the Clarita Formation (Amsden, 1957, p. 21–22; Amsden, 1960, p. 214–218). There is considerable evidence that a similar merging of these two lithofacies occurs elsewhere in the Arkoma Basin (see Chimneyhill, Eastern Outcrops, Blackgum Formation; Chimneyhill, Subsurface).

The Cochrane is a distinctive, mappable lithostratigraphic unit which is underlain by the Keel Formation or, where that unit is missing, by the Sylvan Shale, and is overlain by the Clarita Formation from which it can usually be distinguished by such features as its irregular bedding, chert, and higher glauconite content. In places the Clarita is absent, and the Cochrane is overlain by the Henryhouse Marlstone; over a substantial area in the southwestern part of the Arbuckle Mountains, the Cochrane is directly overlain by the Early Devonian Bois d'Arc Formation (Amsden, 1962b). From all of these units the Cochrane is usually distinguishable by one or more of the characteristics cited (see also subsequent section on Chimneyhill, Lithostratigraphic Correlations).

Although the Cochrane is a grain-supported organic limestone, it is difficult to extract megafossils from the rock, and only a dozen species have been reported (Amsden, 1960, p. 50). The most distinctive of these is *Triplesia alata* Ulrich and Cooper, and on the basis of this brachiopod I have correlated the Cochrane with the Blackgum Formation of eastern Oklahoma and a limestone lens in the Cason Shale of Arkansas (Amsden, 1971, p. 145). These strata are assigned a late Llandoverian (C1) age (Amsden, 1966, p. 1012–1013). Barrick and Klapper (1976, p. 66) identified the *Pterospathodus celloni* zone in the uppermost Cochrane beds at old Hunton townsite (my stratigraphic section C1) in the eastern Arbuckle Mountains, a zone which they assigned to the late Llandoverian (C5). Klapper also identified this zone in the Tenkiller Formation of eastern Oklahoma (see Chimneyhill, Eastern Outcrops, Tenkiller Formation).

Clarita Formation

The type locality for the Clarita Formation is near old Hunton townsite in Coal County, Oklahoma (stratigraphic section C1, Amsden, 1960, p. 52, 182–188). This formation has a maximum thickness of 45 feet in the outcrop area and in most places is less than 25 feet thick. The Clarita is now divided into two members, a lower Prices Falls Member, whose type locality is at Prices Falls in the central part of the Arbuckles, and an upper Fitzhugh Member, whose type locality is situated at the same place as the Chimneyhill Subgroup (Amsden, 1967, p. 943–945). These are distinctive lithostratigraphic divisions that can be recognized throughout the Arbuckle Mountains and Criner Hills.

The Prices Falls Member is a thin but persistent shaly bed that probably does not exceed 2 or 3 feet in thickness. At the type locality this member is a low-calcium shale (93 percent HCl insolubles), but elsewhere it is more calcareous and probably grades into marlstone at many places.

The overlying Fitzhugh Member makes up most of the Clarita Formation and is a low-magnesium, organo-detrital limestone that is remarkable for its relatively thin, evenly bedded character (Amsden, 1960, pl. 3, figs. 1, 2). No reefs or boundstones have been observed, and these strata represent sheets of organic debris spread out on the sea floor. The fossil preservation is generally excellent—articulated brachiopod shells are common (Amsden, 1968, pls. 14-19)—and I believe the organic material has not moved far and that these are essentially life assemblages. No stromatolites are present, and calcareous algae and corals are rare. Throughout much of the outcrop area of the Fitzhugh, disarticulated pelmatozoans, probably mainly crinoids, make up a large part of the organic debris, and many of these have an orange-pink color. This is the unit that earlier investigators called the "pink crinoidal limestone," and this characteristic has been widely used as the basis for surface and subsurface correlations. It should, however, be emphasized that pelmatozoan plates constitute a large part of most Mid-continent Silurian-Devonian organo-detrital limestones, many of which have a pink color. Pink crinoid plates are not uncommon in the pelmatozoan limestones of the other Hunton Formations, and locally the Cochrane Formation grades into a pink crinoidal facies that is very difficult to distinguish from the Fitzhugh (see Cochrane Formation). Furthermore, the Tenkiller Formation of eastern Oklahoma, which has an abundance of pink crinoid plates and a remarkable resemblance to the Fitzhugh Member, is in large part, perhaps entirely, correlative with the Cochrane Formation (see Chimneyhill, Eastern Outcrops). Also, pink crinoid plates are not uncommon in the Late Silurian *Kirkidium* biofacies and can be observed in the upper part of the Phillips 1-C Lee and elsewhere (Amsden, 1975b, p. 93-94). In brief, I do not believe pink pelmatozoan plates are a reliable marker for the Clarita Formation, or even the Chimneyhill Subgroup.

The Clarita Formation is a distinct lithostratigraphic unit with well-defined upper and lower boundaries. Locally there is some difficulty in separating the Fitzhugh from the Cochrane (see Cochrane Formation), and in many parts of the central Arbuckle Mountains the uppermost Fitzhugh beds grade into argillaceous marlstone (ostracode silty marlstone; see subsequent discussion) and resemble the overlying Henryhouse, but even here a sharp lithologic contact separates the two formations (see also Amsden, 1975b, p. 25, pl. 8, figs. 4a, b).

The Fitzhugh strata carry a brachiopod fauna that is similar to that of the Quarry Mountain Formation (Amsden, 1978, p. 11-13) and to the St. Clair Limestone of Arkansas (Amsden, 1968, p. 16-22), to all of which I assign a Wenlockian age. Recently Barrick and Klapper (1976, p. 65-68) and Barrick (1977, p. 47-49) completed a study of the conodonts from the Clarita Formation. These authors assigned the Prices Falls Member a late Llandoverian age and the Fitzhugh Member a Wenlockian age except for the uppermost beds in the central Arbuckles, which possibly are early Ludlovian. It should be noted that almost all the Fitzhugh brachiopods collected and studied by me are from the crinoid sparites in the northeastern part of the Arbuckles, whereas the diagnostic conodonts collected and studied by Barrick and Klapper are mostly from the arthropod micrites and ostracode silty marlstones in the central and southern part of the Arbuckles.

For some years it has been known that the Fitzhugh Member can be divided into a northeastern sparite lithofacies ("calcarenite" facies of Amsden, 1960, p. 52) and a central and southern micrite lithofacies ("calcilutite" facies of Amsden, 1960, p. 52). Recently I have expanded my knowledge of the Fitzhugh by a study of numerous thin sections, many of which were cut from rock samples that have been chemically analyzed in the laboratory of the Oklahoma Geological Survey. In the course of this investigation I have point-counted approximately 50 thin sections (Amsden, 1975a), the principal goal being to obtain detailed data on the rock matrix, its character and volume, and quantitative data on the distribution and concentration of the major invertebrate fossil groups (e.g., pelmatozoan plates, ostracodes, and brachiopods). This thin-section examination, which represents a reasonably comprehensive stratigraphic and geographic sampling of the Fitzhugh Member, is supplemented by a field study of the rock, aided by cut specimens and parlodion peels. This information is being incorporated into a joint study with Dr. Donald Toomey, Cities Service Co., and Dr. James Barrick, The University of Iowa; the study will include detailed biofacies data based on conodonts and arenaceous foraminifers as well as on the megafauna. A brief summary of this work (exclusive of conodonts and foraminifers) is included here to compare the Clarita facies with that of the equivalent Quarry Mountain beds of eastern Oklahoma.

Three lithofacies-biofacies can be recognized in the Fitzhugh Member: (1) crinoidal sparite, (2) arthropod micrite, and (3) ostracode silty marlstone. Each has distinctive lithologic-biologic characteristics, although they grade into one another and are a part of a continuously varying sequence.

The crinoid sparites are organo-detrital, grain-supported rocks, the organic debris cemented by calcspar, and with insoluble residues averaging less than 1 percent. The acid-insoluble residues in the sparites, as well as in the other Fitzhugh facies, are almost entirely silt- and clay-size terrigenous detritus. The matrix averages about 27 percent of the total rock volume, and the organic debris averages about 73 percent (text-fig. 5). The dominant fossils are disassociated pelmatozoan plates, probably in large part crinoid plates, followed by ostracodes and trilobites. Bryozoans and brachiopods are the only other common constituents, with all others combined making up less than 1 percent of the total rock volume.

The arthropod micrites are also grain-supported rocks, but the cementing material is micrite (lime mud) with very little spar. The micrite averages about 36 percent of the total rock volume, of which approximately 5 percent is insoluble detritus. Trilobites and ostracodes combined average about 14 percent, followed by pelmatozoans (11 percent), mollusks (7 percent), and bryozoans-brachiopods (3 percent) (text-fig. 5).

The ostracode silty marlstone has a mud-supported texture, with the matrix averaging almost 70 percent of the total rock volume of which insoluble detritus makes up approximately 18 percent. Fossils, which are scattered through the matrix like plums in a pudding, make up about 30 percent of the rock volume. Ostracodes completely dominate the megafauna, with trilobites the only other group represented in any appreciable volume (text-fig. 5).

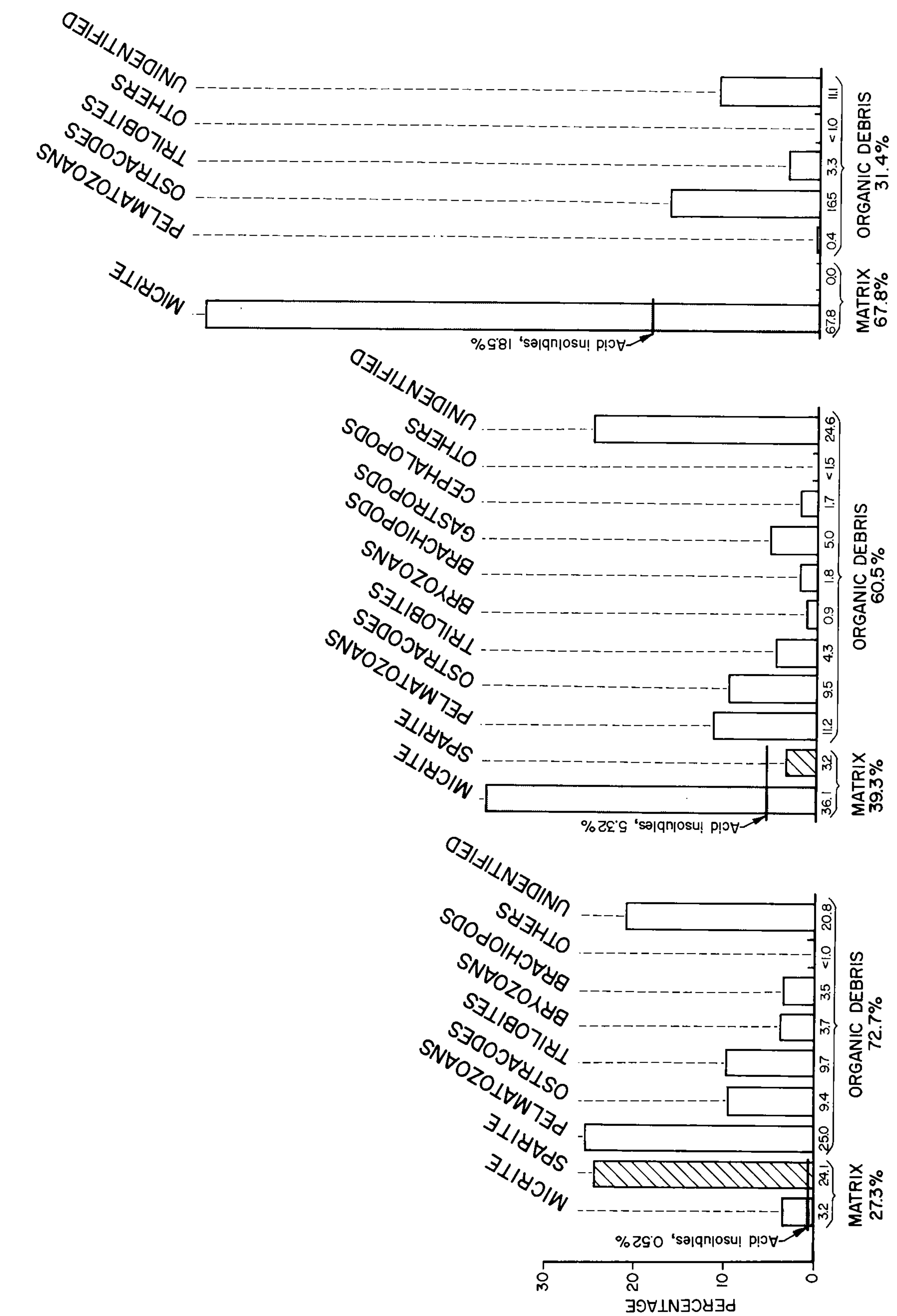
There is some stratigraphic control in the distribution of these facies. Crinoidal sparites overlie the micrites in the northern part of the Arbuckle Mountains (Lawrence Uplift), and the silty ostracode marlstones have their best development in the upper Fitzhugh in the central part of the Arbuckle Mountains. There is, however, good evidence in the Arbuckle Mountain-Criner Hills outcrop area for both lateral and vertical intergradation of these three facies.

The crinoid sparites are almost exclusively confined to the northeastern part of the Arbuckle Mountains, to Pontotoc County and the northeastern tip of Johnston County (text-fig. 6). South and west of here Fitzhugh strata are represented by arthropod micrites and silty marlstones, the latter predominantly developed in the upper Fitzhugh in the central part of the Arbuckle Mountains.

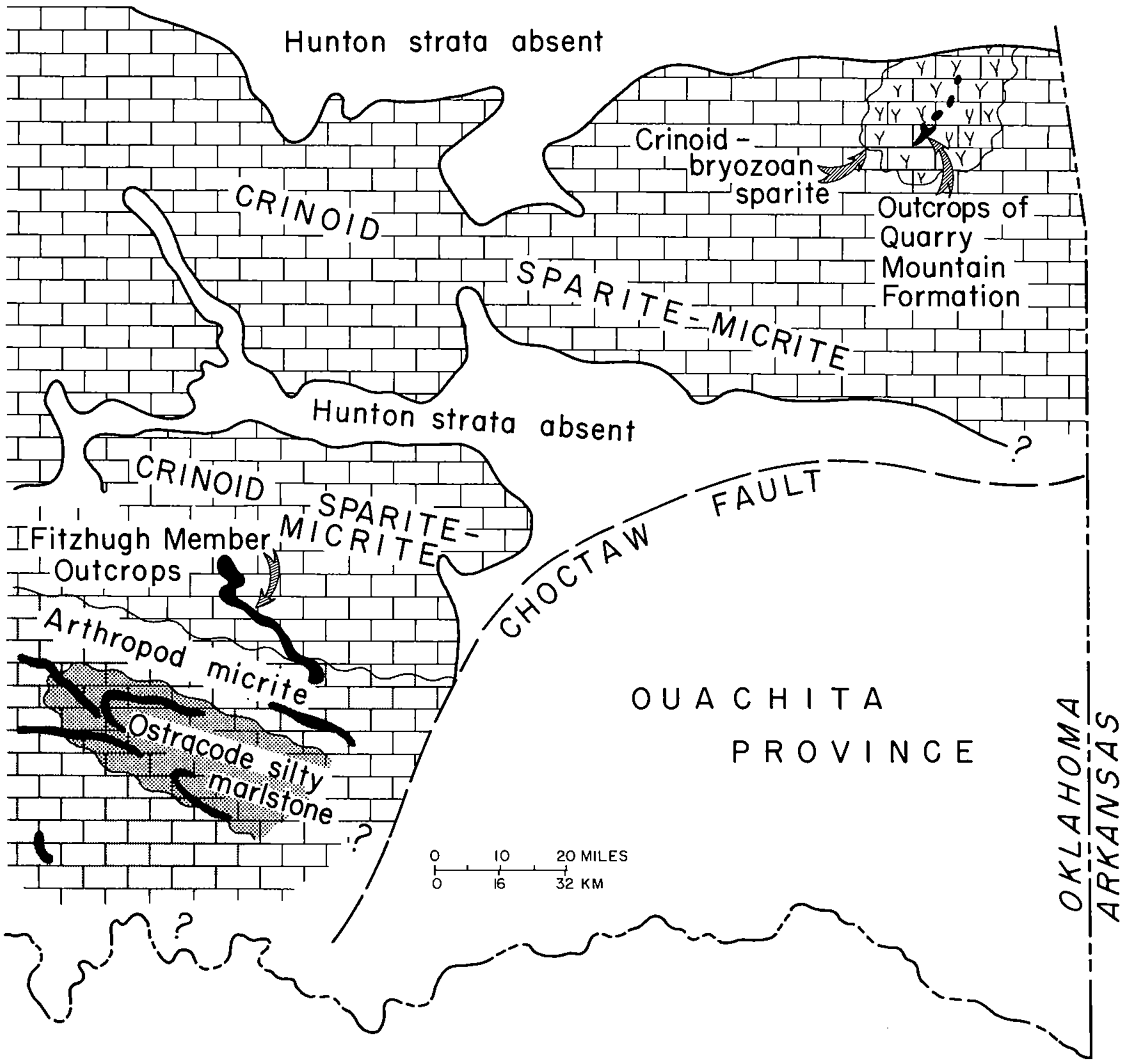
In the eastern Oklahoma outcrop area the correlative Quarry Mountain strata are represented almost exclusively by biosparites, although the biofacies is quite different. In this area pelmatozoans and bryozoans dominate the sessile and vagrant benthos, which comprises a large crinoid-bryozoan community. Brachiopods, trilobites, ostracodes, and other organisms were dispersed through this thicket, in places being moderately abundant. The energy level must have been very low, and the water exceptionally clear, with extra basinal detritus at an absolute minimum.

There is some difficulty in interpreting the facies pattern in the subsurface area between the two outcrop areas, partly because information must be obtained largely from well samples and partly because the texture in many places is obscured by dolomitization. However, present information suggests that these strata are biosparites interbedded with, and in places replaced by, biomicrites (text-fig. 6).

The crinoidal sparites appear to represent a broad offshore carbonate platform with clear water and a firm substrate composed of organic debris. The energy level was relatively low, with only sufficient agitation to move the organic material moderately before burial. In the micrite facies lying to the south the spar was replaced by lime mud, and terrigenous detritus, almost exclusively in the silt-clay fraction, increased abruptly. The lithofacies changes were accompanied by changes in the faunas, the most significant being a reduction in crinoids relative to the arthropods and a replacement of much of the brachiopod fauna by mollusks (text-fig. 5). These changes almost certainly represent a decrease in energy level, probably associated with some increase in water depth. However, the most signifi-



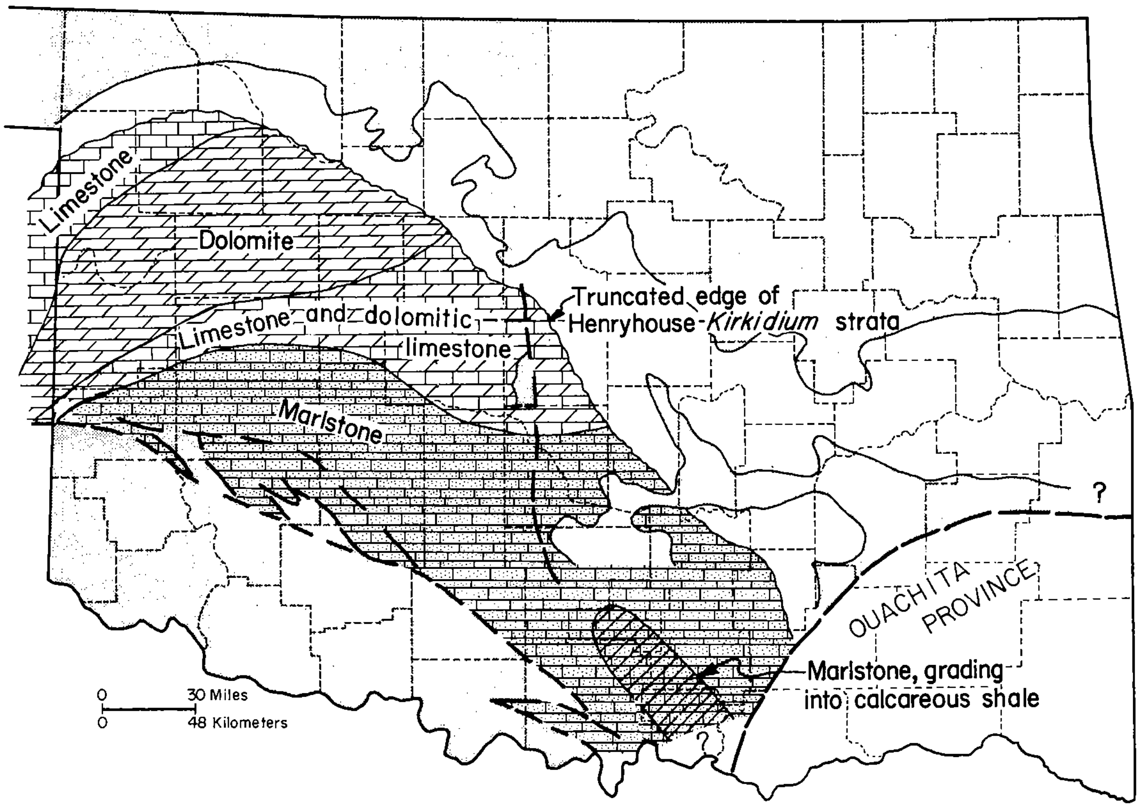
Text-figure 5. Bar graphs showing distribution of matrix components and major megafaunal fossil groups in lithofacies-biofacies units of Fitzhugh Member, Clarita Formation, Arbuckle Mountains-Criner Hills. Based on point counts of thin sections (Amsden, 1978, p. 7).



Text-figure 6. Map showing lithofacies-biofacies pattern in strata of early Late Silurian (Wenlockian) age, eastern Oklahoma. These beds include Fitzhugh Member, Clarita Formation, of Arbuckle Mountains-Criner Hills and Quarry Mountain Formation (mainly Marble City Member) of eastern Oklahoma. Dolomitization not shown.

cant change affecting the biofacies was the development of a muddy substrate, probably accompanied by some turbidity. In the calcareous mudstones the benthos was almost eliminated, and ostracodes (and conodonts) are almost the only faunal element remaining (Amsden, 1976).

The facies pattern shown by the Fitzhugh is similar to that present in the Henryhouse Formation, which also has a strong concentration of terrigenous detritus, including graptolitic shales, in the central and south-central parts of the Arbuckle Mountains (Amsden, 1975b, panel 11; text-fig. 7, this report). This suggests that with the start of Fitzhugh deposition, terrigenous clastics began to be introduced into the Arbuckle region, increasing in intensity toward the close of Wenlockian time. The flood of clastics continued during Henryhouse deposition, extending from the Arbuckle Mountains westward along the present southern margin of the Anadarko Basin. To the north, clastics decrease, and the marlstones grade into the organo-detrital limestones and dolomites of the *Kirkidium* biofacies. Marlstone



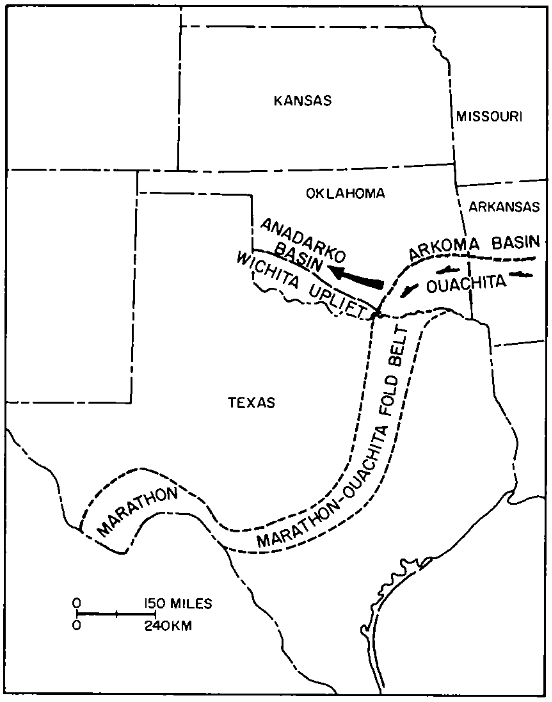
Text-figure 7. Map showing distribution of major lithofacies in Henryhouse Formation and correlative *Kirkidium* biofacies. Modified from Amsden (1975b, panel 11).

deposition continued in the Lower Devonian Haragan–Bois d'Arc Formations, decreasing in intensity toward the close of Helderbergian time and terminating with the period of uplift preceding deposition of the Frisco Formation (see Haragan and Bois d'Arc Formations, Distribution of Helderbergian Strata in Midcontinent). Frisco deposition, which covered much of Oklahoma, took place in a shallow-water carbonate platform that was largely cut off from most extra basinal detritus.

The Arbuckle Mountains–Criner Hills appear to be situated at or near a bend in the Marathon-Ouachita fold belt (text-fig. 8). Paleocurrent indicators in the Jackfork-Johns Valley-Atoka sequence show that sediment transport in the Ouachita clastic province was westward along the axis of the basin (Briggs and Cline, 1967, p. 985, 992–998; Briggs, 1974, p. 274–279), and an extension of these current directions into the southern part of the Anadarko Basin will explain the distribution of the clastic halo in Silurian carbonates in the Arbuckle Mountains-Anadarko Basin (text-figs. 6, 7).

CHIMNEYHILL, EASTERN OUTCROPS

Hunton strata crop out in scattered exposures in Adair, Cherokee, and Sequoyah Counties (Amsden and Rowland, 1965, pl. B; panel 2, this report), where they comprise about 200 feet (maximum) of carbonate rocks lying between the Sylvan Shale and the Chattanooga (Woodford) Shale. Early stratigraphers referred these strata to the St. Clair Limestone, a name first applied to a limestone formation in north-central Arkansas. A few years later the Early Devonian strata were removed from the St. Clair, and in 1965 Amsden and Rowland (p. 12–19)



Test-figure 8. Map showing general trend of Ouachita-Marathon fold belt. Heavy arrow indicates inferred major source of terrigenous clastics in Silurian strata. Small arrows in Ouachita province show paleocurrent direction of late Paleozoic strata.

proposed to abandon the term St. Clair Limestone in Oklahoma, replacing it with three new formations: Quarry Mountain, Tenkiller, and Blackgum (text-fig. 2). As thus defined, Hunton strata in eastern Oklahoma include the Lower Devonian Sallisaw and Frisco Formations and the Silurian Quarry Mountain Formation (with the Marble City and Barber Members), Tenkiller Formation, and Blackgum Formation. In the 1965 report the Pettit Oolite was provisionally included as a member of the Blackgum Formation, but it is here assigned formation status and tentatively correlated with the Upper Ordovician Keel Formation.

In 1965 the Blackgum Formation was correlated with the Cochrane Formation, and the Tenkiller and Quarry Mountain Formations were provisionally correlated with the Clarita and Henryhouse Formations, respectively. In the present report the Blackgum is still regarded as correlative with the late Llandoverian Cochrane Formation, but the Tenkiller is here considered to be in large part, if not entirely, also late Llandoverian in age, and the Quarry Mountain (Marble City Member and upper Barber Member) is assigned a Wenlockian age and correlated with the Fitzhugh Member of the Clarita Formation (Amsden, 1978, p. 11, 13; Amsden and Rowland, 1965, p. 16, 30–31, 41, 47, 52; see also following discussion). According to this interpretation, the Silurian rocks of eastern Oklahoma closely approximate the age of those formations in the Arbuckle Mountains-Criner Hills that constitute the Chimneyhill Subgroup, and it is proposed to extend that subgroup into eastern Oklahoma.

From the foregoing discussion it can be seen that no Late Silurian Henryhouse equivalents (or Early Devonian Haragan-Bois d'Arc strata) are present in the eastern Oklahoma outcrops, and the middle Early Devonian Frisco Formation and late Early Devonian Sallisaw Formation rest directly on the Chimneyhill Subgroup, a relationship which is thought to hold true throughout almost all of the Arkoma Basin (panel 4; text-figs. 7, 16, 17). The evidence for this interpretation is given in the discussion for each of the Chimneyhill formations that follows, and in the sections on the Chimneyhill, Subsurface and Early Devonian Stratigraphy (see also Amsden, 1961, and Amsden and Ventress, 1963).

Pettit Formation

The Pettit is an oolite that was originally described as a member of the Blackgum Formation and which is here assigned formation status. It has a maximum thickness of about 2 feet in the outcrop area, ranging down to a feather edge and being absent in many places. It is composed largely of oolites set in a spar matrix; the oolites have a diameter of less than 2 mm, and many have a pelmatozoan plate as a nucleus. Partial or complete silicification of the Pettit is common (Amsden and Rowland, 1965, p. 22–24).

The Pettit is underlain by the Sylvan Shale and overlain by the Blackgum Formation. There is physical evidence for an erosional unconformity between the Pettit and the Blackgum; the latter truncates the Pettit and includes eroded fragments of oolite in its basal beds (Amsden and Rowland, 1965, p. 24-26).

The Pettit includes substantial organic debris, but no diagnostic fossils have been recovered. On the basis of its lithologic character, stratigraphic relations, and position it is tentatively correlated with the Keel Formation and considered to be a part of the Late Ordovician-Early Silurian oolitic zone that is so widely distributed in the central United States (see discussion of Chimneyhill, Subsurface).

Blackgum Formation

The Blackgum Formation is a dark-gray to tan, organo-detrital, glauconitic, dolomitic limestone with nodules and lenses of chert that are especially abundant in the lower part. Dolomite is common, being concentrated in the lower 5 feet, where it makes a stratigraphic unit that has been informally designated the tan dolomite member. The acid-insoluble residues range from 2 to 12 percent and are in large part composed of glauconite. Most of the glauconite is in the form of irregular to polylobate grains, with some occurring as internal molds, or steinkerns, of fossils. The Blackgum is a grain-supported rock, with pelmatozoan plates making up much of the organic debris; at some localities brachiopods, bryozoans, trilobites, ostracodes, and other forms are present. The cementing material is principally micrite, with only minor spar (Amsden and Rowland, 1965, p. 27-31).

The Blackgum Formation in the outcrop area ranges up to 15 feet in thickness. It rests unconformably on the Pettit or, where that formation has been removed by pre-Cochrane erosion, on the Sylvan Shale. It is overlain by the Tenkiller Formation from which it is separated by a sharp, well-defined lithologic change (see Tenkiller Formation). The relationship of these two formations cannot be satisfactorily determined on the basis of the restricted exposures in the outcrop area (Amsden and Rowland, 1965, pl. B). There is no lithologic evidence for a gradation between the Blackgum and Tenkiller Formations, and the upper part of the latter yields a conodont fauna that is slightly younger than the Blackgum brachiopod fauna (see the following); but it is possible that deposition was essentially continuous through this part of the section (see discussion, Tenkiller Formation).

The upper 10 feet of the Blackgum Formation yields reasonably well-preserved specimens of *Triplesia alata* Ulrich and Cooper and *Microcardinalia protriplesiana* Amsden. On the basis of *M. protriplesiana* I assign the Blackgum an Early Silurian (late Llandoverian C1-2) age, and on the basis of *T. alata* I correlate this formation with the Cochrane Formation of the Arbuckle Mountains-Criner Hills and a part of the Cason Shale of Arkansas (Amsden, 1966, p. 1010-1011, pl. 115, figs, 1-12; Amsden, 1971, p. 144-145, pl. 1). It should be noted, however, that the range of *T. alata* has not been precisely determined, and the Cochrane-Cason strata could be slightly older or slightly younger than the Blackgum.

The Blackgum and Cochrane Formations are the surface exposures of an Early Silurian (late Llandoverian) zone that is commonly glauconitic and which appears to be fairly widely distributed throughout the State. However, as noted elsewhere, correlations based exclusively on the presence of glauconite should be used with much caution because of the known vagaries in the distribution of this mineral (see discussion of Cochrane Formation in following section on Chimneyhill, Subsurface).

Tenkiller Formation

The Tenkiller is a gray to pinkish-gray, generally low-magnesium, organo-detrital limestone with well-defined, even beds ranging up to 6 inches or so in thickness (Amsden and Rowland, 1965, p. 32-41; pls. 7-11). The pinkish color is caused by the presence of many orange-pink pelmatozoan plates, which produce the typical "pink-crinoidal" lithology. The Tenkiller has a grain-supported texture, with pelmatozoan plates making up the bulk of the fossil debris, although many other organisms, such as brachiopods, trilobites, and ostracodes, are represented. The cementing material includes both spar and micrite, and, in fact, the two are commonly interbedded, sometimes with well-marked cross-bedding (Amsden and Rowland, 1965, pl. 7, figs. 1, 4). The dolomite content is low, averaging about 4 percent, except for the uppermost beds, in which the dolomite increases and the formation appears to grade into the overlying Barber Member of the Quarry Mountain Formation. Tenkiller insoluble detritus ranges from 2 to 7 percent and consists in large part of quartz crystals (?overgrowths on detrital quartz); chert is sparse. A common feature in the Tenkiller are structures that Amsden and Rowland (1965, p. 36–41, pls. 8–10) interpreted as sediment-filled cavities. The sediment filling these cavities is similar to that of the surrounding rock, and the cavities, in part, may represent penecontemporaneous cavities that were filled by sediment swept in from above. The effect, if any, of these structures on the porosity and permeability of the Tenkiller is not known, but the structures are further evidence of the solution that has affected Chimneyhill strata in eastern Oklahoma (see Quarry Mountain Formation).

The Tenkiller Formation in the outcrop area ranges up to 27 feet in thickness. It is underlain by the Blackgum Formation, from which it is separated by a sharply defined lithologic contact, and overlain by the Barber Member of the Quarry Mountain Formation or, where upper Hunton strata have been removed by post-Early Devonian erosion, by the Sylamore Sandstone Member of the Chattanooga Shale. The Tenkiller-Barber boundary appears to be gradational, the pink crinoidal limestones of the Tenkiller becoming increasingly dolomitic and grading into the solid dolomites of the Barber through a transitional interval of 3 to 10 feet (Amsden and Rowland, 1965, p. 37–39). I have no information bearing on the age of most of the Barber Member, but the uppermost strata of this Member and the overlying Marble City Member are assigned a late Early Silurian (Wenlockian) age on the basis of their brachiopod faunas (see Quarry Mountain Formation).

The Tenkiller is richly fossiliferous, but I have not observed any diagnostic megafossils. This formation does, however, yield conodonts, and Professor Gilbert Klapper of the University of Iowa (letter, May 14, 1976) stated that he has collected *Pterospathodus celloni* from a bed 14.9 to 15.7 feet above the base of the Tenkiller Formation at the type locality on Lake Tenkiller (stratigraphic section Ch2, Amsden and Rowland, 1965, p. 92; 20 feet of Tenkiller strata exposed). Barrick and Klapper (1976, p. 66) reported on the *P. celloni* zone, to which they assigned a Late Llandoverian (C5) age, from the uppermost Cochrane beds in the eastern Arbuckle Mountains, indicating that a considerable part, perhaps all, of the Tenkiller Formation is correlative with the Cochrane Formation.

The Tenkiller Formation has a pink crinoidal lithology similar to that of the Fitzhugh Member of the Clarita Formation. In texture, color, and bedding characteristics, these two stratigraphic units are much alike, and, in the absence of any diagnostic fossils, Amsden and Rowland (1965, p. 16) provisionally treated the Tenkiller and Fitzhugh as correlative. However, the recent conodont studies of Klapper and Barrick show that a considerable part, perhaps all, of the Tenkiller is equivalent to the Cochrane Formation and older than the Prices Falls Member of the Clarita Formation. This is additional evidence that the pink crinoidal lithology is a lateral facies of the glauconitic limestones, as noted in my earlier discussion on the Cochrane Formation; moreover, this presents special problems in the subsurface correlations between the eastern outcrops and those in the Arbuckle Mountains (see Chimneyhill, Subsurface).

Quarry Mountain Formation

The Quarry Mountain Formation includes a sequence of low-insoluble limestones, dolomitic limestones, and dolomites that make up the uppermost formation of the Chimneyhill Subgroup. The Quarry Mountain has a maximum thickness of about 150 feet and is the youngest Silurian formation in the outcrop area, being overlain by the Lower Devonian Frisco or Sallisaw Formation or, where these units have been removed by post-Hunton erosion, by the Sylamore Sandstone Member of the Chattanooga (Woodford) Shale.

The Quarry Mountain is divided into a lower Barber Member and an upper Marble City Member, a lithologic distinction based on $MgCO_3$ content, the Barber being composed of dolomitic limestones and dolomites and the Marble City of limestones with some dolomitic limestones (Amsden and Rowland, 1965, p. 42).

Barber Member.—The Barber Member is composed of dolomitic limestones and dolomites having a maximum $MgCO_3$ content of 36 percent and averaging about 18 percent (text-fig. 21). The less intensively dolomitized beds are organo-detrital pelmatozoan-bryozoan limestones similar to the overlying Marble City Member; as the $MgCO_3$ content increases, dolomite crystals begin to replace the matrix, gradually impinging on the fossil clasts; in the final stage, crystalline dolomite completely replaces and obliterates the fossils. Although some Barber strata range into crystalline dolomite, the average lithology falls in the category of moderately heavily dolomitized limestone. Farther east, Silurian strata are more heavily dolomitized, with specimens from the lower Chimneyhill in the Shell 1 Western Coal and Mining Co. core in western Arkansas (Appendix) ranging as high as 41.18 percent and averaging 34.4 percent $MgCO_3$ (text-fig. 21). Thus, on the whole, Barber strata in the Marble City area represent a stage of dolomitization intermediate between the low-magnesium stone of the Arbuckle Mountains-Criner Hills region and the heavily dolomitized rocks of easternmost Oklahoma and western Arkansas. This is discussed more fully in the section on Hunton Dolomite.

The Barber Member has a low acid-insoluble content; the maximum is slightly over 2 percent, with an average of about 0.5 percent (Amsden and Rowland, 1965, p. 43–47, pl. 12).

The Barber Member in the outcrop area has a maximum thickness of approximately 80 feet and is underlain by the Tenkiller Formation and overlain by the Marble City Member.

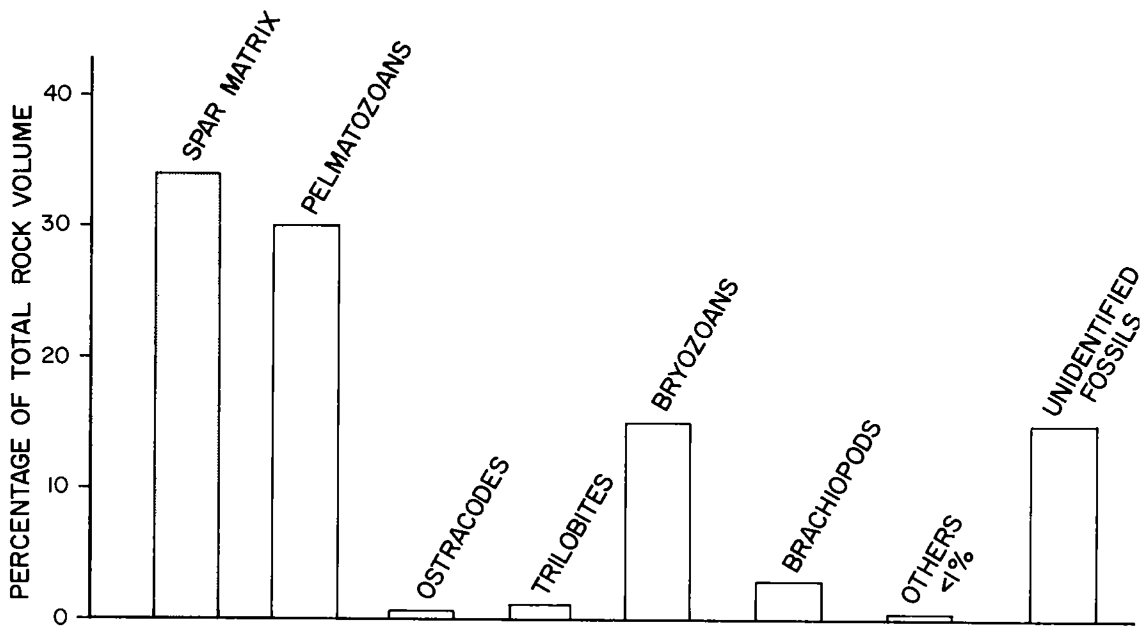
The only diagnostic fossils observed by me are from the upper few feet of the Barber Member in the St. Clair Lime Co. limestone quarry. These are similar to those from the overlying Marble City Member, and the biostratigraphic and lithostratigraphic relations of these two members are discussed in the following section on the Marble City Member.

Marble City Member.—This member is predominantly a light-gray to pinkish-gray, organo-detrital limestone comprising, on the average, about 35 percent matrix (mostly spar) and 65 percent fossil debris. The HCl-insoluble residues are extremely low, averaging about 0.3 percent, with a maximum of 1.5 percent; the insolubles are mostly silt-size, subangular quartz detritus. Some of the Marble City is composed of high-calcium limestone, and in places, as around Marble City, it is a rock of exceptional purity which is mined as a source of lime. However, beds of dolomitic limestone are locally common, and some of these grade into crystalline dolomite with as much as 36 percent $MgCO_3$ (Amsden and Rowland, 1965, p. 47–52, text-fig. 2, pls. 13–17). Parts of the Marble City Member include numerous pink crinoids and resemble the pink crinoidal lithology of the underlying Tenkiller Formation, the Fitzhugh Member of the Clarita Formation, and the St. Clair Limestone of Arkansas.

The Marble City Member is well exposed in natural outcrops and in various quarries and mines excavated in the vicinity of Marble City. It is 63 feet thick at the type locality in the St. Clair Lime Co. quarry and 73 feet thick in Oklahoma Geological Survey core 3. Its thickness in the subsurface is uncertain owing to problems in correlation (see following discussion).

I have not observed any reefs or boundstone, and the Marble City appears to represent sheets of organic debris spread out on the sea floor. The fossil debris shows relatively little breakage or evidence of size sorting by wave and current action. In fact, on the whole the preservation is excellent, with articulated brachiopod shells and delicate skeletal material such as bryozoan fronds and brachiopod frills preserved. This suggests that the organic material was not shifted far after death and that the faunal assemblage is essentially a life assemblage (Amsden, 1978, p. 3–10, pls. 9, 12, 13).

The Marble City faunal assemblage, as determined by thin-section point counting, is an interesting one, being dominated by pelmatozoan plates and bryozoan plates and bryozoans (text-fig. 9). This contrasts sharply with the correlative Fitzhugh Member of the Clarita Formation of the Arbuckle Mountains and the St. Clair Limestone of Arkansas, both of which are predominantly pelmatozoan-arthropod assemblages (mainly ostracodes and trilobites) (Amsden, 1978, text-fig. 5). The Marble City also includes brachiopods, trilobites, ostracodes, and some mollusks; corals and calcareous algae are



Text-figure 9. Graph showing distribution of matrix and major fossil groups in Marble City Member and uppermost beds of Barber Member, Quarry Mountain Formation, Marble City area. Data represent an average of point counts of thin sections prepared from specimens collected from different localities and different beds. After Amsden (1978, text-fig. 5).

rare or absent. The Marble City thus appears to represent a relatively large crinoid-bryozoan community or thicket, with brachiopods, arthropods, and mollusks representing the other sessile and vagrant benthos (see discussion of Clarita Formation in section on Chimneyhill, Arbuckle Mountains and Criner Hills).

The Silurian exposures in eastern Oklahoma are a key point in establishing a regional biostratigraphic and lithostratigraphic framework for Hunton strata across the eastern half of Oklahoma. They are especially important, since very few cores are available in the Arkoma Basin (see section on Chimneyhill, Subsurface). Thus the Marble City area with its excellent exposures of fossiliferous Silurian and Early Devonian rocks forms an eastern anchor for the sedimentary model herein proposed, the western end being tied to the well-known exposures in the Arbuckle Mountains. The age of the Marble City beds is of particular interest, as they are the uppermost Silurian strata overlain by either Lower Devonian carbonate strata (Frisco or Sallisaw Formation) or by the Upper Devonian Sylamore Sandstone, which is a basal facies of the Chattanooga (Woodford) Shale. In the past the Marble City beds have been variously correlated with the Henryhouse Formation, the Clarita Formation, or with pre-Clarita strata. The uncertainties in correlation are almost certainly compounded by the unusual crinoid-bryozoan biofacies represented by the Marble City, which is quite unlike the biofacies in the Henryhouse-Chimneyhill sequence in the Arbuckle Mountains or in the St. Clair Limestone of Arkansas (Amsden, 1978, p. 7–11). In the 1978 study of the Quarry Mountain Formation, I described the brachiopods from the Marble City Member and the upper beds of the Barber Member (see Barber-Marble City Relationship), assigned them a Wenlockian age, and correlated them with the Fitzhugh Member of the Clarita Formation and with the St. Clair Limestone of Arkansas. Dr. David Holloway, University of Edinburgh, who has studied my collection of Marble City trilobites, concurs in this age assignment. To my knowledge, these are the only faunal groups furnishing diagnostic fossils. According to this age assignment, there are no Late Silurian Henryhouse (Ludlovian) or early Early Devonian Haragan–Bois-d'Arc (Helderbergian) equivalents present, and the middle Early Devonian Frisco Formation or late Early Devonian Sallisaw Formation rests unconformably on the Quarry Mountain Formation.

Barber–Marble City relationship.—The boundary between the Barber and Marble City Members is based entirely on dolomite content, the top of the former being drawn at the place where the $MgCO_3$ content generally exceeds 10 percent (Amsden and Rowland, 1965, p. 46). This lithostratigraphic division has proved to be a useful concept in studying the eastern outcrop area, but it should be noted that this is an arbitrary division of what gives every indication of being a gradational sequence. The dolomite content of the Quarry Mountain Formation increases progressively but irregularly downward, a relationship that is amply documented in the lithologic descriptions and chemical analyses presented in Amsden and Rowland (1965; see especially text-figs. 10, 15, pls. A, B). Although this is a useful distinction in the intensely studied area centering around the eastern outcrops, it does not appear to be usable in the subsurface, where the control is derived largely from well samples; this is discussed in the section on Chimneyhill, Subsurface (see also later section on Hunton Dolomite). The close relationship of the Barber and Marble City strata is also supported by the similarity of the brachiopods and trilobites from the upper beds of the Barber Member to those from the Marble City Member (Amsden, 1978, p. 11). In fact, the lithologic and faunal relations strongly suggest that deposition was essentially continuous from the Tenkiller through the Quarry Mountain. There is a fairly well-defined lithologic break between the Blackgum and Tenkiller Formations, but the late Llandoverian age of the Blackgum suggests that if any depositional break is present it was of short duration.

Strata Overlying Marble City Member

In the Marble City area this member is unconformably overlain by the middle Lower Devonian Frisco Formation or by the Upper Devonian Sylamore Sandstone Member of the Chattanooga (Woodford) Shale. Each of these formations is separated from the Silurian Strata by a period of erosion during which there was truncation accompanied by extensive solution.

An extensive regional unconformity was developed prior to Frisco deposition (see Early Devonian Stratigraphy, Frisco Formation). The Marble City area is an excellent place at which to study the pre-Frisco surface, as the Frisco–Marble City contact can be observed at several outcrops, being especially well displayed in the old mine of the St. Clair Lime Co. Here, the upper beds of the Marble City show the presence of numerous solution cavities and crevices that were later filled with sediment when the Frisco was deposited. The configuration of these cavities indicates that Silurian strata were indurated at the time of dissolution, but apparently very little regolith was developed as the basal Frisco includes few rock fragments. This is perhaps not surprising, as only carbaonte rocks were exposed at the surface; see the following discussion of the pre-Chattanooga regolith (also Amsden, 1961, p. 37–42, text-figs. 13, 14, pls. 4, 5). An erosional interval also separates the Sallisaw Formation from earlier strata, during which time the Frisco Formation was truncated, allowing the Sallisaw to rest on the Quarry Mountain in many places (Amsden and Rowland, 1965, pl. A).

Deposition of the Woodford-Chattanooga was preceded by a long period of erosion during which time there was extensive truncation of the underlying strata; here again, the Marble City area is an excellent place at which to study the pre-Late Devonian surface. During this long period of exposure, upper Hunton strata, consisting of a thin veneer of Lower Devonian Sallisaw and Frisco beds, underlain by Silurian strata, underwent extensive solution, which developed crevices, cavities, and small caverns extending down some 40 feet into the Silurian limestones (Christian, 1953, p. 20–21; Amsden, 1961, p. 63–66). Some of the caverns developed a type of collapse breccia, and all of the cavities were extensively filled by sand at the time of Sylamore deposition. In the Marble City area, these sand-filled cavities, some of which can be observed to extend almost 40 feet into the Marble City, include some Upper Devonian conodonts, representing a potential source of faunal contamination. Although many of these solution cavities were later filled, it seems probable that some were not; undoubtedly these contribute to the overall porosity, discussed in the next section. The sand, pebbles, and boulders of the Sylamore Sandstone Member of the Chattanooga Shale were derived in large part from the underlying rock and appear to represent a regolith developed during pre-Chattanooga erosion. Locally and regionally, the development of a basal clastic facies in the Chattanooga-Woodford (Sylamore-Misener) seems to be directly related to the availability of resistant materials such as quartz and chert (Amsden, 1960, p. 139; Amsden, 1961, footnote on p. 42, p. 63; Amsden and Klapper, 1972, p. 2331–2332).

Porosity

Numerous cavities can be observed in Hunton rocks exposed at the surface and in the shallow diamond-core holes near Marble City (pls. 2, 3). These range in size from microscopic to several centimeters across, some of which contain bituminous material (Amsden, 1961, p. 17) or light oil (Christian, 1953, p. 18). The origin of some cavities is obscure, but many can be categorized with reasonable certainty as primary, in the sense that they were formed at or near the time of deposition, and others as secondary, in the sense that they were produced by dissolution of the rock after lithification.

Primary cavities may have resulted from incomplete cementation of the fossil debris. Hunton rocks in this area are almost entirely organo-detrital limestones composed of skeletal material cemented by spar. The spar matrix surrounding the organic material or filling the inside of hollow fossils such as brachiopods and cephalopods may have been incomplete, thus leaving a void (pl. 2, figs. 1, 2, 5; pl. 3, figs. 1, 3). The latter condition is especially common in the Marble City Member of the Quarry Mountain Formation and the upper, less strongly dolomitized part of the Barber Member of the Quarry Mountain; many of the articulated brachiopod shells are only partly filled or empty except for a thin lining of calcite druse (pl. 3, fig. 2). It is not uncommon for the internal structure of these shells, including the spiralia of spiriferoid brachiopods, to be preserved with a thin coating of calcite crystals (pl. 2, figs. 1, 2).

Secondary-solution cavities (pl. 2, fig. 6; pl. 3, fig. 3) include the dissolution produced during the periods of erosion that preceded deposition of the Frisco, Sallisaw and Chattanooga formations. Some of this dissolution appears to have been controlled by fractures or bedding planes, and in some instances fossils appear to have been the locus (pl. 3, fig. 1). I have observed very little dolomite porosity (Amsden, 1975b, p. 59–63) in the Barber Member of the Quarry Mountain Formation. This is probably due to the fact that the Barber generally has less than 30 percent $MgCO_3$ and thus is not sufficiently dolomitized to produce the crystalline texture commonly associated with dolomite porosity (see preceding section on Barber Member of Quarry Mountain Formation; also later section on Hunton Dolomite).

Sedimentary structures that Amsden and Rowland (1965, p. 36–37) called sediment-filled cavities are common in the Tenkiller and Quarry Mountain Formations (pl. 2, fig. 4, pl. 3, fig. 3). These enigmatic structures appear to have been formed during deposition of the enclosing sediments; the sequence would appear to be lithification, followed by development of the cavity, and finally introduction of sediments at or near the time the next bed was laid down. Regardless of the precise sequence of events involved in their origin, these structures are commonly the site of cavities, probably in part owing to incomplete filling of the original cavity and in part to these structures' serving as loci for later dissolution.

I have no quantitative data on the volume of pore space represented in Hunton rocks of this area, but a visual inspection of outcrops, cut specimens, and thin sections suggests that pore space is significant, especially in the Quarry Mountain Formation. No information is available to me on permeability.

CHIMNEYHILL, SUBSURFACE

The area covered in this report extends from the eastern part of the Arbuckle Mountains eastward to, and slightly beyond, the Oklahoma-Arkansas border (text-fig. 1). It thus includes the two outcrop areas where fossiliferous Chimneyhill strata are well exposed (stratigraphic section *A–A′*, panel 1) and where their lithostratigraphic and biostratigraphic relations are reasonably well known (see preceding discussion). It is difficult to correlate Chimneyhill strata in the subsurface, especially since cores cutting this part of the section are sparse, but the presence of two reasonably well understood exposures near the southwestern and northeastern corners of this area simplifies the problem and strengthens the conclusions.

Ten wells are known to have cored the Chimneyhill Subgroup: American 4A Bayne, Kahan Lewis 6 Bean, Shell 1 Boley, Sunray 1C Davis, Humble 1 Farmers Flag, Huber 1 Fargo, Bunker 2 McElvaney, Sunray 10A Rentie, King 1 Tiger, Shell 1 Western Coal & Mining Co. Of these, only five provide some faunal information: Sunray 1C Davis, Humble 1 Farmers Flag, Bunker 2 McElvaney, Sunray 10A Rentie, and King 1 Tiger (see Appendix).

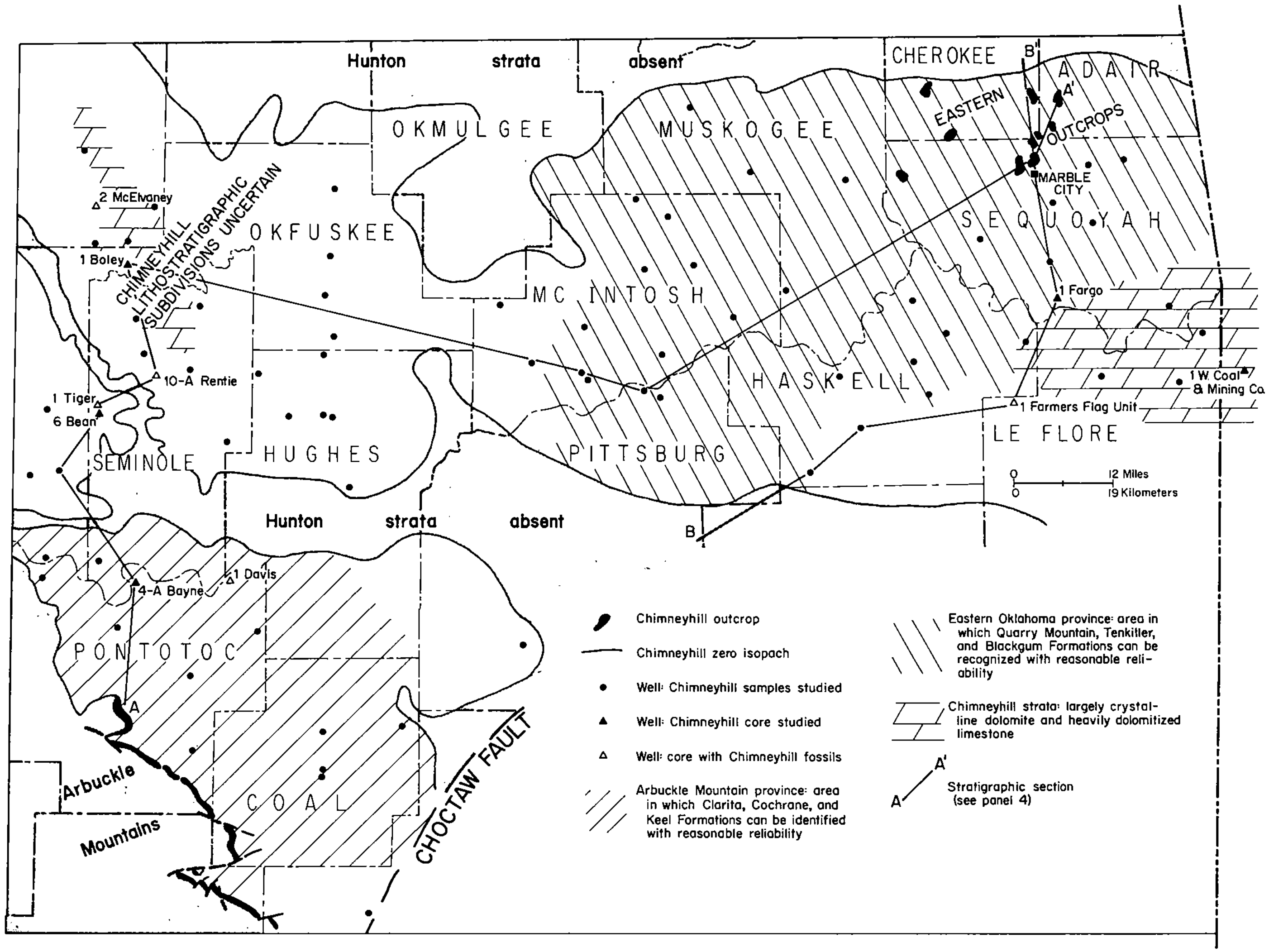
The Sunray 1C Davis cored a part of the Keel Formation and furnished specimens of the Keel brachiopod *Brevilamulella thebesensis* (Savage) (Amsden, 1974, p. 64–65, pl. 1, figs. 1–9, pl. 2, figs. 1–2) from a bed 9 feet above the Hunton-Sylvan contact. The upper 20 feet of the Hunton strata in the Humble 1 Farmers Flag (just beneath the Woodford Shale) yielded Marble City-type conodonts (identified by Barrick and Klapper; see Appendix). The upper 2 feet of the Hunton in the Bunker 2 McElvaney (just below the Misener Sandstone) yielded Clarita-type conodonts (identified by Barrick and Klapper; see Appendix). The upper 10 feet of core in the Sunray 10A Rentie (core starts 1 foot below Woodford contact) yielded Clarita-type conodonts (identified by Barrick and Klapper; see Appendix). A specimen of the brachiopod *Resserella* sp., collected from the core 28 feet below the Woodford-Hunton contact in the King 1 Tiger, is similar to a species present in the St. Clair Limestone in Arkansas (Appendix).

The foregoing shows that Chimneyhill strata are certainly present in the area north of the Arbuckle Mountains, and, of particular importance, evidence suggests that the Clarita Formation constitutes the uppermost Hunton in southern Lincoln and Okfuskee Counties and in northern Seminole County. This supports the lithostratigraphic evidence that Chimneyhill strata in the area centering around the Shell 1 Boley are directly overlain by the Frisco Formation, with the Upper Silurian Henryhouse and Lower Devonian Haragan–Bois d'Arc Formations being absent here and in the area to the east (map and stratigraphic section *A–A′*, panel 4). The two cores provided by the Huber 1 Fargo and Humble 1 Farmers Flag are also of strategic importance, because uppermost Hunton beds in the Huber 1 Fargo yield Frisco brachiopods whereas the upper Hunton strata in the Humble 1 Farmers Flag have Marble City-type conodonts; this shows the truncation of the Lower Devonian going southward toward the Choctaw Fault (panel 4, stratigraphic section *B–B′*).

CHIMNEYHILL, LITHOSTRATIGRAPHIC CORRELATIONS

Correlation of Chimneyhill strata on strictly lithostratigraphic characteristics is difficult and, where extended for any considerable distance without supporting biostratigraphic control, generally unreliable. In the Arbuckle Mountains, Chimneyhill strata are commonly overlain by the Henryhouse and (or) Haragan marlstones and thus are part of a distinctive sequence of organo-detrital limestones, commonly with an oolitic unit at the base (Keel), sandwiched between the overlying marlstones and the underlying Upper Ordovician Sylvan Shale. Northward and eastward from the Mountains this sequence can be traced into the subsurface for a short distance with fairly gratifying results; the marlstones are well developed, and the presence of Henryhouse and Haragan strata can be verified in the Riddle 1 Atterberry (Fee) and in the American 4A Bayne (text-figs. 10, 17; panel 4, pre-Woodford geologic map, stratigraphic section *A–A′*).

However, farther north in northern Seminole and Hughes Counties, the marlstone disappears, and Chimneyhill strata either make up the entire Hunton Group or are directly overlain by the Frisco Formation. In this area the Upper Silurian Henryhouse Formation and Lower Devonian



Text-figure 10. Map showing distribution of stratigraphic provinces in Chimneyhill Subgroup of eastern Oklahoma. Lithostratigraphic information on subsurface obtained largely from sample study based on thin sections, supplemented by a few cores (Appendix; see also pre-Woodford geologic map, Chimneyhill lithofacies map, and stratigraphic sections on panel 4).

Haragan–Bois d'Arc Formations are missing, either by pre-Woodford and pre-Frisco erosion (as interpreted by me) or by nondeposition (text-figs. 7, 16; panel 4, pre-Woodford geologic map, stratigraphic section *A–A′*). It should be noted that going northwestward from the Arbuckle Mountains into Cleveland, Oklahoma, and Kingfisher Counties, the Hunton marlstones also disappear (Amsden, 1975b, panel 10). The disappearance of the Haragan–Bois d'Arc marlstones in this area is also ascribed to pre-Frisco and pre-Woodford erosion, but I believe that the loss of the Henryhouse marlstone is due to a facies change, the Upper Silurian marlstones grading laterally into the organo-detrital limestones of the *Kirkidium* biofacies (Amsden, 1969, p. 962–966; Amsden, 1975b, p. 37–42). Where faunal control is lacking it is difficult to separate the Chimneyhill organo-detrital limestones from those of the overlying *Kirkidium* biofacies, a problem that is further complicated by the intense dolomitization of Silurian rocks that occurs over much of northwestern Oklahoma (Amsden, 1975b, p. 19, 43–56).

The Chimneyhill Subgroup in eastern Oklahoma comprises four formations (descending): Quarry Mountain, Tenkiller, Blackgum and Pettit (text-fig. 2; Chimneyhill, Eastern Outcrops). In 1965 T. L. Rowland (Amsden and Rowland, 1965, p. 124–157) traced these units for some distance into the subsurface (Rowland also distinguished the Marble City and Barber Members, but these divisions based on dolomite are not here considered to be recognizable in the subsurface; see Hunton Dolomite). I have expanded this subsurface investigation to find that for the most part a fourfold division can be recognized as far west as western McIntosh County (text-fig. 10). Farther west, the Chimneyhill divisions are lost, and there is a sizable area in the northwestern part of the region under investigation where the formations of this subgroup have not been recognized (note that Clarita-type conodonts are present in cores from the 2 McElvaney and the 10A Rentie, text-fig. 10). It should be emphasized that the lithostratigraphic correlations are complicated by the fact that the divisions in the eastern Oklahoma outcrops do not match the lithostratigraphic divisions in the Arbuckle Mountains, according to the correlations established by biostratigraphic studies. Thus the pink crinoidal lithology of the Fitzhugh Member of the Clarita Formation is most closely matched by the pink crinoidal character of the Tenkiller; however, conodont biostratigraphy indicates that the latter is largely, if not entirely, correlative with the Cochrane Formation. Conversely, the glauconitic character of the Cochrane is matched by that of the Blackgum, but the Cochrane also includes correlatives of the pink crinoidal Tenkiller. Biostratigraphic data indicate that the Fitzhugh Member is correlative with at least the upper, fossiliferous part of the Quarry Mountain Formation. The limestones of the latter are generally a pale-gray color but do include some pink crinoidal beds similar to those in the Fitzhugh, but there is nothing in the Arbuckle section that matches the strongly dolomitized beds of the lower Quarry Mountain (Barber Member).

The lithofacies changes required to match the western and eastern sections as established by biostratigraphic correlations are readily envisioned, even though the precise method and place of transition are uncertain. Assuming the biostratigraphic correlations to be sound—and I believe the evidence is both compatible and reliable—this points up the uncertainties in regional lithostratigraphic correlations. In particular it demonstrates that the pink-crinoidal lithology is in part a facies of the glauconitic limestones and thus unreliable for regional correlations and that even locally it should be used with caution (see Chimneyhill, Arbuckle Mountains and Criner Hills). Furthermore, the pink-crinoidal lithology is also undependable for distinguishing the Chimneyhill from later Hunton units such as the Upper Silurian *Kirkidium* biofacies or even the Lower Devonian Frisco Formation.

The late Llandoverian Cochrane and Blackgum zones are commonly rich in glauconite, and glauconitic limestones are frequently encountered in lower Hunton strata in the subsurface. However, it should be emphasized that many wells cutting this part of the section do not include any glauconite-rich beds in the lower Hunton, and there is sound evidence for ascribing this in large part to a lateral gradation into nonglauconitic beds. Good evidence for this can be observed in western Oklahoma, where the cores from the Chevron 1 Zellers (Carter County) and Carter 1 Hester (McClain County) have Cochrane-Blackgum brachiopods in a glauconitic limestone whereas Cochrane-Blackgum brachiopods are found in a core from the Phillips 1-D Franklin (Gray County, Texas), where they occur in a low-magnesium, pink-crinoidal limestone with little or no glauconite. Cochrane-Blackgum brachiopods are also present in the Calvert Mid-America 2 Bloyd (Woods County) in a crystalline dolomite, parts of which have considerable glauconite, but these heavily dolomitized beds overlie a pink-crinoidal limestone with little or no glauconite (Amsden, 1975b, p. 81, 86, 88, 105).

It should be stressed that the Cochrane and Clarita Formations, and the Blackgum, Tenkiller, and Quarry Mountain Formations, constitute well-defined lithostratigraphic and biostratigraphic units in the outcrop areas. These strata are well exposed in the Arbuckle Mountains-Criner Hills and in the Marble City areas, and their lithologic and faunal relationships are reasonably well understood. It is in the subsurface, where biostratigraphic data are sparse and the lithostratigraphic information must be obtained in large part from well samples, that the relationships become uncertain.

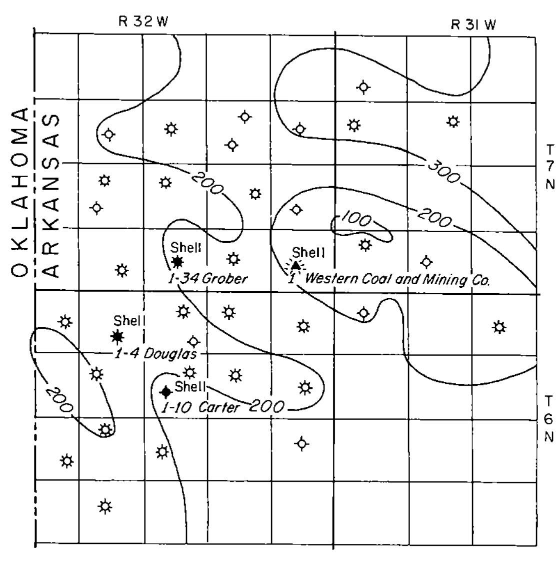
Strata Overlying Chimneyhill Subgroup

In the eastern Arkoma Basin, from about R. 12 E. eastward into Arkansas, the Chimneyhill strata are overlain by the Lower Devonian Frisco Formation, by the Lower Devonian Sallisaw Formation, or by the Upper Devonian (locally Middle Devonian) Sylamore (Misener) Sandstone Member of the Chattanooga Shale or the Chattanooga itself. (For a comparison with the Upper Silurian Henryhouse Formation or Lower Devonian Haragan–Bois d'Arc Formations, see previous discussion). The Frisco Formation is an organo-detrital limestone similar to the undolomitized beds of the Marble City Member of the Quarry Mountain Formation, and the two could be confused in well cuttings and mechanical logs. However, the Frisco is invariably a low-magnesium limestone, whereas the Marble City almost everywhere includes some dolomitized beds so that if any appreciable thickness is penetrated it will include some dolomitic limestone (see Early Devonian Stratigraphy, Frisco Formation). The Sallisaw Formation is a dolomitic sandstone that grades into a sandy dolomite, commonly with chert, which is readily distinguished from the low-insoluble Quarry Mountain carbonate strata (see Lower Devonian Stratigraphy, Sallisaw Formation). The Sylamore (Misener) Sandstone and Chattanooga Shale commonly present no identification problem.

Bonanza Gas Field, Western Arkansas

Because of limitations in time and space, the present investigation is restricted to the Oklahoma portion of the Arkoma Basin. However, a brief discussion of the Bonanza Gas Field is included, since it is a major Hunton gas producer and, in fact, the largest Hunton gas field presently known in the basin (Buchanan and Johnson, 1968). Moreover, it is directly adjacent to the area studied and provides additional information on the strata discussed in this report. My remarks will be confined to a discussion of Hunton lithostratigraphy, stratigraphic correlations, and dolomitization, with no attempt to deal with the geologic conditions responsible for the locus of the gas reservoir.

A number of wells have been drilled in the Bonanza area (text-fig. 11), and I have



Text-figure 11. Bonanza Gas Field, Sebastian County, Arkansas. Isopach lines (in feet) show Hunton thickness (defined to include Penters Chert). Wells in solid black described in Appendix. (Data supplied by Gary W. Hart, Oklahoma City, and O. A. Wise, Arkansas Geological Commission.)

examined the Welling-Hunton sequence in four of these: Shell 1 Western Coal & Mining Co.; Shell 1-4 Douglas; Shell 1-34 Grober; Shell 1-10 Carter (Appendix). The core and samples from the Shell 1 Western Coal & Mining Co. and the samples and well logs of the others were studied and 59 thin sections prepared. Most of the wells in this area are air-drilled down to or into the Hunton, so that in many wells part of the upper Hunton and overlying strata are represented by samples that are too fine for satisfactory lithologic examination. Nevertheless, enough data are available to give a reasonable view of Hunton lithostratigraphy. The lower Hunton and upper Sylvan strata were cored in the Shell 1 Western Coal & Mining Co. and are described in the Appendix of the present report (see also Haley and Frezon, 1965, p. 13).

Hunton strata in the Bonanza Field comprise two distinct lithostratigraphic units: an upper chert and carbonate sequence with quartz detritus and a lower group of dolomites and dolomitized organo-detrital dolomites. Haley and Frezon (1965, p. 13) correlated the upper unit with the Penters Chert, a formation whose type locality is in Izard County, north-central Arkansas. I believe the Sallisaw Formation of eastern Oklahoma to be correlative with the type Penters Chert (Amsden, 1963a, p. 161), and it seems reasonable to correlate these upper sandy cherts and carbonates in the Bonanza Field with the Sallisaw Formation as both are similar in lithology and in stratigraphic position. As noted elsewhere, in parts of the subsurface it is difficult to separate the late Early Devonian sandstones from the Late Devonian Sylamore Sandstone, and possibly the Penters Chert (Sallisaw Formation) of western Arkansas includes some Sylamore.

The underlying carbonate strata were referred by Haley and Frezon (1965) to the St. Clair Limestone, and I provisionally assign them to the Chimneyhill as they appear to be an extension of the eastern Oklahoma strata here referred to that subgroup. The St. Clair Limestone of north-central Arkansas is considered by me to be approximately correlative with the Quarry Mountain and Clarita Formations of Oklahoma (Amsden, 1968, p. 20-23; Amsden, 1978, p. 11-13), whereas I suspect that the strata in the Bonanza area also include correlatives of the older Cochrane-Blackgum-Tenkiller units and the Keel-Pettit. (There is no biostratigraphic information bearing on this problem, the closest control being the core from the 1 Farmers Flag unit and the eastern Oklahoma outcrops.) Chimneyhill strata in the Bonanza Field are largely crystalline dolomites and heavily dolomitized organo-detrital limestones and thus represent a continuation of the strong dolomite lithofacies present in eastern Oklahoma (panel 4). The crystalline dolomites, which show considerable visual porosity, are probably the principal producing zones.

Hunton strata in the Bonanza Field range up to about 270 feet in thickness. The thickness of the Sallisaw Formation (Penters Chert) appears variable, probably owing in considerable part to post-Hunton erosion; the total thickness of the Hunton Group in the Shell 1 Western Coal & Mining Co. well is 150 feet, with the Sallisaw Formation (Penters Chert) about 40 feet and the Chimneyhill about 110 feet.

Ordovician-Silurian Boundary, Texas Panhandle to Southeastern Missouri

I have studied Late Ordovician–Early Silurian strata in the surface and subsurface of Oklahoma and the Texas Panhandle and have also examined correlative beds in the Batesville district of north-central Arkansas and along the Mississippi River in eastern Missouri and western Illinois (fig. 1). Throughout this region these strata make up a sequence consisting of Late Ordovician organo-detrital limestones ("Fernvale"-Welling-Cape formations) overlain by calcareous shales and argillaceous limestones and dolomites (Sylvan-Cason-Maquoketa formations), which are in turn overlain by limestones, commonly with a basal oolite (Keel–Pettit–basal Edgewood formations). Most investigators have referred this oolite to the Silurian, placing the Ordovician-Silurian boundary at the top of the shale. However, in 1974 I (Amsden, 1974, p. 26–29) assigned the Lower Edgewood and Keel oolite to the Silurian, placing the Silurian-Ordovician boundary between this unit and the overlying Cochrane organo-detrital limestones.

A substantial amount of paleontologic and stratigraphic work has been done in the

Arbuckle Mountain–Criner Hills area, and there is now a solid body of biostratigraphic data bearing on the relative ages of these strata. Major fauna studied include the following.

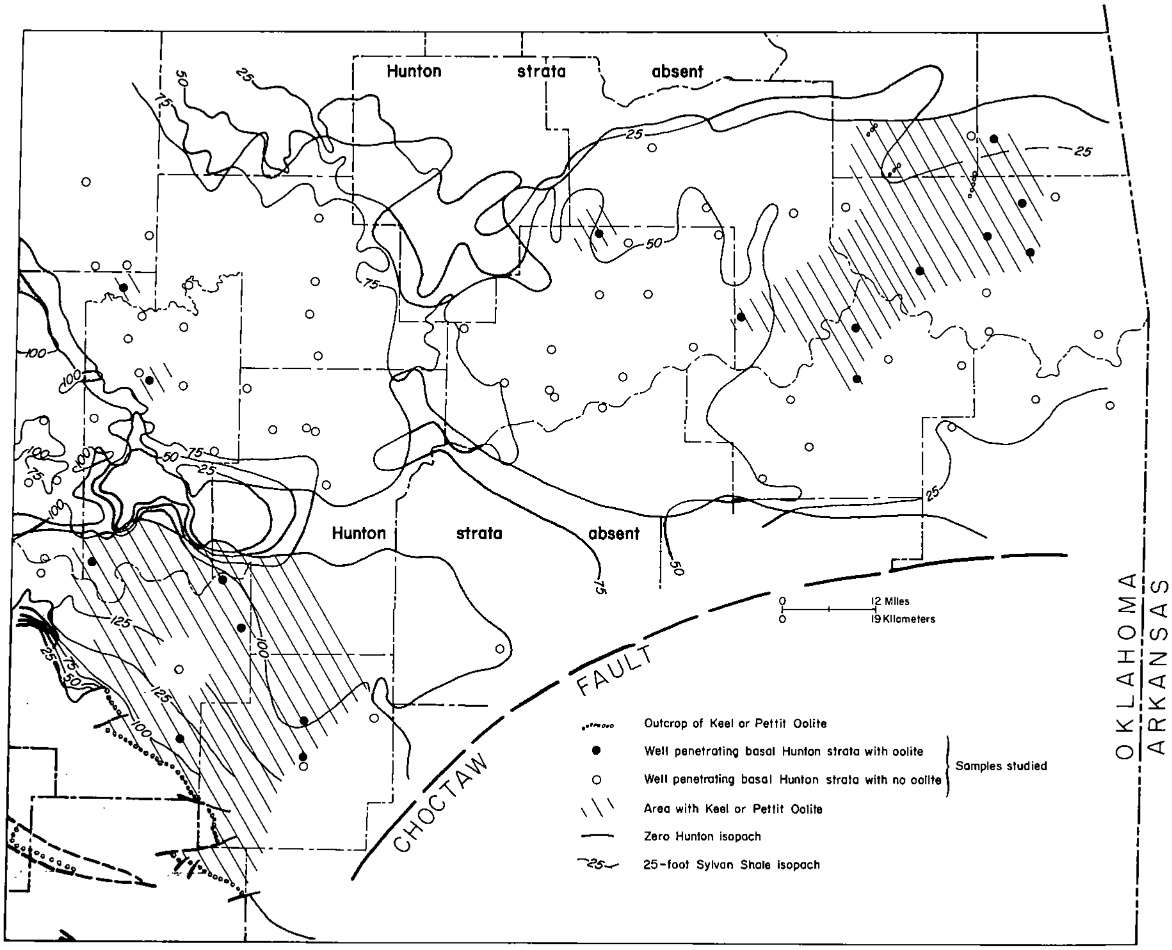
Viola-"Fernvale" (Welling) graptolites were described by Ruedemann and Decker (1934), chitinozoans by Jenkins (1969), and articulate brachiopods by Alberstadt (1973). Graptolites from the lower part of the Sylvan Shale were described by Decker (1935), and chitinozoans from the lower and upper parts were described by Jenkins (1970). Keel articulate brachiopods were described by me (Amsden, 1974), the Cochrane articulate brachiopod *Triplesia alata* was described by me (Amsden, 1971), and Barrick and Klapper (1976) described the conodont *Pterospathodus celloni.* Finally, the articulate brachiopods from the Fitzhugh Member of the Clarita Formation were described by me (Amsden, 1968), and the conodonts from the Prices Falls and Fitzhugh Members of the Clarita were described by Barrick (1977) and Barrick and Klapper (1976).

There is general agreement that the Welling-"Fernvale"-Sylvan beds represent a Late Ordovician (Cincinnatian) age, although their precise position within this series involves some uncertainty. There is also a consensus that the Cochrane Formation represents a late Early Silurian (late Llandoverian) age and that the Fitzhugh Member of the Clarita Formation is early Late Silurian (Wenlockian) except for the upper few feet of strata, which Barrick and Klapper (1976) provisionally assigned to the earliest Ludlovian. However, some difference of opinion exists concerning the age of the Keel Formation. In 1968 I assigned this formation to the latest Ordovician (Hirnantian), an age assignment that was questioned by Lespérance (1974, p. 26–27; Lespérance and Sheehan, 1976, p. 1–2). I have already discussed the evidence for assigning the Keel–early Edgewood strata to the Late Ordovician, and there is no reason for further review.

At the present time, no general agreement exists on the exact position of the Ordovician-Silurian boundary, and until a stratotype has been selected a zone of uncertain age will occupy this part of the section. In the Arbuckle Mountains, and at several other areas where Silurian strata crop out, there is physical evidence for a regional unconformity between the oolitic beds (Keel–early Edgewood) and the overlying limestones (Cochrane-Blackgum-Sexton Creek formations). This evidence can be observed in the Arbuckle Mountains (Amsden, 1960, p. 43; 1963b, p. 634), in eastern Oklahoma (Amsden and Rowland, 1965, p. 21–26), in the Batesville district of Arkansas (see following discussion), and along the Mississippi River exposures (Amsden, 1974, p. 18; Rubey, 1952, pl. 6B). In my opinion, this pre–late Llandoverian unconformity has no bearing on the question of the age of the oolite zone, and I only point out that, aside from the Keel-Edgewood, middle and early Llandoverian strata are poorly represented in this region, a relationship that may be due at least in part to this Early Silurian unconformity. Finally, it should be stressed that transferring the Keel oolitic zone from the Late Ordovician to the Early Silurian would have little effect on the regional relations discussed in the following paragraphs.

The Keel is a part of a Late Ordovician carbonate zone, commonly oolitic, which is irregularly present from the Texas Panhandle to the Mississippi River and which includes the Keel and Pettit Formations of Oklahoma, the Noix Oolite and Leemon Formation of the Edgewood Group in eastern Missouri and western Illinois (Amsden, 1974, text-figs. 4, 16), and some unnamed oolitic beds in the Cason Shale, Batesville district, north-central Arkansas. These beds are commonly underlain by Late Ordovician shales (Sylvan, Cason in part, Maquoketa) and overlain by carbonate strata of late Early Silurian (late Llandoverian) age (Cochrane, Blackgum, Sexton Creek, and an unnamed limestone lens bearing *Triplesia alata* in the Cason Shale of north-central Arkansas).

Within the Arbuckle Mountains–Criner Hills outcrop area the distribution of the Keel Formation is irregular, being present in some areas and absent in others. This patchy distribution also extends into the subsurface of western Oklahoma (Amsden, 1975b, p. 19, panel 10) and eastern Oklahoma (text-fig. 12). In 1960 I attributed this erratic distribution in the Arbuckle Mountains–Criner Hills to pre-Cochrane erosion, and there is excellent physical evidence that the Keel was exposed to both pre-Clarita



Text-figure 12. Map showing distribution of Keel or Pettit oolite.

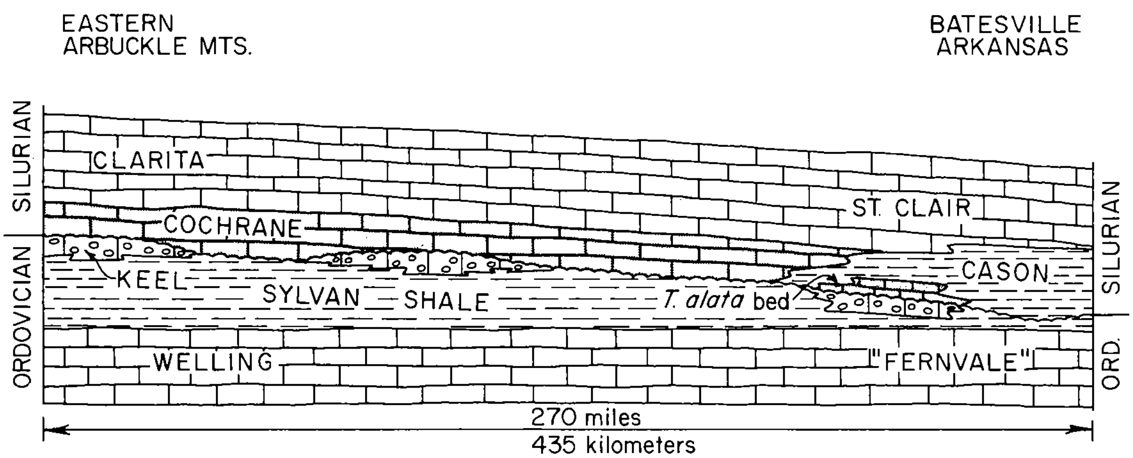
and pre-Cochrane erosion (Amsden, 1963b, p. 631–635). Although Early Silurian erosion was rather widespread throughout this region, its effects on the underlying strata were local and moderate. Silurian strata in the area extending from the Texas Panhandle across Oklahoma and into eastern Arkansas everywhere rest on the Sylvan Shale. At no place in this region known to me did pre-Cochrane (or pre-Clarita or pre-Henryhouse) erosion breach the Sylvan Shale and expose the underlying Welling or older limestones, thus allowing later Silurian strata to be deposited on these formations. These relations probably do not hold in the Batesville district of Arkansas, as there are local exposures where Silurian strata probably are in contact with the "Fernvale." It should be noted that at several places Devonian strata rest on pre-Sylvan limestones.

I believe that the erratic distribution of the oolite beds is also controlled in part, perhaps in large part, by variations in the environment of deposition, the absence of the oolite being due to a lateral gradation into a shale lithofacies. This is the relationship at Love Hollow quarry in the Batesville district of Arkansas, where beds bearing the brachiopod *Triplesia alata* are locally present as a limestone lens within the Cason Shale (Amsden, 1968, p. 6, text-fig. 5). These are the strata which I assign a late Llandoverian age and correlate with the Blackgum and Cochrane Formations (Amsden, 1971, p. 143–146) and which are almost certainly equivalent to at least some part of the strata which Craig (1969, p. 1622) assigned to the *celloni* and upper Bereich 1 zones. (Barrick and Klapper (1976, p. 66) reported *Pterospathodus celloni* from the uppermost

Cochrane Formation, Arbuckle Mountains, and from the Tenkiller Formation in eastern Oklahoma.)

When I visited the Love Hollow quarry in 1966 the *Triplesia alata* beds comprised about 18 inches of organo-detrital crinoidal limestones. This was underlain by about 6 inches of oolite, the entire carbonate unit being about 2 feet thick and overlain and underlain by Cason Shale. The field relations are illustrated on plate 4, and details of the oolite-organo-detrital-limestone (*T. alata* beds) contact, on plates 5 and 6. The latter contact is a welded contact that is commonly a stylolite seam (Craig, 1969, p. 1623; this report, pl. 5, fig. 3, pl. 6, figs. 1, 2); but one small part of this contact is an unaltered sedimentary boundary, and here the oolites appear to have been lithified and beveled before deposition of the overlying pelmatozoan limestone. This contact, which is nearly identical to the Cochrane-Keel contact in the central part of the Arbuckle Mountains (Amsden, 1962a, fig. 5; 1963b, fig. 2, pl. 1), points to an erosional surface, a relationship supported by the juxtaposition of the late Early Silurian *T. alata* beds to the oolite, which almost certainly represents the Late Ordovician Keel-Noix horizon. That the oolite-pelmatozoan-limestone unit is a limestone lens that grades laterally into typical Cason Shale is suggested by the stratigraphic relations shown on plate 4, and more conclusively by the fact that when I revisited the Love Hollow quarry in 1967, quarrying operations had removed it, its stratigraphic postion being represented entirely by a shale lithofacies. In 1979 I again visited the Batesville district in Arkansas and examined one outcrop where a lens of Silurian limestone appeared to be separated from the "Fernvale" Limestone by only a thin seam of shale. The upper surface of the "Fernvale" commonly appears weathered, and Miser (1922, p. 23) noted that the "upper surface of the Fernvale is irregular, containing channels and fissures, some as much as 2 feet deep, that are filled with the materials of the succeeding deposits, which is usually conglomeratic or earth, but at a few places the fissures contain a gray oolitic limestone."

The foregoing lithostratigraphic-biostratigraphic relationships indicate that across the eastern Oklahoma-Arkansas region the Sylvan-Cason shales are diachronous and that the Ordovician-Silurian boundary transgresses most if not all of this shale sequence (text-fig. 13). This also appears to



Text-figure 13. Generalized stratigraphic diagram showing lithostratigraphic and biostratigraphic relations of Late Ordovician-Early Silurian strata in area extending from eastern Arbuckle Mountains of south-central Oklahoma to Batesville district in north-central Arkansas. Vertical exaggeration necessitates considerable distortion of stratigraphic thickness.

be the relationship of the Ordovician-Silurian boundary in western Oklahoma and the Texas Panhandle, as discussed below.

Although biostratigraphic evidence bearing on this point is meager, lithostratigraphic evidence shows that the Hunton-Sylvan boundary in parts of Oklahoma is gradational, suggesting that the Ordovician-Silurian boundary may well transgress into the shale lithofacies. In the Arbuckle Mountains–Criner Hills outcrop area the Keel-Sylvan contact appears to be a reasonably well-defined lithologic boundary, at least judging from the few available exposures (Amsden, 1960, pl. 1). However, the upper part of the Sylvan is a greenish-gray argillaceous dolomite that overlies a darker graptolitic shale with much reduced calcareous content. This upper greenish-gray Sylvan unit can be generally recognized in cores and samples across eastern Oklahoma. The following analyses indicate that these upper beds are argillaceous dolomites rather than shales.

Shell 1 Boley core: greenish-gray Sylvan Shale, upper 2 inches. $CaCO_3$, 47.32 percent; $MgCO_3$, 30.84 percent; HCl-insoluble residues, 20.32 percent.

Oklahoma Geological Survey core 2: greenish-gray Sylvan Shale, upper 2 inches. $CaCO_3$, 38.74 percent; $MgCO_3$, 24.25 percent; HCl-insoluble residues, 35.54 percent.

Shell 1 Western Coal & Mining Co. core: greenish-gray Sylvan Shale, upper 1 foot. $CaCO_3$, 39.71 percent; $MgCO_3$, 27.34 percent; HCl-insoluble residues, 31.77 percent. The underlying dark-gray unit is apparently a strongly dolomitic shale, as indicated by the following analyses.

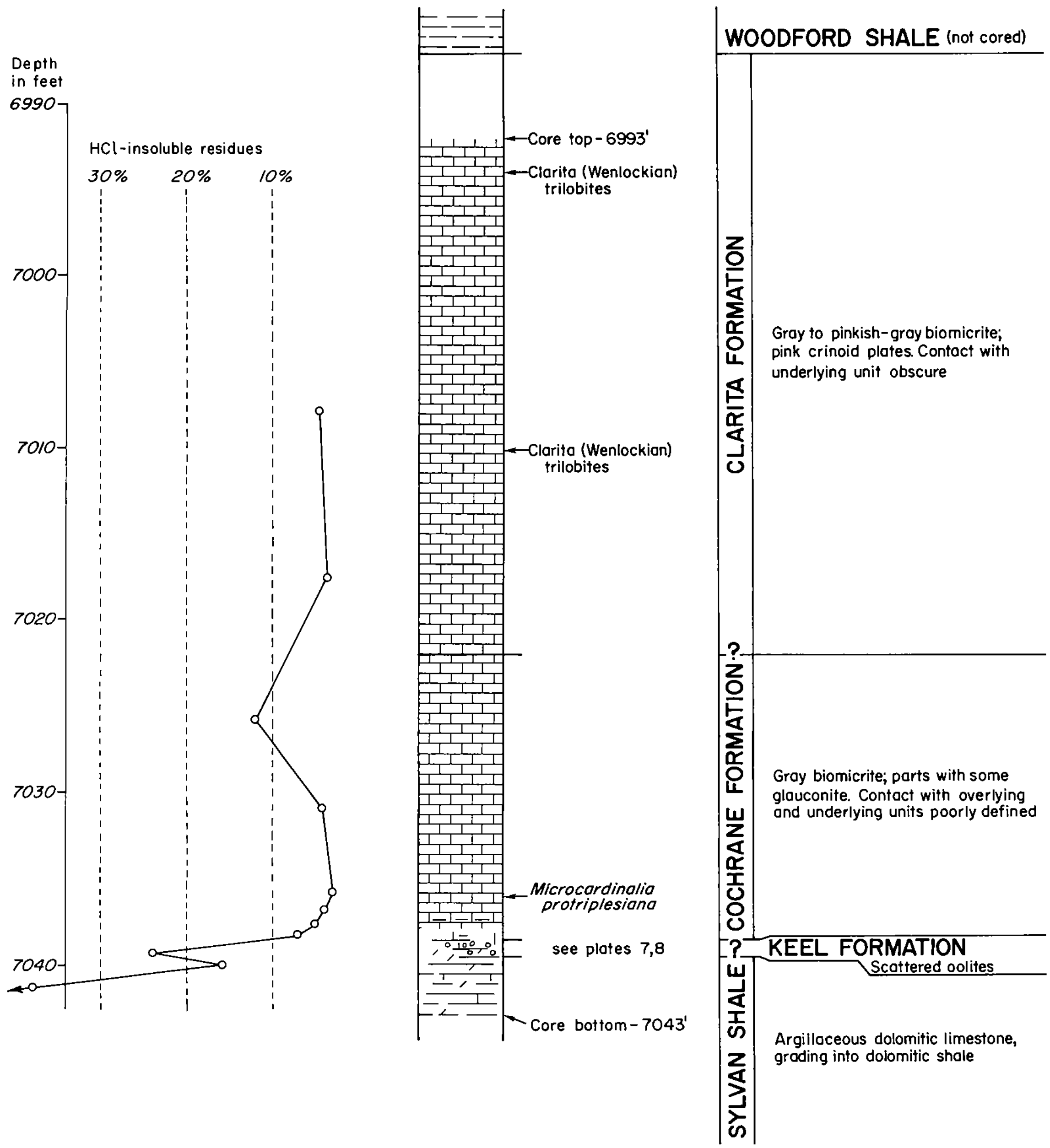
Shell 1 Western Coal & Mining Co. core: Dark Sylvan Shale, 5 feet below top. $CaCO_3$, 27.99 percent; $MgCO_3$, 19.22 percent; HCl-insoluble residues, 51.81 percent.

Sunray DX 10-A Rentie: Sylvan Shale, upper 6 feet. $CaCO_3$, 24.19 percent; $MgCO_3$, 15.11 percent; HCl-insoluble residues, 57.20 percent.

The Hunton-Sylvan contact was cored in the Shell 1 Boley, in which the uppermost Sylvan was a greenish-gray argillaceous dolomite (see previous analysis) and the basal Hunton consisted of a few inches of heavily dolomitized Keel oolites ($CaCO_3$, 62.56 percent; $MgCO_3$, 32.57 percent; HCl-insoluble residues, 3.24 percent). This contact was cored in the Shell 1 Western Coal & Mining Co. well (see previous analyses and Appendix), in which the basal Hunton was crystalline dolomite (see previous analysis and Appendix). The contact is exposed at the surface in the Marble City area and in several cores that cut the upper Sylvan (see previous analyses) and the basal Hunton oolite. In all of these cores and exposures the Hunton-Sylvan boundary is fairly well defined lithologically, and throughout eastern Oklahoma it can be determined with reasonable precision in both electric logs and in well samples. However, there are areas in western Oklahoma where considerable uncertainty is encountered in drawing the Hunton-Sylvan boundary.

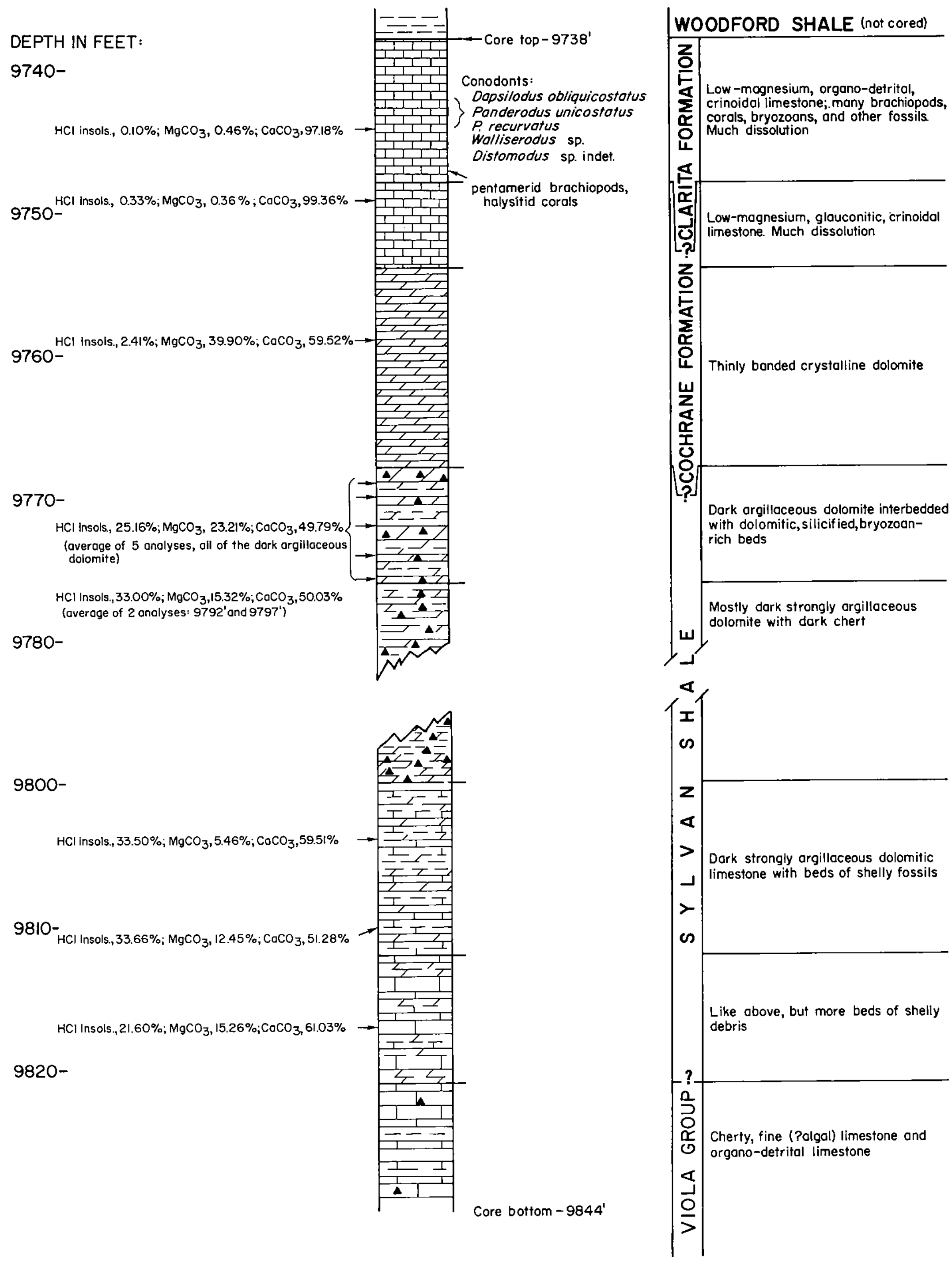
The Kirkpatrick 1 Blevins unit in western Logan County (sec. 7, T. 17 N., R. 4 W.) cored almost all the Hunton and the upper part of the Sylvan Shale (Amsden, 1975b, p. 80–81, 122, panel 10). This is an excellent well from which to study the Chimneyhill-Sylvan relationship, especially since it provides some biostratigraphic control; Clarita-type trilobites are present in the upper part of the core, and excellent specimens of the Blackgum stricklandiid brachiopod *Microcardinalia protriplesiana* are present in the lower few feet of the Chimneyhill (text-fig. 14). The basal beds of the Chimneyhill become increasingly argillaceous (and dolomitic) downward, grading into an argillaceous and dolomitic micrite and finally into a strongly calcareous mudstone (plates 7, 8). Strata provisionally assigned to the Keel Formation are represented by oolites scattered through a couple of inches of argillaceous marlstone, this bed being poorly marked off from the overlying Cochrane Formation and the underlying Sylvan Shale. There is no physical evidence for an unconformity above the oolites, and, in fact, the stratigraphic relations shown in the core suggest continuous deposition from the Sylvan into the overlying carbonate strata. However, it should be noted that the late Early Silurian (late Llandoverian) *Microcardinalia*-bearing beds are only 3 feet above the oolite zone of presumed Late Ordovician age.

Farther west, in northwestern Woodward County, the Mackellar 1 Ferguson cored the entire Sylvan Shale. Conodonts indicative of an early Clarita age were re-



Text-figure 14. Stratigraphic diagram of core from Kirkpatrick 1 Blevins Unit, C NE¼SW¼ sec. 7, T. 17 N., R. 4 W., Logan County, Oklahoma. Illustrations of this core and photomicrographs of thin sections prepared from core are shown on plates 7 and 8. Trilobites from this core were examined by Prof. K. S. W. Campbell, Australian National University, Canberra. (Core originally described by Amsden, 1975b, p. 80–81, 122; additional chemical analyses obtained in 1977.)

covered and identified by Dr. Gilbert Klapper and Dr. James Barrick, The University of Iowa, from the upper Hunton organo-detrital limestones (text-fig. 15). These conodont-bearing strata are underlain by low-insoluble limestones and dolomites and are here referred to the Chimneyhill Subgroup (Cochrane-Clarita) on the basis of their lithologic character and stratigraphic position (no oolites observed). Beneath this interval is a sequence of dark argillaceous dolomites interlayered with bryozoan-rich



Text-figure 15. Stratigraphic diagram of core from Mackellar 1 Ferguson, C SW¼NE¼ sec. 35, T. 24 N., R. 21 W., Woodward County, Oklahoma. Conodonts from this core were recovered and identified by Dr. Gilbert Klapper and Dr. James Barrick, The University of Iowa. Study of this core was augmented by 12 thin sections and 14 rock analyses.

beds. Underlying the bryozoan beds is a stratigraphic unit composed largely of dark, strongly argillaceous dolomites with nodules of dark chert, which in turn passes downward into argillaceous dolomites with beds of shelly debris; the latter become increasingly abundant, and the strata grade into more typical Viola Limestone. In this Hunton-Sylvan-Viola sequence the Sylvan Shale is poorly defined. A recognizable lithostratigraphic boundary can be drawn at the top of the highest argillaceous dolomite (9,868 feet); so defined, however, the Sylvan will include numerous interbeds rich in shelly debris. The contact between the Sylvan and the underlying Viola is even more uncertain, and there is really no clearly marked lithostratigraphic basis for locating the Sylvan Shale–Viola Limestone boundary. In fact, none of the Sylvan strata in this well appears to be a true shale, as all of the samples analyzed have less than 35 percent insoluble residue (text-fig. 15).

A similar situation has been observed in Ellis County, in a group of wells extending from the Clark Canadian 1 Hanan (C SW¼NE¼ sec. 35, T. 20 N., R. 23 W.) west to the Woods 1 Oblander (C SE¼NW¼, sec. 27, T. 20 N., R. 25 W.). A study of samples from the five wells shown in text-figure 16, including a number of thin sections, shows the Sylvan to be cherty, heavily dolomitized shale and argillaceous dolomite, similar in lithologic character to that present in the 1 Ferguson (text-fig. 15). In this region the Sylvan has clearly lost some of its lithostratigraphic identity, grading toward the overlying and underlying cherty carbonates. By using electric logs and thin sections prepared from samples, the Sylvan Shale can be identified in most wells with reasonable assurance, although there appear to be some discrepancies, judging from the reported tops. The stratigraphic relations point to some lateral as well as vertical gradation between the Sylvan and the Hunton, suggesting that the boundary between the two is diachronous and that deposition was continuous from Late Ordovician into Early Silurian time.

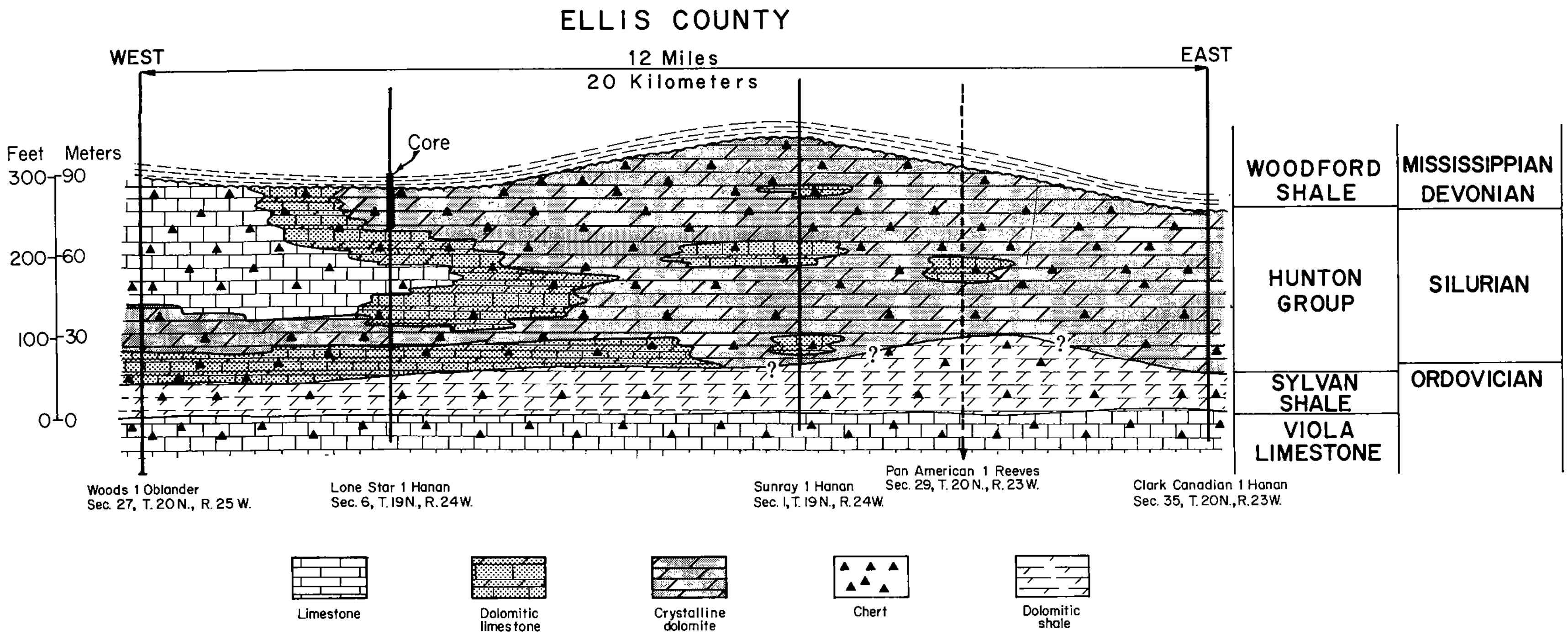
The wells illustrated in text-figure 16 span an area across the western part of the northwestern dolomite province previously described by me (Amsden, 1975b, p. 46, panel 2, maps A, B, C). Hunton strata in the eastern part of this area are almost entirely crystalline dolomite, as determined by thin sections prepared from the samples. To the west, these strata become increasingly calcareous, and in the Wood 1 Oblander the upper half of the Hunton is low-magnesium, organodetrital limestone. I assign all the Hunton strata in this general area to the Silurian (Amsden, 1975b, panel 9) and believe the limestones to be a lateral facies of the dolomites (Amsden, 1975b, p. 44–46; this report, Hunton Dolomite).

Henryhouse Formation

The Henryhouse Formation comprises a sequence of Late Silurian marlstones whose type locality is on Henryhouse Creek in the western part of the Arbuckle Mountains. This formation is believed to extend into the southeastern part of the Anadarko Basin with little changes in lithofacies (Amsden, 1975b, p. 27). Equivalent-age strata also are present over much of northwestern Oklahoma, although in this region they have undergone extensive facies changes and are represented by the *Kirkidium* biofacies (Amsden, 1975b, p. 28–37). In eastern Oklahoma the Henryhouse Formation probably extends as far east as R. 11 E. and as far north as T. 8 N. (panel 4; text-fig. 7).

HENRYHOUSE, ARBUCKLE MOUNTAINS AND CRINER HILLS

The type locality for the Henryhouse Formation is on Henryhouse Creek in Carter County in the western part of the Arbuckle Mountains. The Henryhouse is the uppermost Silurian formation in the Hunton Group (text-fig. 2) and is widely distributed and well exposed in the Arbuckle Mountains and Criner Hills. The Henryhouse is typically a greenish-gray, low-magnesium marlstone having a mud-supported fabric with fossils scattered through the matrix in varying degrees of concentration. The matrix is composed of clay- and silt-size detritus mixed with finely divided carbonate. The HCl-insoluble detritus averages about 20 percent, ranging widely from bed to bed. There is also a geographic pattern in the concentration of terrigenous detritus, this being greatest in the central and southern areas, where reddish marlstones are common, and least



Text-figure 16. East-west stratigraphic section showing inferred relationship of Viola-Sylvan-Hunton-Woodford strata in Ellis County, western Oklahoma. Datum is Viola-Sylvan contact. Based mainly on thin sections prepared from well samples. Lower Woodford and upper Hunton strata were cored in Lone Star 1 Hanan and studied by means of thin sections, chemical analyses, and porosity-permeability tests (Amsden, 1975b, p. 87–88, 131, 167–168).

at the northern end, where locally the Henryhouse grades into a grain-supported, organo-detrital limestone (Amsden, 1975b, p. 23, panel 1, map C, panel 2; this report, text-fig. 7). In the outcrop area the Henryhouse has a maximum thickness of 250 feet; from this maximum the formation thins, and over much of the southeastern part of the Arbuckle Mountains it is absent. A more complete discussion of the Henryhouse Formation, with illustrations of outcrops, thin section, maps, chemical analyses, and other data, is given in Amsden (1960, p. 66-84, 288-297, pls. 4, 5, 13, map panels 1-3; 1975b, p. 23-28, 38-57, pls. 8, 9, Appendix).

STRATA OVERLYING AND UNDERLYING HENRYHOUSE

Henryhouse strata in the outcrop area are generally overlain by the lithologically similar Haragan-Bois d'Arc Formations, or, where pre-Woodford erosion has removed the Lower Devonian strata, by the Woodford Shale. The Henryhouse-Haragan-Bois d'Arc relations are discussed in the section, Silurian-Devonian Boundary.

The Henryhouse Formation is underlain in most areas by the Clarita Formation (Wenlockian), from which it is readily distinguished on lithostratigraphic grounds. Locally, pre-Henryhouse erosion has removed the Clarita Formation, allowing the Henryhouse to rest directly on the Early Silurian Cochrane Formation (Amsden, 1960, p. 73-74; Amsden, 1975b, p. 25, pl. 8, figs. 4a, 4b).

HENRYHOUSE, AGE AND CORRELATION

The Henryhouse Formation is Late Silurian in age. The lower part carries graptolites, which earlier authors assigned to the early Ludlovian, although Hermann Jaeger recently proposed a somewhat younger Ludlovian age (discussed in Amsden, 1975b, p. 24). Based on conodonts, Barrick and Klapper (1976, p. 64) placed the basal Henryhouse in the early Ludlovian. The upper Henryhouse may range into the Pridolian, although definitive megafauna data bearing on this point are lacking. Henryhouse faunal studies include brachiopods (Amsden, 1951), corals (Sutherland, 1965), ostracodes (Lundin, 1965), trilobites (Campbell, 1967), and crinoids (Strimple, 1963).

The Henryhouse Formation is considered to be correlative with the Bainbridge Formation of eastern Missouri and the Brownsport Formation of western Tennessee (Amsden, 1960, p. 84). These formations are composed of lithologically similar marlstones, suggesting that Late Silurian argillaceous limestones were deposited as a more or less continuous blanket of sediments covering much of the central United States. According to this interpretation, the present patchy distribution is the result of breeching by subsequent erosion.

HENRYHOUSE, SUBSURFACE

Henryhouse marlstones are well developed at the northeastern end of the Arbuckle Mountain outcrops, where they are overlain by the Lower Devonian Haragan marlstones (Amsden, 1960, panels 2, 3). The marlstone lithology can be readily recognized in samples from wells in this area, although as noted elsewhere the Henryhouse and Haragan can only be distinguished by means of their faunas (see section, Silurian-Devonian Boundary). I have examined only two cores that provide positive faunal identification of the Henryhouse and Haragan Formations: the Riddle 1 Atterberry (Fee) (sec. 11, T. 3 N., R. 5 E.), containing Haragan fossils, and the American 4-A Bayne (sec. 16, T. 5 N., R. 6 E), containing Henryhouse fossils (panel 4; Appendix). Elsewhere, the Henryhouse and Haragan marlstones cannot be distinguished, and on the pre-Woodford geologic map (panel 4) the marlstone lithology is mapped as Henryhouse-Haragan undifferentiated. The marlstones can be recognized as far east as R. 11 E. and as far north as T. 9 N. (panel 4). North and east of this region only two small patches of marlstone have been recognized, and throughout most of eastern Oklahoma Chimneyhill strata are believed to be directly overlain by the Lower Devonian Frisco or Sallisaw Formation or by the Upper Devonian-Mississippian Woodford (Chattanooga) Shale (commonly with the Misener-Sylamore Sandstone at its base). In the 1 Boley (sec. 8, T. 11 N., R. 6 E.) the Frisco Formation (containing Early Devonian fossils) rests directly on a dolomitized pink organo-detrital crinoidal limestone here referred to the Chimneyhill Subgroup. North of this well, in the 2 McElvaney (sec. 10, T. 12 N., R. 5 E.), the limestones just beneath the Woodford Shale yield conodonts, indicating a correlation with the Clarita Formation, Chimneyhill Subgroup (Appendix). From this area east, the Henryhouse fauna has not been identified in the surface or the subsurface, and the Silurian part of the Hunton Group is believed to be composed entirely of Chimneyhill-age strata (see discussion under Chimneyhill Subgroup; panel 4). I attribute the absence of Henryhouse throughout this area to its removal by pre-Frisco and pre-Woodford (Chattanooga) erosion (see sections covering Woodford Shale, Silurian-Devonian Boundary, and Frisco Formation). Note that in the Anadarko Basin of western Oklahoma the Henryhouse marlstones lose their identity by merging into the organo-detrital limestones and dolomites of the *Kirkidium* biofacies (text-fig. 7), a relationship that can be established by numerous fossiliferous cores, demonstrating that these are Late Silurian limestones (Amsden, 1975b, p. 29–38).

EARLY DEVONIAN STRATIGRAPHY

The Hunton Group in Oklahoma is defined to include strata ranging in age from Late Ordovician (Keel Formation) through Early Devonian (Sallisaw Formation) and probably Middle Devonian in the deep part of the Anadarko Basin, where deposition may have been continuous. In the eastern part of the State, in the region covered by the present report, Hunton rocks include four Lower Devonian Formations: Haragan and Bois d'Arc (Helderbergian-Gedinnian), Frisco (Deerparkian-Siegenian), and Sallisaw (Esopusian-Emsian). The Helderbergian Haragan and Bois d'Arc Formations are confined to the southwestern part of this region, and the Esopusian Sallisaw Formation has its best development in the eastern part, with the Frisco Formation preserved as scattered patches over much of the area (panel 4). Lower Devonian Hunton strata attain a maximum thickness of 325 feet in the Arbuckle Mountains–Criner Hills (Amsden, 1960, p. 87); elsewhere in eastern Oklahoma these strata probably do not exceed 50 feet and in most places are considerably less.

Haragan and Bois d'Arc Formations

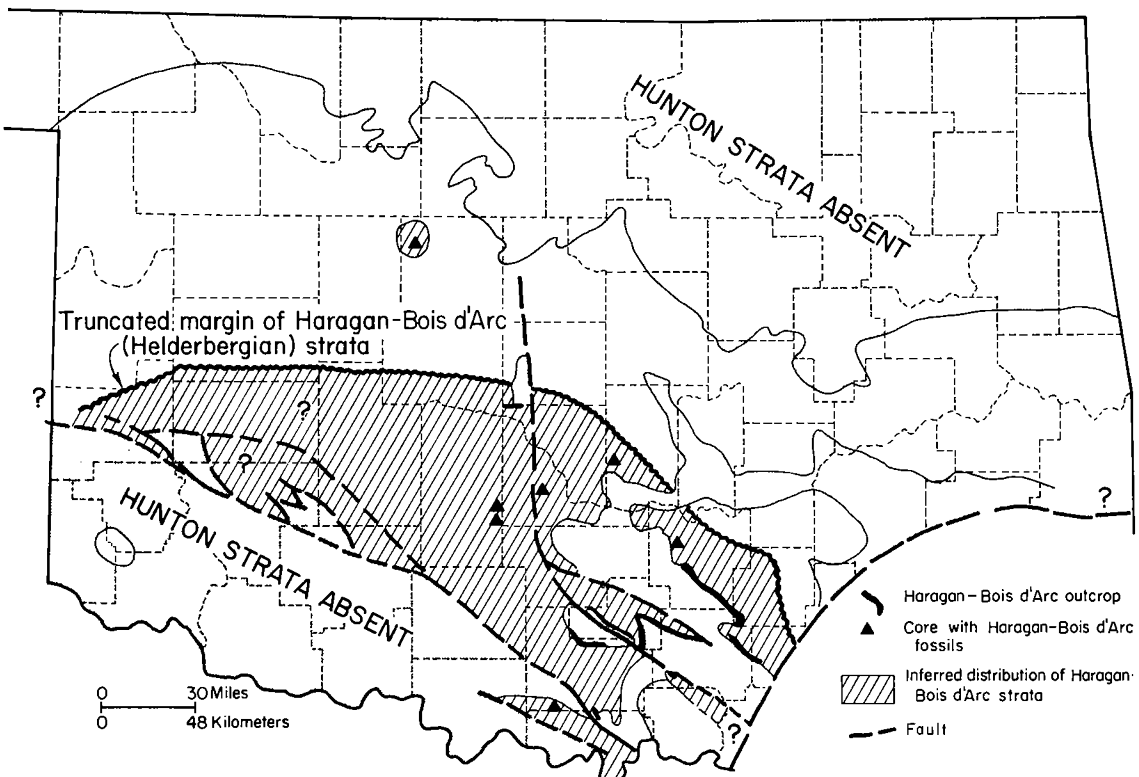
I consider the Haragan and Bois d'Arc Formations to be largely, perhaps entirely, a lateral facies of one another and therefore treat them as a single unit in the present report. In the outcrop areas of the Arbuckle Mountains and Criner Hills it is biostratigraphically and lithostratigraphically useful to recognize two distinct units (Amsden, 1960, p. 85), but for a regional, mainly subsurface, study, such as the present one, they are best designated as the Haragan–Bois d'Arc Formations.

The type locality for the Haragan Formation is on Haragan Creek near White Mound in the central part of the Arbuckle Mountains. The strata are richly fossiliferous marlstones composed of silt- and clay-size insoluble detritus mixed with finely divided carbonate. The Haragan has a mud-supported fabric with fossils scattered through the matrix in varying degrees of concentration. The insoluble detritus ranges widely, averaging about 16 percent. Lithostratigraphically, Haragan rocks are indistinguishable from the underlying Henryhouse, although the two formations are readily separated on the basis of megafossils, the Haragan containing a large Early Devonian fauna, and the Henryhouse, a large Late Silurian fauna. For a more detailed description and discussion of this formation see Amsden (1960, p. 86–99; 1975b, p. 65–69) and also Silurian-Devonian Boundary, this report.

The type locality for the Bois d'Arc Formation is on Bois d'Arc Creek, Lawrence Uplift, at the northern end of the Arbuckle Mountains. This formation has been divided into two lithostratigraphic units: a lower Cravatt Member and an upper Fittstown Member. In its typical expression the Cravatt Member consists of mud-supported, fossiliferous marlstones with varying amounts of chert. It is similar to the underlying Haragan Formation except for the presence of chert. The Fittstown Member in its characteristic expression is composed of grain-supported, organo-detrital sparite. In most places some chert is present, but there are areas, such as the Lawrence Uplift, where chert is sparse. It should be emphasized that typically these stratigraphic divisions are distinct, although they do grade laterally and vertically into one another. Thus the Haragan marlstones grade into the Cravatt cherty marlstones, and, as the latter lose their argillaceous character and develop an increasingly high fossil content, they grade into the Fittstown grain-supported calcarenites. A more detailed description and discussion of these relationships is given in Amsden (1960, p. 86–125), Amsden and Ventress (1963, p. 38–41), and Amsden (1975b, p. 65–68).

Although the Haragan-Cravatt-Fittstown divisions are recognizable and useful in the surface exposures, their recognition in the subsurface presents problems. The marlstone and cherty-marlstone lithology is easily identifiable on the basis of cores and well samples; but the Fittstown organo-detrital limestones probably cannot be distinguished from the Frisco organo-detrital limestones on the basis of well samples, although they can be separated in those cores providing faunal control. This should be kept in mind when using the pre-Woodford geologic map accompanying this report (panel 4), because Frisco subcrops some distance removed from any biostratigraphic control may include some Fittstown.

The marlstone lithofacies is confined to the southwestern part of the area under study, and in the subsurface, as in the surface exposures, these strata probably include both Devonian (Haragan) and Silurian (Henryhouse) age rocks. North and east of this region the marlstones disappear, and I believe that over most of eastern Oklahoma Haragan (and Henryhouse) strata are absent, having been removed by pre-Frisco erosion (see Silurian-Devonian Boundary, Henryhouse, Subsurface, Frisco Formation). As noted above, there is a possibility that some Helderbergian-age (Fittstown) beds are locally included with the Frisco Formation; however, it should be emphasized that Frisco fossils are present in the 1 Boley and 1 Fargo cores, and in the eastern outcrops, whereas no Haragan–Bois d'Arc (Helderbergian) fossils have been identified throughout this region (text-fig. 17).



Text-figure 17. Map showing inferred distribution of Haragan–Bois d'Arc (Helderbergian) strata. Outcrops described in Amsden (1960, p. 87, and Appendix), and cores with Helderbergian fossils in Amsden (1975b, p. 68 and Appendix).

HARAGAN-BOIS D'ARC OIL AND GAS PRODUCTION

Oil and gas production has been widely reported from the Bois d'Arc. While some of these occurrences undoubtedly are from this formation, I believe that much is actually from either the Frisco Formation or from Silurian-age strata (Amsden and Rowland, 1971, p. 105–109; Amsden, 1975b, p. 68, 74–75). Helderbergian-age strata appear to be largely confined to the south-central part of the State, probably extending into the deep part of the Anadarko Basin (Introduction, Silurian-Devonian Boundary; panel 4, this report; Amsden, 1975b, panel 9).

Distribution of Helderbergian Strata in Midcontinent

Helderbergian-age strata are widely distributed over the Midcontinent region, being represented in south-central Oklahoma by the Haragan–Bois d'Arc Formation, in southeastern Missouri–southwestern Illinois by the Bailey Limestone, and in western Tennessee by the Birdsong Shale. These rocks are largely in a fossiliferous marlstone lithofacies, locally grading into organo-detrital limestones with varying quantities of chert. They are underlain by Late Silurian marlstones—the Henryhouse Formation in Oklahoma, the Moccasin Springs Formation in Missouri-Illinois, and the Brownsport Formation in western Tennessee. This distribution suggests that the fine terrigenous clastics in the marlstones were derived from the same southern source that supplied the clastics for the Ouachita Mountains (Amsden, 1969, p. 971). The major flood of clastics appears to have started in Late Silurian (early Ludlovian) time, extending into Early Devonian (Helderbergian-Gedinnian) time, and then was fairly sharply shut off in middle Early Devonian (Deerparkian-Siegenian) time. Although the major pulsation began in early Ludlovian time, a more modest clastic halo developed in the Clarita Formation, indicating that the southern source was being activated as early as Wenlockian time (see Chimneyhill Subgroup).

The lithofacies and biofacies similarity of Helderbergian strata throughout the Midcontinent region suggests that they were laid down as a more or less continuous blanket of sediments. According to this interpretation, the present scattered outcrops are erosional remnants isolated by pre-Frisco, pre-Sallisaw, and pre-Woodford (Chattanooga) subaerial erosion. Other explanations can be suggested. For example, the present distribution of Helderbergian strata may be due in part to the sediments' lapping out on an older surface. Whatever explanation is postulated, I believe there is sound evidence for both pre-Frisco and pre-Chattanooga (Woodford) subaerial erosion; this is discussed under the sections covering the Woodford (Chattanooga) Shale and the Frisco Formation.

Frisco Formation

The type locality for the Frisco Formation is on Bois d'Arc Creek at the northeastern end of the Arbuckle Mountains. The Frisco is a light-gray to pinkish-gray, organo-detrital, grain-supported limestone. It includes a wide variety of shelly debris, much of which appears to have been fragmented and disarticulated before deposition. The Frisco is everywhere a low-magnesium limestone, averaging only 1 percent or so $MgCO_3$; the insoluble residues are also low, rarely exceeding 2 or 3 percent. In the Arbuckle Mountain area the Frisco is underlain by the Fittstown Member of the Bois d'Arc Formation, from which it is easily distinguished both lithostratigraphically and biostratigraphically; it is overlain by the Woodford Shale. The Frisco Formation is confined to the northern end of the Arbuckle Mountains, being absent elsewhere in the Mountains and in the Criner Hills. A maximum thickness of 60 feet is attained at the type locality, but it is generally much thinner (Amsden, 1960, p. 125–135; Amsden, 1961, p. 25–45; Amsden and Ventress, 1963, p. 16–24; Amsden, 1975b, p. 69–75).

The Frisco Formation is preserved in isolated remnants scattered over the eastern part of Oklahoma. It crops out in Sequoyah, Cherokee, and Adair Counties in a lithofacies and biofacies very similar to that of the Arbuckle Mountain area; here, the formation yields a large Deerparkian (Siegenian) brachiopod fauna. Frisco fossils have also been recovered from the Shell 1 Boley and Huber 1 Fargo cores (Appendix), and the formation has been traced in well samples over a considerable area (panel 4). Throughout this region the Frisco is a light-gray to pinkish-gray, low-magnesium, organo-detrital limestone. It has some lithologic resemblance to the underlying undolomitized limestones of the Marble City Member (Quarry Mountain Formation), and locally there may be some problem in separating the two formations. They can, however, be distinguished with some assurance on the basis of dolomite content, the Frisco being virtually free of $MgCO_3$ whereas almost any appreciable thickness of Marble City will show a fair quantity of dolomite. The present investigation is based in part on a study of well samples by means of thin sections, which makes it possible to detect relatively small concentrations of dolomite and thus to distinguish the dolomite-free Frisco from the underlying Silurian strata with reasonable precision. As noted elsewhere, it is possible that some Helderbergian organo-detrital limestone may have been included with the Frisco, but there is sufficient biostratigraphic control in eastern Oklahoma to suggest that such inclusions, if present, are localized and of minor extent.

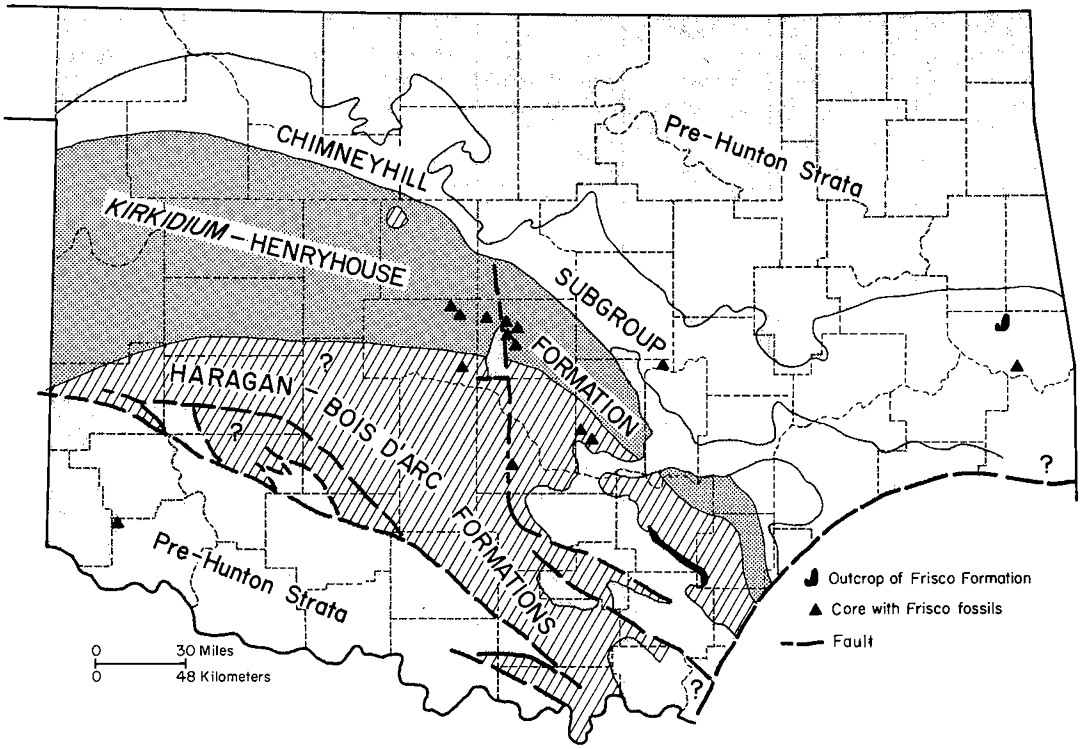
FRISCO FORMATION IN OKLAHOMA

Erosional remnants of the Frisco Formation are widely distributed over the State, biostratigraphic-lithostratigraphic identifications having been made from a core in the Hollis Basin, a number of cores in central Oklahoma, the previously cited outcrops in the Arbuckle Mountains and eastern areas, and one core in eastern Oklahoma. Furthermore, I believe that the Frisco is represented by a reasonably thick sequence of limestones covering a large area in the deep part of the Anadarko Basin (Amsden, 1975b, text-fig. 36, panel 9; this report, panel 4). Throughout this area it maintains very similar lithologic and faunal characteristics and thus provides a reliable marker in the upper part of the Hunton Group (Amsden, 1975b, panel 10; this report, panel 4). It is separated from the underlying strata by an erosional unconformity of some magnitude and thereby exerts considerable control on the distribution of older Hunton units (hence its importance in interpreting Hunton stratigraphic relations). Finally, it is itself an important Hunton oil- and gas-producing unit (Amsden and Rowland, 1971; Amsden, 1975b, p. 74).

PRE-FRISCO UNCONFORMITY

An erosional unconformity separates the Frisco Formation from the underlying strata, bringing this formation into contact with beds ranging in age from Early Devonian (Haragan–Bois d'Arc Formations) to Late Ordovician (Viola Limestone, text-fig. 18). There is substantial lithostratigraphic and biostratigraphic evidence to support these relationships: (1) at the north end of the Arbuckle Mountains, fossiliferous Frisco strata can be observed in contact with fossiliferous Lower Devonian (Helderbergian) Bois d'Arc limestones; (2) in several cores in Oklahoma, fossiliferous Frisco beds can be observed in contact with fossiliferous limestones of the Upper Silurian *Kirkidium* biofacies; (3) in the eastern Oklahoma outcrop area, fossiliferous Frisco beds are exposed in contact with fossiliferous Silurian (Wenlockian) limestone (Chimneyhill Subgroup, Quarry Mountain Formation); (4) in the Tidewater 1 Johnson core from the Hollis basin, fossiliferous Frisco limestones are in contact with fossiliferous Ordovician limestones (Viola Limestone) (Amsden, 1975b, Appendix; this report, Appendix).

The pre-Frisco unconformity is thought to be largely the result of subaerial erosion. This interpretation is based primarily on the evidence for dissolution affecting the pre-Frisco surface. The most favorable area at which to study this unconformity is the outcrop area in eastern Oklahoma, where the Frisco–Quarry Mountain contact is exposed at a number of places. One of the best exposures is in the old limestone mine of the St. Clair Lime Co., where the Frisco–Quarry Mountain contact is continuously exposed for some 60 feet. Here, several feet of relief was developed on the old surface by channeling and solution, with crevices and cavities having been produced by dissolution of the Silurian limestone which were later filled by tongues of Frisco sediments. This boundary is also well exposed in surface outcrops, especially at stratigraphic sections S1 and S10 (Amsden, 1961, Appendix), where irregular tongues of Frisco



Text-figure 18. Pre-Frisco geologic map, showing inferred distribution of pre-middle Early Devonian (pre-Deerparkian-Siegenian) formations. Surface and subsurface biostratigraphic control shown for Frisco Formation; biostratigraphic control for older formations given in Amsden (1975b) and elsewhere in this report.

extend down into the Quarry Mountain, indicating the development of solution cavities at least 2 to 3 feet deep on the pre-Frisco surface. The contact of the Frisco with the Quarry Mountain is commonly welded, making it possible to study the relationship in thin sections and polished surfaces. This boundary is discussed and illustrated in Amsden (1961, p. 37–42, frontispiece, pls. 2, 4, 5, 8).

The Frisco-Upper Silurian (*Kirkidium* biofacies-Henryhouse Formation) contact can be observed in cores from several wells in central Oklahoma: Gulf 1 Schroeder, Gulf 1 Streeter, Tenneco 1-5 Biller, and Phillips 1-B Brooks (Amsden, 1975b, Appendix; this report, Appendix). The area of contact exposed in a core is, of course, small, but in the 1 Streeter, 1-B Brooks, and 1-5 Biller it is welded and can be studied in thin section and polished surface (Amsden, 1975b, pl. 15; this report, pl. 9, figs. 1-4, pl. 10, figs. 1-5). These thin sections and polished surfaces demonstrate that the old Silurian surface was lithified and beveled before the Frisco sediments were deposited, as Silurian shells are cut off along the unconformity (Amsden, 1975b, pl. 15, figs. 1, 2).

The erosion interval preceding deposition of Frisco sediments almost certainly contributed to the dissolution affecting the porosity of Silurian strata; see sections on Chimneyhill Subgroup, Porosity; Chimneyhill, Subsurface; and Regional Structure and Thickness of Hunton Strata.

Throughout the State, Frisco strata exhibit little change in lithostratigraphic or biostratigraphic character, and, in fact, the Little Saline Limestone exposed along the Mississippi River (Amsden and Ventress, 1963, p. 49–58) is similar to the Frisco in all respects. This suggests that the formation was originally deposited as a relatively thin blanket of sediments covering most of the State, probably extending east for a considerable distance. The subsequent period (or periods) of erosion which preceded deposition of the Late Devonian-Early Mississippian dark shales extensively dissected the Frisco Formation and the underlying pre-Frisco erosion surface. Thus the latter surface is preserved only in those places where it was protected by an erosional remnant of the Frisco Formation. These relationships should be kept in mind when examining the pre-Frisco subcrop map shown in text-figure 18.

FRISCO OIL AND GAS PRODUCTION

I have no definitive information concerning Frisco production in the area covered by the present report. Kunsman (1967, p. 178–185) reported Bois d'Arc production (one Frisco producer) from parts of Coal, Pontotoc, Pottawatomie, and Seminole Counties—areas that are known to include Frisco strata (panel 4); since this formation produces in central Oklahoma (Amsden, 1975b, p. 74; see Tenneco 1-5 Biller, Appendix, this report), it seems reasonable to believe that some of these fields represent Frisco rather than Bois d'Arc production or Frisco combined with Bois d'Arc production. In Sequoyah County, Hunton gas production is reported from the Stephens 1 B&F Ranch (SE¼SE¼NW¼SE¼ sec. 23, T. 11 N., R. 24 E.; the upper 2 feet of Hunton rocks was perforated). I have not examined the samples from this well, but Frisco strata are certainly present in this area and probably in this well (panel 4; see Huber 1 Fargo, Appendix).

Sallisaw Formation

The type locality for the Sallisaw Formation is on Sallisaw Creek near Marble City, in the eastern Oklahoma outcrop belt. Typically, the Sallisaw is an arenaceous, dolomitic limestone with HCl insolubles, mostly quartz detritus, rarely exceeding 15 percent and averaging only 9.5 percent. Quartz, which makes up most of the insoluble detritus, is largely in the form of angular to subangular grains ranging up to 0.15 to 0.2 mm in diameter. (Traces of glauconite are generally present.) The dolomite content is variable, ranging from less than 1 to 25 percent $MgCO_3$, averaging about 11 percent. For the most part, megafossils are uncommon and, where present, are predominantly brachiopods and *Tentaculites*. Nodules and lenses of chert are present, and locally the arenaceous dolomitic limestones grade into a bedded arenaceous chert lithofacies. The detrital quartz in the latter is similar in size and shape to that found in the arenaceous limestones. Fossils are abundant in parts of the chert, commonly having been leached so they are now preserved as casts and molds.

The Sallisaw Formation is thin throughout the outcrop area and probably does not exceed 20 feet. It commonly rests on the middle Lower Devonian Frisco Formation, from which it is easily distinguished, the latter being entirely a low-magnesium, low-insoluble organo-detrital limestone. In places the Sallisaw truncates the Frisco and rests directly on the Silurian Chimneyhill Subgroup. Throughout the Marble City area the Sallisaw is overlain by the Late Devonian Sylamore Sandstone (for a comparison, see discussion which follows). A more detailed description of the Sallisaw Formation is given in Amsden (1961, p. 45–59, pls. 1, 2, 11, 12).

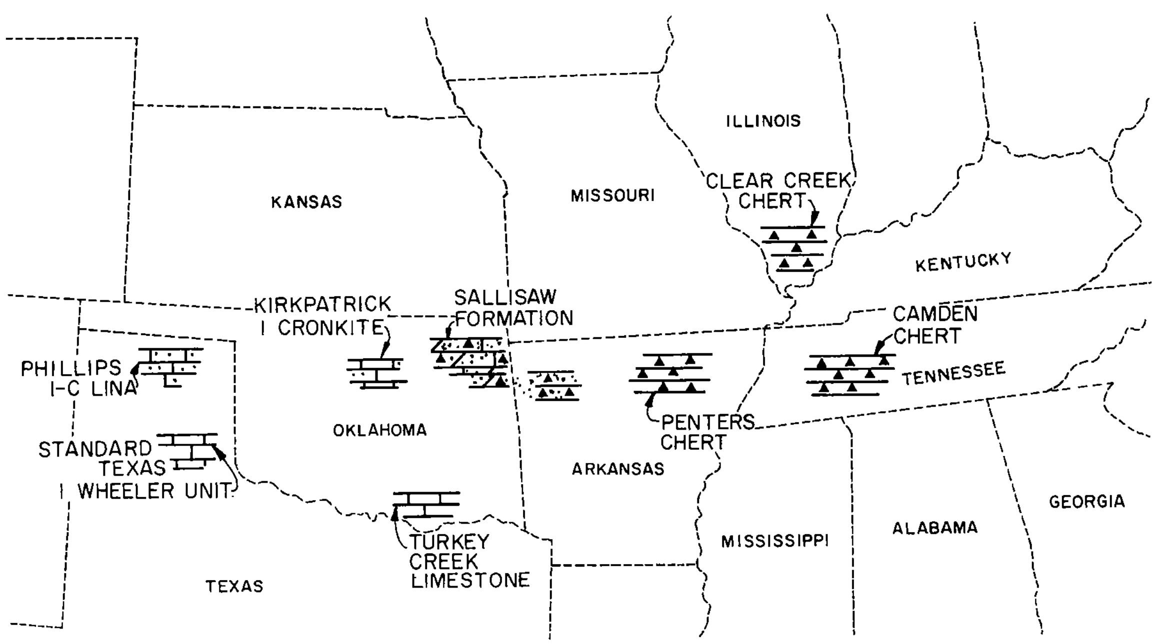
Comparison of Sallisaw and Sylamore (Misener) Formations

In the Marble City area the Sallisaw is mainly an arenaceous, dolomitic limestone and is readily distinguished from the Sylamore, which is quartz sandstone with rounded grains having prominent quartz overgrowths largely filling the interstices. The arenaceous chert lithofacies of the Sallisaw is a high-silica rock like the Sylamore, but its texture is distinct (see Amsden, 1961, pl. 12, fig. 6, pl. 13, figs. 1–6).

The Misener Sandstone of central Oklahoma is correlative with the Sylamore Sandstone. Conodont studies indicate that both formations are mainly of Late Devonian age, although locally the Misener includes beds as old as late Middle Devonian (Amsden and Klapper, 1972, p. 2326–2331). Lithologically, the Misener ranges from a dolomitic sandstone into an arenaceous dolomite, with parts resembling the Sallisaw Formation (Amsden and Klapper, 1972, p. 2324–2327). In the absence of faunal control, the separation of these two formations presents a real problem—one which is especially troublesome—since late Early Devonian strata are now known to be widely distributed across the Midcontinent region, extending as far west as the Texas Panhandle. Generally speaking, late Early Devonian strata tend to be bedded cherts in the eastern areas, grading westward into low-insoluble carbonate strata, but there is a broad belt across eastern and central Oklahoma where the Sallisaw and Sylamore-Misener rocks are in a similar lithofacies that can be, and probably has been, confused (see following section).

Regional Distribution of Late Early Devonian Strata

Emsian (Esopusian) age strata are widely distributed in the Midcontinent region. These include the Camden Chert of western Tennessee, the Clear Creek Chert of southwestern Illinois, the Penters Chert of Arkansas, and the Sallisaw Formation of eastern Oklahoma (Amsden, 1963a, p. 150–162). Strata of approximately this age are also present in central Oklahoma and in the Texas Panhandle (Amsden, 1975b, p. 75–76). In Marshall County, Oklahoma, the informally designated Turkey Creek limestone is a low-magnesium, low-acid-insoluble limestone that is slightly older than the Sallisaw Formation (but younger than the Frisco Formation); it rests directly on the Sylvan Shale. An upper Hunton core from the Kirkpatrick 1 Cronkite in Kingfisher County, central Oklahoma (Amsden, 1975b, p. 83), comprises low-magnesium limestones furnishing brachiopods similar to those in the Sallisaw Formation. The Phillips 1-C Lina, Ochiltree County, Texas Panhandle, yielded a small brachiopod fauna with similarities to that in the Sallisaw Formation, and the Standard of Texas 1 Wheeler Unit, Texas Panhandle, yielded terebratuloid brachiopods possibly representing the Sallisaw (Amsden, 1975b, p. 94, 103); in both cores the fossiliferous strata are low-magnesium, low-insoluble limestones. These late Early Devonian strata display an interesting lithofacies pattern. In the eastern areas of Tennessee, Illinois, and Arkansas they are mainly bedded cherts (novaculites), whereas the Sallisaw Formation of eastern Oklahoma is predominantly arenaceous, dolomitic limestone, locally grading into arenaceous, bedded chert; however, in central Oklahoma and the Texas Panhandle all known occurrences are represented by relatively low-magnesium limestones (text-fig. 19). These



Text-figure 19. Sketch map summarizing known distribution and lithofacies patterns of strata of late Early Devonian (Emsian, Esopusian) age in Midcontinent region.

strata were probably deposited as a more or less continuous sheet of sediment, and their present patchy distribution in Oklahoma is the result of extensive pre-Woodford erosion.

Pre-Sallisaw (Emsian) Erosion

Late Early Devonian strata are separated from the underlying strata by an erosional unconformity. In the eastern Oklahoma outcrop area the Sallisaw generally rests on the Frisco Formation, but locally it truncates the Frisco and rests directly on the Quarry Mountain Formation (Wenlockian) (Amsden, 1961, p. 55–58). In the subsurface areas south and east of Marble City the Sallisaw generally rests on the Chimneyhill Subgroup. Late Early Devonian strata cored in the Kirkpatrick 1 Cronkite of central Oklahoma probably rest on the Late Silurian *Kirkidium* biofacies, and in Marshall County strata of about this age rest on the Ordovician Sylvan Shale, a stratigraphic relationship that is also present in the Phillips 1-C Lina of the Texas Panhandle. In areas where the Frisco Formation is absent and the Sallisaw rests on older beds, an undetermined amount of the stratigraphic deletion may be ascribed to pre-Frisco erosion. However, the Sallisaw certainly truncates the Frisco, and the regional lithostratigraphic and biostratigraphic distribution of the latter suggests that it was originally a widely distributed blanket of sediments that was extensively breached subsequently by pre-Sallisaw as well as pre-Woodford (Chattanooga) erosion (see Frisco Formation).

Late Early Devonian Oil and Gas Production

The Sallisaw Formation (Penters Chert) covers a large area in eastern Oklahoma and western Arkansas (panel 4), an area that includes three fields reporting Hunton gas production (text-fig. 25). Of these, the Southeast Railford Field (T. 9 N., R. 14 E.; Kunsman, 1967, p. 176) reports gas production from the upper Hunton, from strata that probably include both the Sallisaw Formation and the upper part of the Chimneyhill Subgroup (see 1 Brotten and 1 Follansbee, Appendix). The Stephens 1 B&F Ranch, sec. 23, T. 11 N., R. 24 E., also reports Hunton gas production; Sallisaw strata are probably present in this well, although I have not been able to confirm this by sample examination. The Bonanza Gas Field in western Arkansas produces from the Hunton, but this is probably largely, if not entirely, from dolomitized lower Chimneyhill strata (see Bonanza Gas Field, Western Arkansas; 1 Western Coal & Mining Co., Appendix).

Emsian-age strata are present in central Oklahoma, in a lithofacies similar to that of the underlying Frisco Formation, which has production; however, I have no information on oil or gas production from these beds. Similar-age strata are also present in the Texas Panhandle, although, again, I have no data that would link Hunton production to this zone.

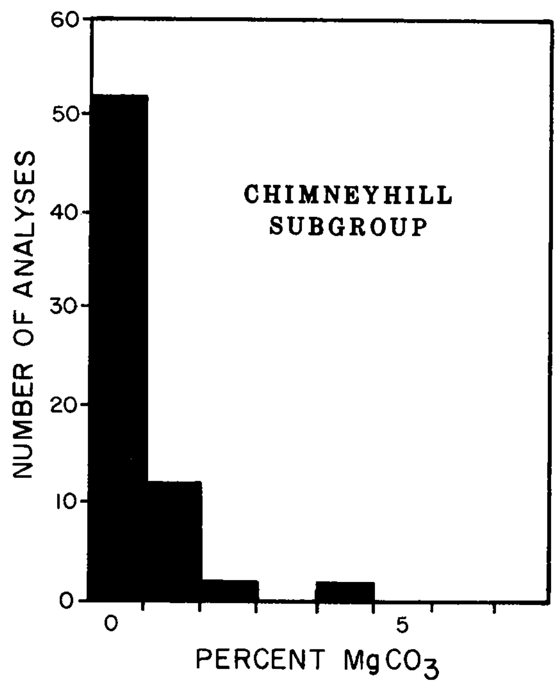
HUNTON DOLOMITE

The present investigation is a continuation of a study on Late Ordovician–Silurian–Devonian dolomites begun some years ago, a study primarily concerned with the geographic and stratigraphic distribution of the dolomite lithofacies and its relationship to the limestone lithofacies. Earlier papers discuss in some detail the dolomitization in the eastern outcrop area (Amsden and Rowland, 1965, p. 53–56), the Arbuckle Mountains-Criner Hills (Amsden, 1960, p. 16–18), and western Oklahoma (Amsden, 1975b, p. 43–56). Dolomitization in the Arkoma Basin is similar to that described in these earlier investigations, and I will confine my remarks principally to a discussion of new data acquired in the investigation of the subsurface of eastern Oklahoma.

Chimneyhill Dolomite Eastern Oklahoma

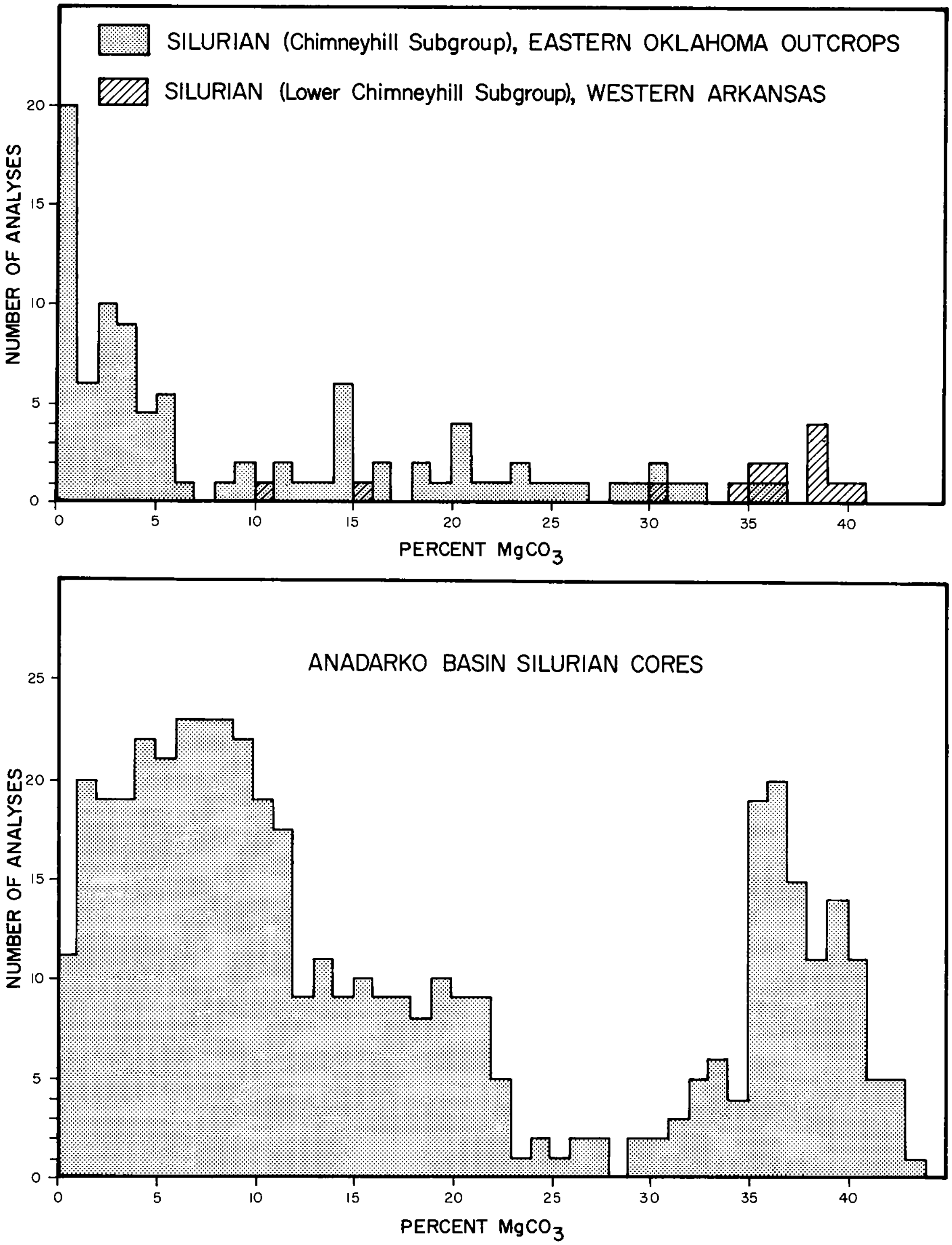
The region covered in the present report extends from the low-magnesium limestones of the Arbuckle Mountains into the dolomitized areas lying to the north and east. As discussed elsewhere, Upper Silurian strata are largely confined to the Arbuckle Mountains, Silurian rocks in the other parts of eastern Oklahoma comprising Chimneyhill equivalents only (text-fig. 7; panel 4). For this reason the following comments on Silurian dolomites are restricted to the Chimneyhill Subgroup, although it should be emphasized that dolomitization affects the entire Silurian section (Amsden, 1975b, p. 43-56) and that the absence of Upper Silurian rocks in eastern Oklahoma is the result of events that are independent of the limestone-dolomite lithofacies distribution.

Chimneyhill strata in the Arbuckle Mountains-Criner Hills are almost universally low-magnesium limestones, with the arithmetic mean, the mode, and the median being less than 1 percent $MgCO_3$ (text-fig. 20). A study of well samples by means of thin sections indicates that this low-magnesium lithofacies is fairly well confined to the southwestern part of the area under investigation, to parts of Atoka, Coal, and Pontotoc Counties and to southern Hughes, Seminole, and Pottawatomie Counties (panel 4). North and east of this region, Chimneyhill rocks are almost entirely dolomitic limestones and dolomites, i.e., strata that are estimated to exceed 6 percent $MgCO_3$ and that in large part exceed 10 percent $MgCO_3$. Chimneyhill dolomitization has been thoroughly investigated in the Marble City outcrop area, including numerous chemical analyses, and I believe this presents a good picture of the dolomitization that is present throughout most of the subsurface (Amsden and Rowland, 1965, p. 27-29, p. 33-35, 53-56, Appendix).



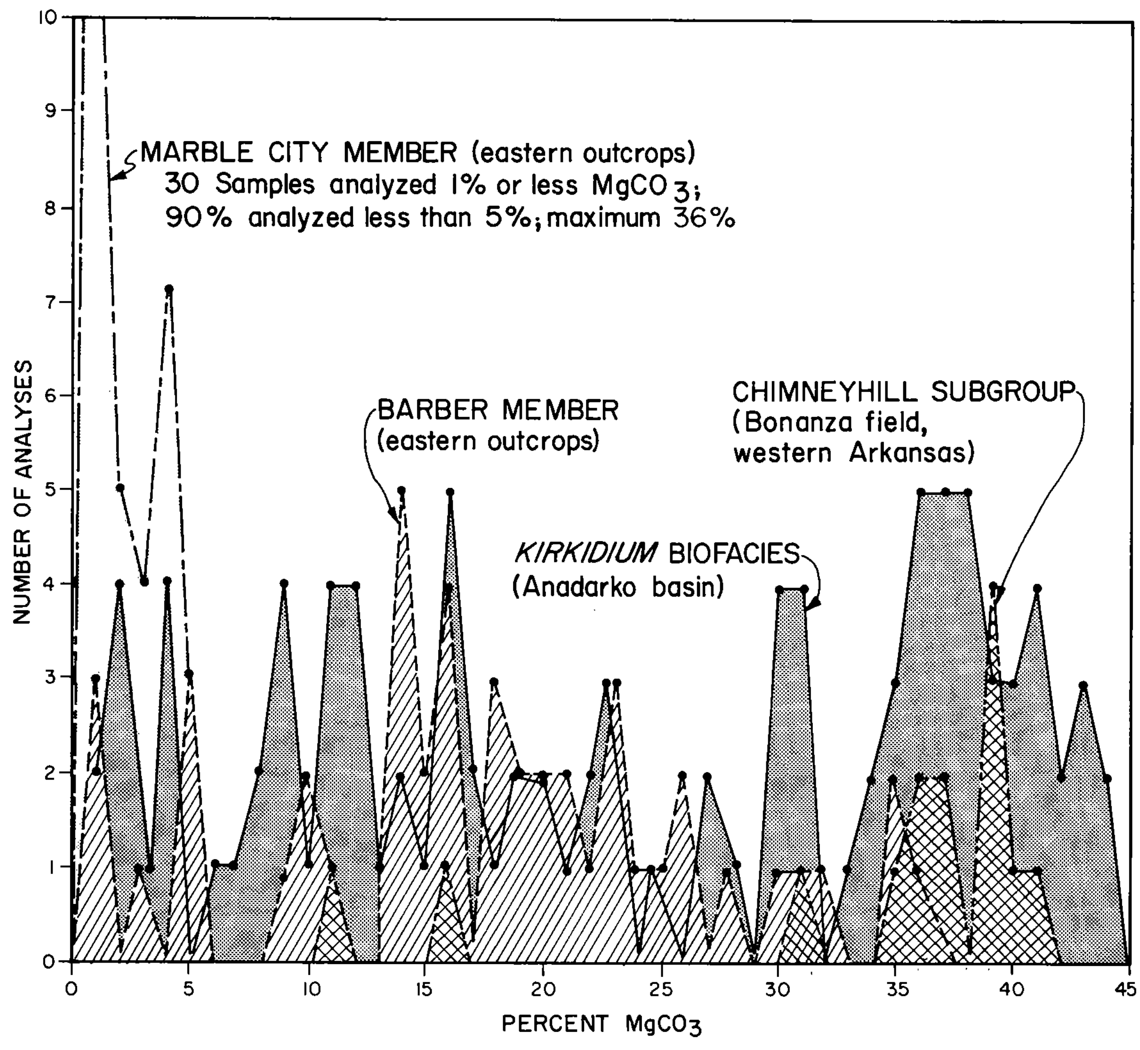
Text-figure 20. Frequency diagram showing distribution of $MgCO_3$ in surface samples of Chimneyhill Subgroup in Arbuckle Mountains-Criner Hills, Oklahoma. One Keel Formation analysis of 36.38 percent not shown (Amsden, 1960, p. 291). Data largely from Amsden (1960, Appendix).

The Chimneyhill strata in the Marble City area show a distinct stratigraphic control in the distribution of dolomite. However, all stratigraphic units, including the marble City Member, which has considerable high-calcium stone, show a lateral as well as a vertical gradation from limestone into dolomite. This gradation, which can be studied in mine and quarry exposures, in natural outcrops, in thin sections and in chemical analyses, takes place as follows: dolomite is first introduced as scattered euhedral crystals in the matrix of the organo-detrital limestones; the crystals increase in quantity and begin to impinge on the fossil clasts; the final stage is a complete obliteration of the organic material to produce a crystalline dolomite. The transformation from heavily dolomitized limestone to crystalline dolomite takes place at 28 to 29 percent $MgCO_3$ in a rock with low-acid insolubles (Amsden and Rowland, 1965, p. 53-54; Amsden, 1975b, p. 47). In the Marble City area, most of the Chimneyhill strata are represented by limestones, dolomitic limestones, and calcitic dolomites, with relatively little crystalline dolomite. Most chemical analyses fall below 25 percent $MgCO_3$ (text-figs. 21, 22), and even the relatively heavily dolomitized Barber Member seldom exceeds 27 percent $MgCO_3$ (the maximum is slightly over 36 percent $MgCO_3$, Amsden and Rowland, text-fig. 12, this report, text-fig. 22). In contrast, dolomitization in the Silurian cores of western Oklahoma is much more intense, with substantial bodies of crystalline dolomite and a number of analyses exceeding 40 percent $MgCO_3$ and some approaching pure dolomite (Amsden, 1975b, p. 44; text-figs. 20, 21, this report). This indicates that Silurian rocks in the Marble City area, as in most of the subsurface of eastern Oklahoma, are, on the whole, represented by an intermediate stage of dolomitization. A more intense dolomitization is present in easternmost Oklahoma, in northern Le Flore and southern Sequoyah Counties, extending westwards into Sebastian County, Arkansas



Text-figure 21. Frequency diagram comparing distribution of $MgCO_3$ in Silurian rocks from outcrop area, eastern Oklahoma, and a core from 1 Western Coal & Mining Co., western Arkansas, with Silurian strata from subsurface (cores), Anadarko Basin, western Oklahoma. Rocks sampled in eastern Oklahoma are from Chimneyhill Subgroup (Quarry Mountain, Tenkiller, and Blackgum Formations). Western Arkansas samples are from a core cutting lower part of Chimneyhill Subgroup. Anadarko Basin cores are from Chimneyhill Subgroup and overlying Upper Silurian *Kirkidium* biofacies. From Amsden and Rowland (1965, p. 158–167), Amsden (1975b, p. 48, 118–176), and Appendix, this report.

(panel 4). A study of well samples by thin section shows much crystalline dolomite, and the Shell 1 Western Coal & Mining Co. well in the Bonanza Gas Field, Arkansas, cored the lower part of the Hunton and the upper few feet of the Sylvan Shale (Appendix). Thin sections and chemical analyses of this core show it to be largely porous, crystalline dolomite with only a 2-foot bed of moderately dolomitized, organo-detrital, crinoidal limestone having 11 to 16 percent $MgCO_3$ (text-figs. 21, 22; pl. 1, figs. 1-6). Twelve of the chemical analyses (spot samples) from this core exceed 30 percent $MgCO_3$, and two are more than 40 percent (pl. 1, figs. 1, 2, 4-6). This area, and another in the northwestern part of the region studied (panel 4), represent a more intense dolomitization than developed in other parts of eastern Oklahoma and one which approaches that of the northwestern Anadarko Basin (Amsden, 1975b, panel 2; cf. with panel 4, this report).



Text-figure 22. Frequency diagram showing distribution of $MgCO_3$ in Barber and Marble City Members, Quarry Mountain Formation, eastern Oklahoma outcrops (one analysis from each member with 36 percent $MgCO_3$); *Kirkidium* biofacies, Anadarko Basin, western Oklahoma; and core from lower Chimneyhill Subgroup, 1 Western Coal & Mining Co., Bonanza Field, western Arkansas (Appendix). (Quarry Mountain is uppermost formation in Chimneyhill Subgroup and is older than *Kirkidium* biofacies.) Modified from Amsden and Rowland (1965, text-fig. 12), Amsden (1975b, text-fig. 14), and Appendix, this report.

Chimneyhill Dolomite Porosity

Well-sample studies show two areas in eastern Oklahoma where Chimneyhill strata are heavily dolomitized (panel 4). These areas are believed to include considerable porous, crystalline dolomite, although it is difficult to obtain much quantitative data because of the scarcity of cores. A welcome exception is the Shell 1 Western Coal & Mining Co. core, which cuts the lower 15 feet of the Chimneyhill. Thin sections and chemical analyses show this rock to be mainly porous, crystalline dolomite, with many of the pores formed of fossil molds, produced mainly by the dissolution of crinoid plates, along with some fractures that were probably enlarged by solution (pl. 1, figs. 1-6). This rock is identical in appearance and chemical composition to the porous, crystalline dolomites of western Oklahoma, and the rocks in the two regions are believed to have originated in the same way (Amsden, 1975b, p. 56-65).

Silurian Dolomitization

The principal conclusions with respect to Silurian dolomitization in Oklahoma and adjacent areas can be summarized as follows: (1) Silurian dolomites were emplaced before middle Early Devonian (Siegenian) time; the Frisco Formation is a widely distributed, universally low-magnesium limestone that extends from the undolomitized onto the dolomitized Silurian strata but does not itself participate in the dolomitization; (2) all of the Late Ordovician-Silurian limestones, dolomitic limestones, calcitic dolomites, and crystalline dolomites (where they preserve any original texture) bear marine fossils; (3) the limestones are a lithofacies of the dolomites; and all data—field, megascopic, and microscopic—clearly indicate that low-magnesium limestones grade laterally and vertically into high-magnesium dolomites; (4) there is much geographic and stratigraphic variation in the degree of dolomitization, but all parts from the Keel oolite (Late Ordovician) through the Henryhouse Formation (Late Silurian) participate in the dolomitization; (5) Hunton Silurian dolomites have a distinct geographic concentration in Oklahoma and are a part of the North American dolomite province.

Hollrah (1978, p. 173-174), in a recent study of Hunton rocks in Payne, Lincoln, and Logan Counties, suggested that the dolomites originated by a process of secondary, late-stage dolomitization. I would like to comment on this explanation, as it relates to the regional distribution of Silurian dolomites, of which the Hunton rocks are clearly a part. For some years it has been known that Silurian strata in North America are represented by a limestone province and a dolomite province, separated by a reasonably well-defined dolomite "front" which can be traced across Mexico, the United States, and Canada (Amsden, 1955, map, p. 62-63; Berry and Boucot, 1970, p. 87-89, map, pl. 1; Amsden, 1975b, panel 11). Some dolomites do occur in the limestone province, but for the most part these strata are largely low-magnesium limestones; Hunton Silurian strata in the Arbuckle Mountains average less than 3 percent $MgCO_3$. Dolomitization intensity does vary in the dolomite province, and some low-magnesium strata are present, but viewed regionally dolomitization is pervasive, with beds of dolomitic limestone, calcitic dolomite, and crystalline dolomite distributed through the entire Silurian section. The quantity of magnesium carbonate locked up in the dolomite province is immense. Other than dolomite, there is no essential difference between the carbonate rocks in these two provinces, both being made up in large part of organic material, commonly dominated by pelmatozoan debris. The dolomite front is independent of structure, cutting across such major features as the Anadarko Basin and the Central Oklahoma Fault Zone. Unconformities are not a factor in the locus of dolomitization, and there appears to be no relationship between the Silurian dolomites in Oklahoma and the pre-Woodford erosion surface (Amsden, 1975b, panel 10).

I do not think a process of secondary dolomitization is adequate to explain these relationships. Certainly there is some secondary dolomitization, as shown by the dolospar-filled cavities; however, there is substantial evidence to indicate that this is only a minor reorganization imposed on an earlier, major dolomite pattern (Amsden, 1975b, p. 62-63, pl. 3, figs. 1, 3, pl. 12, figs. 1, 2). A reorganization of magnesium in the dolomite province by meteoric waters removing magnesium from the crinoidal limestones and concentrating it in beds of dolomite would appear to be an inadequate source of magnesium carbonate. Numerous analyses of organic-rich, pelmatozoan limestones from the limestone province show a $MgCO_3$ content averaging only 1 or 2 percent. On the other hand, derivation of the magnesium from the organic-rich debris in the limestone province by solution, and transportation by meteoric waters, involve the movement of such a large volume, and over such long distances, as to appear quite unrealistic. In earlier papers I have explained the major Silurian dolomitization by penecontemporaneous replacement at the depositional interface, utilizing the sea water as the source and transporting medium. I readily admit that such a hypothesis encounters serious difficulties, especially with respect to the extraction of the magnesium from the sea water. The origin of dolomite is a difficult, perhaps in some cases unsolvable, problem, but I would emphasize that both the textural and time-space (stratigraphic-geographic) relationship of limestone to dolomite in Silurian-age strata is now reasonably well known, and any plausible explanation should be in accord with these data.

Sallisaw Dolomite

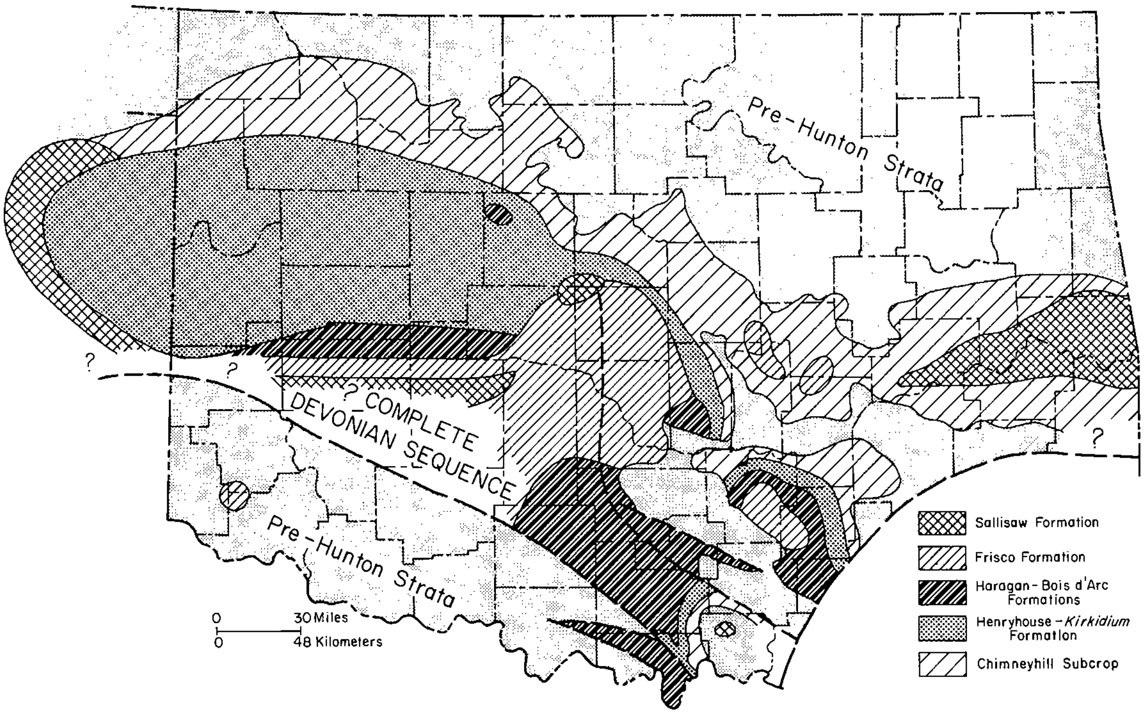
The $MgCO_3$ content of the Sallisaw Formation ranges widely, from a trace to slightly over 25 percent, averaging about 11 percent (Amsden, 1961, p. 47–54). In the Marble City area this formation is generally underlain by the Frisco Formation, which is everywhere a low-magnesium limestone. Parts of the Sallisaw are also low-magnesium stone, but in places beds of high-magnesium, arenaceous limestone rest directly on the Frisco limestone. Underlying the Frisco limestone is the Marble City Member of the Quarry Mountain Formation, which also has a highly variable magnesium content, and in some outcrops Marble City beds of high-magnesium carbonate are in direct contact with the Frisco Formation. Thus at stratigraphic section S9 in Payne Hollow, the Frisco Formation, with less than 2 percent $MgCO_3$, is underlain by the Marble City Member, the uppermost beds of which have slightly more than 35 percent $MgCO_3$, and overlain by the Sallisaw Formation, with more than 26 percent $MgCO_3$ (Amsden and Rowland, 1965, p. 54). This stratigraphic control in the distribution of dolomite strongly suggests that the Sallisaw dolomite, like the Silurian dolomite, was introduced at the time of deposition.

As noted in the chapter on the Sallisaw Formation, the regional lithofacies pattern for late Early Devonian strata shows the arenaceous dolomitic limestones and arenaceous cherts of the Sallisaw Formation grading eastward into bedded cherts and westward into limestones (text-fig. 19).

MIDDLE PALEOZOIC HISTORY OF ANADARKO AND ARKOMA BASINS

During Late Ordovician (Sylvan) to Early Mississippian (Woodford-Chattanooga) time, Oklahoma and adjacent areas had a complex geologic history, with periods of widespread marine sedimentation alternating with times of uplift and erosion. Three major depositional episodes are represented: (1) an initial deposition of gray muds, in places strongly calcareous and grading into limestones, during the Late Ordovician (Sylvan); followed by (2) shallow-water carbonate sedimentation (Hunton), interrupted by two major and several minor periods of uplift and erosion, and concluding with a long period of uplift and erosion (Middle Devonian; text-fig. 23); (3) burial of the entire sequence by a blanket of dark muds (Woodford-Chattanooga) laid down in a westward-advancing sea that locally incorporated substantial clastic debris (Misener-Sylamore) derived largely from the underlying erosional surface. The carbonates are mostly intrabasinal in origin, being composed mainly of organic material and including only moderate amounts of fine, terrigenous clastics derived almost entirely from the Ouachita region to the south. Silurian carbonates comprise a southern limestone belt and a northern dolomite belt, both bearing typical benthic marine faunas.

A large part of this region was occupied by two structural-sedimentary basins: the Anadarko Basin of western Oklahoma and the Texas Panhandle and the Arkoma Basin of eastern Oklahoma and western Arkansas (text-figs. 24, 25). The structurally deeper, southern part of the Anadarko Basin was actively subsiding during the middle Paleo-



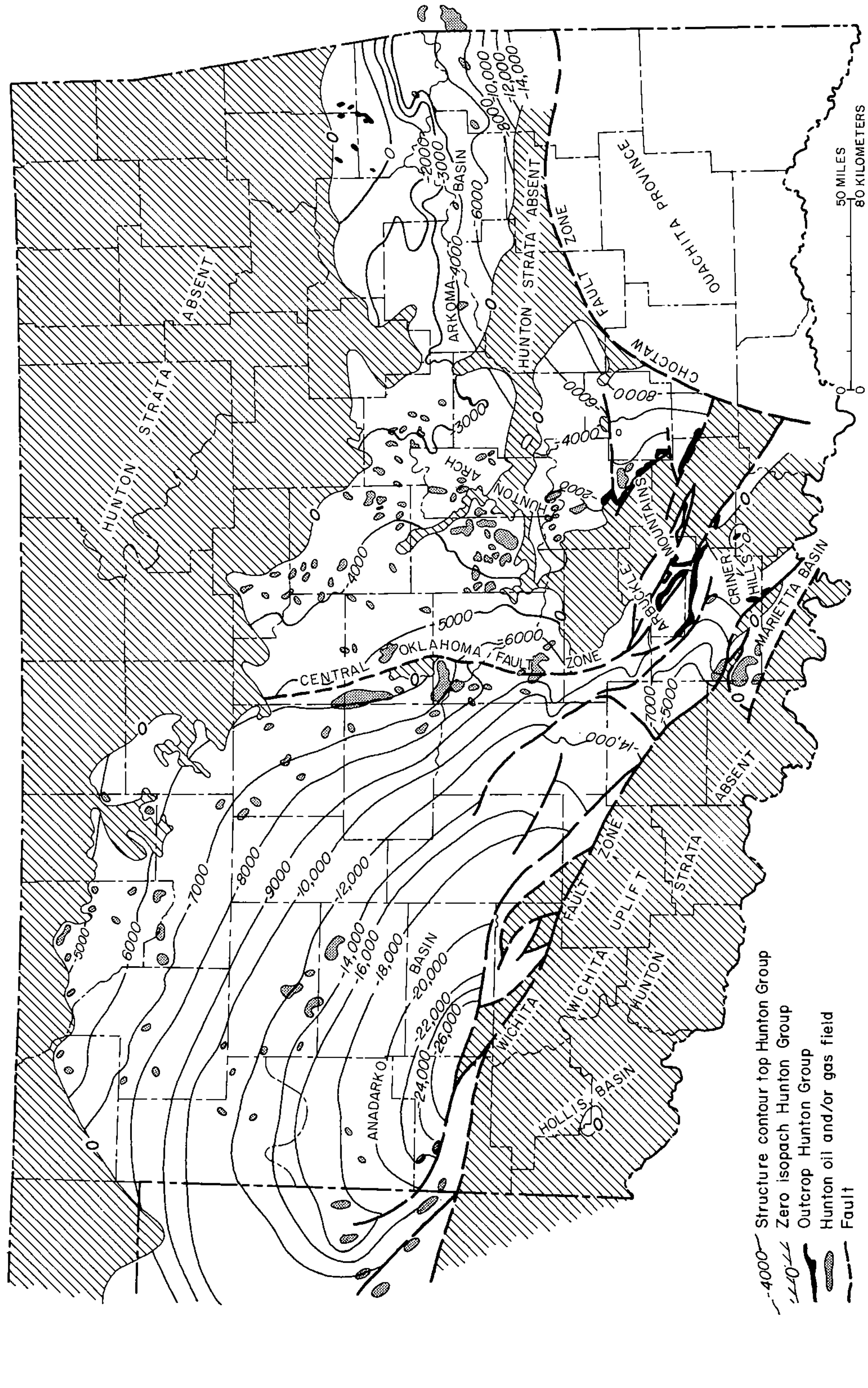
Text-figure 23. Pre-Woodford geologic map. From Amsden (1975b, panel 9) and from panel 4, this report. Sallisaw Formation on map includes Turkey Creek limestone of Marshall County and various late Early Devonian limestones in central and western Oklahoma and Texas Panhandle.

zoic, although no geosynclinal sediments were deposited during this time. On the other hand, there is no evidence for a clearly defined south-subsiding Arkoma sedimentary basin during the Late Ordovician, Silurian, and Early Devonian, and it was not until the Late Devonian that a reasonably well-delimited south-subsiding basin was again developed. (The Middle Ordovician Simpson Group thickens toward the south and west.)

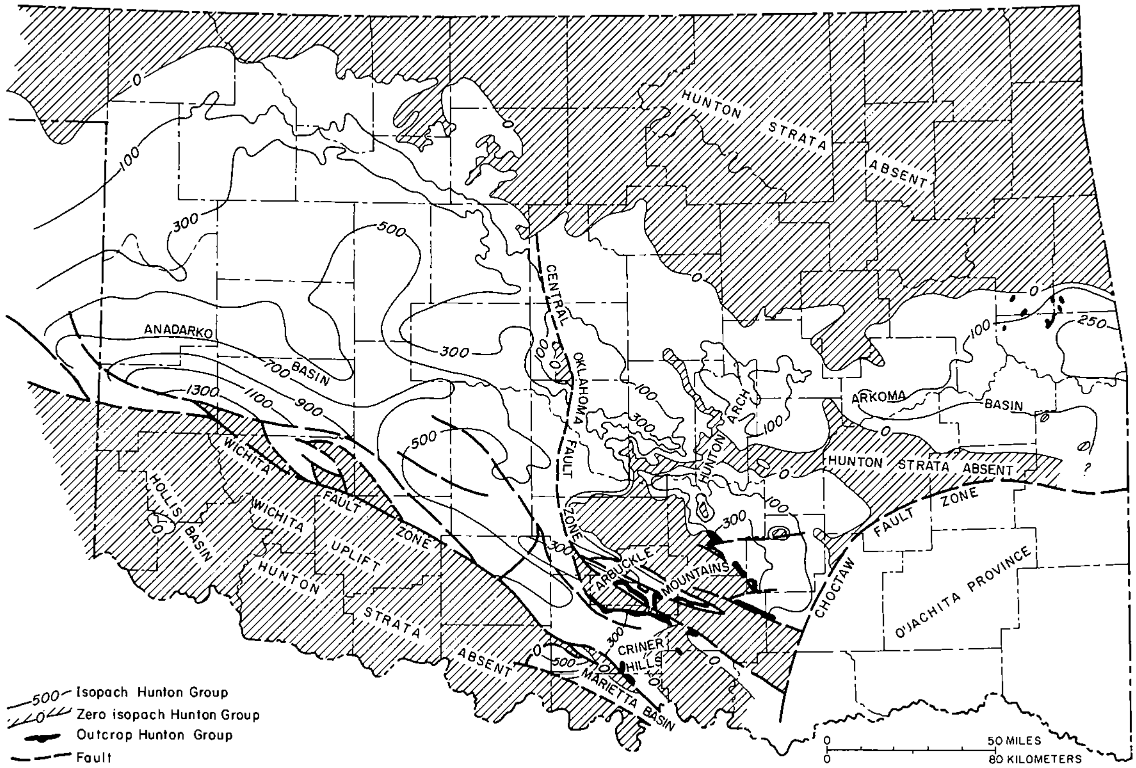
The Anadarko and Arkoma Basins are separated from one another by a region that includes the Arbuckle Mountains and Criner Hills, the Hunton Arch, and the Central Oklahoma Fault Zone. (The Marietta and Ardmore Basins are not herein discussed.) The relatively thin stratigraphic sequence and the presence of numerous local unconformities in the Arbuckle Mountains–Criner Hills, plus the evidence for movement on the Central Oklahoma Fault Zone during the middle Paleozoic (Amsden, 1975b, p. 15), suggest that this region was intermittently positive during this time.

Anadarko Basin

The following discussion is primarily concerned with the Late Ordovician (Sylvan Shale) to Early Mississippian (Woodford Shale) history of the Anadarko Basin in western Oklahoma (text-figs. 24, 25). It should be stressed that very little biostratigraphic information is available for depths greater than −15,000 feet. The Ampexco 1 Green (sec. 31, T. 10 N., R. 26 W.), which cored the intervals from 19,599 to 19,770 feet and 20,230 to 23,260 feet, provides some useful lithostratigraphic and biostratigraphic information and will be discussed in a later report. Aside from this well, almost all my information on the deep part of the basin comes from mechanical logs and well samples, the latter having been studied by means of thin sections. These results provide no biostratigraphic data, and accordingly almost all age assignments below −15,000 feet are based on inferences derived from lithostratigraphic correlations with areas where the biostratigraphy is known, pri-



Text-figure 24. Structure map of Hunton Group. Contour values shown in feet. After Amsden (1975b, panel 5) and this report, panel 2. Stippled areas show Hunton oil and gas fields (mainly from Kunsman, 1967, with later additions; data for northwestern Oklahoma supplied by Warren Evans; Texas Panhandle data from Jemison, 1979, p. 805).



Text-figure 25. Isopach map of Hunton Group. Isopach values shown in feet. After Amsden (1975b, panel 6) and this report, panel 2.

marily the Arbuckle Mountains–Criner Hills to the east and the cored areas in the shallower northern and western parts of the basin. My 1975 Anadarko basin study (Amsden, 1975b) includes the following regional maps: isopach and structure maps of the Sylvan Shale, Hunton Group, and Woodford Shale; pre-Woodford geologic map, lithofacies maps, and stratigraphic sections.

In Late Ordovician time the Sylvan sea largely covered Oklahoma, extending from the Wichita Fault Zone over much of the Anadarko Basin. In this report it is assumed that the Wichita Fault Zone developed early in the basin history (Ham and others, 1964, p. 33–37, 149–154, text-fig. 3; Amsden, 1975b, p. 76), with the area to the north more or less continually depressed to produce a shallow sedimentary basin and the area to the south intermittently uplifted to produce a topographic high. No Sylvan, Hunton, or Woodford strata have been found on the Wichita Mountain Uplift (Chase and others, 1956, p. 37, fig. 1). Hunton and Sylvan strata are reported to be rather widely distributed in the Hollis Basin (Jordan, 1962); however, the only biostratigraphic record of Hunton strata in this basin known to me is from a core in the Tidewater 1 Johnson (sec. 19, T. 3 N., R. 23 W.), where the Frisco Formation is overlain by Mississippian(?) and underlain by Viola (Amsden, 1975b, p. 21). According to my interpretation, Frisco strata are present in the deep part of the Anadarko Basin, where they rest on a substantial thickness of older Hunton and Sylvan beds (Amsden, 1975b, panel 10, section *C–C′*), and the presence in Jackson County of the Frisco Formation resting directly on the Viola Limestone indicates movement along the Wichita Fault Zone during middle Paleozoic time. The amount of Late Ordovician–Early Devonian sedimentation, if any, which occurred prior to Frisco time cannot be determined on the basis of the available evidence. Similarly, if any Devonian strata had been deposited after middle Early Devonian time they were removed by post-Woodford erosion, leaving only an isolated remnant (or remnants) of Frisco strata on the Wichita Uplift.

The Sylvan sea supported almost no sessile or vagrant benthos, and only one inarticulate brachiopod has been described (Cooper, 1956, p. 244, pl. 23D, figs. 7-13); the Sylvan does, however, have a substantial fauna of graptolites (Decker, 1935, 1945), chitinozoans, and acritarchs (Jenkins, 1970). This sea deposited a thin blanket of gray to greenish-gray muds, calcareous muds, and dolomitic muds, which probably never exceeded a few hundred feet in thickness (Ham, 1969, p. 10; Amsden, 1975b, panel 8). Along the northern margin of the present Anadarko Basin, Sylvan strata thin to zero as the result of pre-Woodford erosion, but in those areas where it is overlain by Hunton rocks the Sylvan shows a modest but persistent thickening into the deep part of the basin, where locally it attains a thickness of about 400 feet (Amsden, 1975b, panel 8). This progressive increase in thickness in the structurally deep part of the basin, a condition that persisted through Hunton and Woodford time, is attributed to an increased rate of subsidence in the southern part of the basin bordering the Wichita Uplift. Sylvan sedimentation appears to have continued with little or no interruption into Hunton time, with some evidence that the carbonate deposition of the Hunton began at different times in different parts of the basin (see earlier section on Silurian-Devonian boundary). The depositional environment of shales whose faunas and floras are largely restricted to planktonic organisms is conjectural. The Sylvan is everywhere composed of fine clastics, suggesting that it was some distance removed from the source or, alternately, that some barrier effectively screened out the coarser material. The finely divided, evenly bedded character of the sediments, combined with the almost complete absence of any sessile or vagrant benthos, suggests either relatively deep water (Ham, 1969, p. 11), cold water, or a basin with a restricted bottom circulation. The lateral gradation of the Sylvan Shale into a carbonate lithofacies, which occurs in some places, suggests that the latter explanation is the most plausible.

The start of Hunton sedimentation in the Late Ordovician initiated a long period of carbonate deposition. This deposition commonly began with the formation of oolites, followed by organo-detrital sparites and micrites. Insoluble detritus, almost exclusively in the silt and clay size, is concentrated in the southern margin of the basin, extending from the structurally deep part of the basin eastward to the Arbuckle Mountains and Criner Hills. In the Chimneyhill Subgroup these clastics are low in volume and form a rather faint southern halo, but in the Upper Silurian Henryhouse Formation and Lower Devonian Haragan Formation the terrigenous detritus increases to an average of about 20 percent and locally passes into a calcareous shale. The concentration of this detritus in a broad belt lying along the southern margin of the basin points to a southeastern source in the Ouachita region (Amsden, 1975b, p. 23–24, panel 11; this report, Clarita Formation, and text-figs. 6–8). Northward, these marlstones pass into typical shallow-water organo-detrital platform deposits (*Kirkidium* biofacies). (Early Devonian (Helderbergian) deposits are largely absent in this region, owing to pre-Frisco erosion.) Still farther north, Silurian limestones pass into dolomites, which I interpret as representing a penecontemporaneous replacement brought about by a moderate shoaling of the water (Amsden, 1975b, p. 51–56). It should be emphasized that all Hunton limestones are shallow-water deposits, and even the marlstones appear to represent an outer neritic environment, probably well under 200 meters deep (Amsden, 1975b, p. 38–41). In the structurally deep part of the basin, marlstone deposition was succeeded by organo-detrital limestones, probably representing Frisco and younger Devonian limestones (Amsden, 1975b, panel 10).

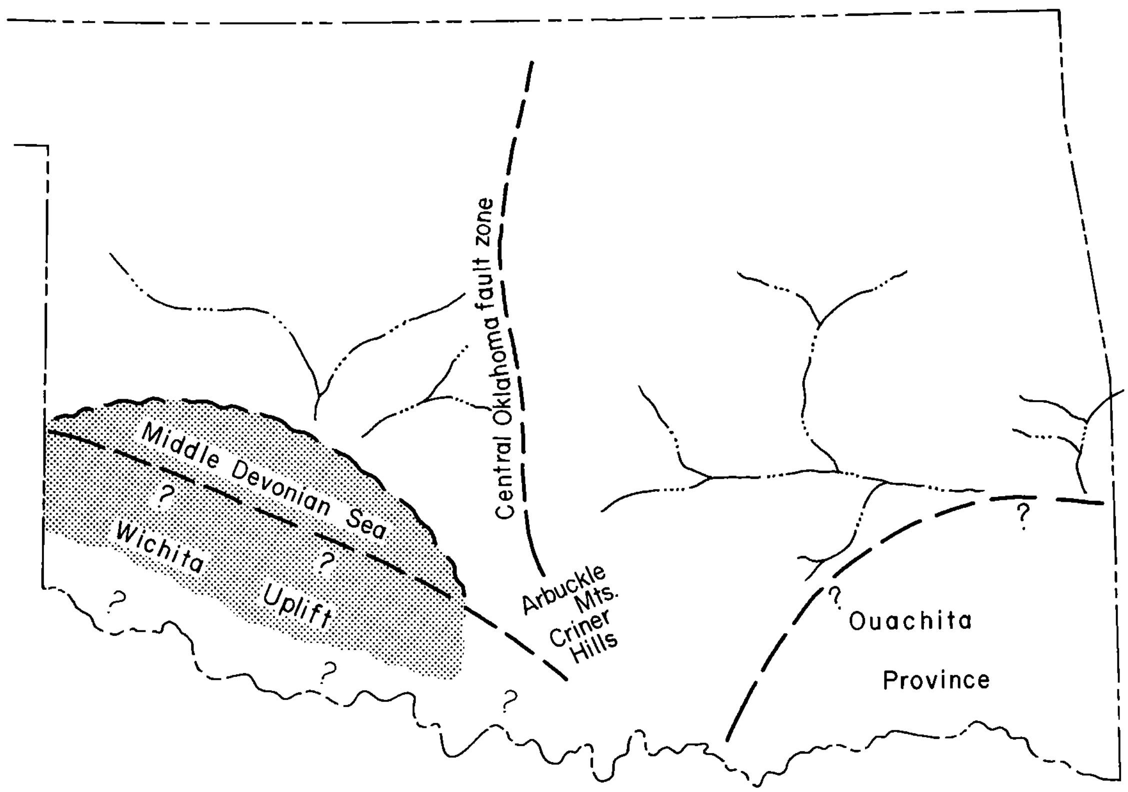
I believe that deposition in the southern, structurally deep part of the basin was essentially continuous from Late Ordovician time (certainly Sylvan time, and probably beginning earlier) through Silurian, Devonian, and into Mississippian time (Woodford time and probably continuing much later). Since no biostratigraphic control is available for the deep part, this is an inference based on the following data: (1) all stratigraphic units thicken from north to south, reaching their maximum thickness in the structurally deepest part of the basin, and (2) Hunton isopachs show many irregularities in the northern, shallower part of the basin, becoming regular and more or less paralleling the structural contours in the structurally deep part (Amsden, 1975b, panel 1, map B, panels 5, 6; this report, figs. 24, 25). I interpret these conditions as the result of continuous subsidence and deposition in the southern part of the Anadarko Basin, whereas in the northern part sedimentation was interrupted by periods of uplift and erosion, demonstrably in pre-Frisco and pre-Woodford time but possibly including other times as well. The unconformable relationships in the northern area can be documented in the cores cutting Woodford and Hunton strata; however, the biostratigraphic relations in the deep part must be inferred from the lithostratigraphic and isopach data available from samples and mechanical logs. It is, of course, possible that the uniformity of isopachs in the deep part of the basin is more apparent than real, being the result of a decrease in the number of control wells in the structurally deep part. But I do not think this is the case, because the sample data indicate that all lithostratigraphic units in the Hunton Group thicken, thus suggesting that the Early and Middle Silurian (Chimneyhill) organo-detrital limestone sequence was thickening, the Late Silurian and Early Devonian marlstones (Henryhouse–Haragan–Bois d'Arc) were thickening, and so on.

The pre-Frisco and pre-Woodford unconformities involve subaerial erosion (see sections, Woodford (Chattanooga) Shale and Misener (Sylamore) Sandstone, Frisco Formation), and for the latter a drainage pattern is postulated in text-figure 26. This drainage is based largely on a Hunton isopach map (Amsden, 1975b, panel 6) and infers streams flowing southward into a restricted sea. These streams were flowing primarily over a carbonate terrane and thus transported only modest quantities of fine detritus. A relatively thick sequence of silty carbonates, provisionally referred to the Misener, is present at the top of the Hunton in the deep part of the Anadarko Basin (Amsden, 1975b, panel 10, section *C–C′*). A part of this sequence may have been provided by this drainage system, but I believe most of the sediments came from the Ouachita region (text-fig. 8). Pre-Woodford erosion took place mainly in Middle Devonian time; this restricted southern Anadarko sea thus would be mainly of Middle Devonian age. According to this explanation, the sea extended south to the Wichita block, which was at times partly to completely submerged and at other times uplifted and exposed to erosion. On the north the sea was bounded by the uptilted, north segment of the Anadarko Basin. This explanation requires a southeast-northwest, somewhat arcuate hinge line along which the basin rotated—up to the north and down to the south. The rotation required is slight, needing only a moderate downtilt to the south sufficient to produce a shallow-water basin and an uptilt to the north sufficient to produce a moderate uplift above sea level.

In late Middle to early Late Devonian time the entire region was submerged, and the Woodford (Chattanooga) sea deposited a blanket of sediments covering most of Oklahoma and adjacent areas. Where terrigenous clastic material was available—largely quartz sand and chert detritus—this material was incorporated as a basal facies (Misener-Sylamore) of the Woodford. In the Anadarko Basin the southern part continued to subside faster than the northern part, producing a thickness increase from about 25 feet in the north to more than 500 feet in that part bordering the Wichita Uplift. No Woodford has been recognized on the Wichita Uplift; if any was deposited, it was removed by subsequent erosion. The Woodford (Chattanooga) is mostly a dark shale with a large fauna of conodonts, spores, and *Tasmanites,* a spore-like alga; also present are fish, crustaceans, and large tree trunks (see Wilson, 1958, p. 176). The tree trunks may have been washed in from some land area, or possibly they were derived from the old land surface over which the Woodford sea advanced. The Woodford fauna, like that of the Sylvan, has little or no sessile or vagrant benthos, indicating restricted bottom conditions.

Arkoma Basin

The following discussion pertains to the period from Late Ordovician (Sylvan Shale) to Early Mississippian (Woodford, Chattanooga Shale) time in the region extending



Text-figure 26. Map showing inferred drainage pattern developed during pre-Woodford erosion, and restricted Middle Devonian sea in southern part of Anadarko Basin. Based mainly on Hunton isopach maps from Amsden (1975b, panel 6) and this report, panel 2. Gary W. Hart, Oklahoma City, provided data for Bonanza Field in western Arkansas.

from the eastern Arbuckle Mountains to western Arkansas, including the Arkoma Basin. Several cores from the area north of the Arbuckle Mountains were examined, but only three cores were available to me from the Arkoma Basin, the most southerly being the Humble 1 Farmers Flag unit in sec. 3, T. 8 N., R. 23 E (Appendix). All information on the region south of this well was derived from a study of well samples by means of thin sections. The panels accompanying this report include isopach and structure maps of the Sylvan Shale, Hunton Group, and Woodford Shale; a pre-Woodford geologic map; stratigraphic sections; and a Chimneyhill lithofacies map. During Sylvan time a sea covered most of Oklahoma, including the Arkoma Basin, the Arbuckle Mountains–Criner Hills, and the Anadarko Basin. This sea deposited a thin blanket of greenish-gray to gray muds, which became increasingly dolomitic toward the close of Sylvan time. Over most of the area of the present structural Arkoma Basin, the Sylvan is less than 75 feet thick, with no evidence for any southward thickening; in fact, the only clearly visible trend is a thickening toward the southwest into the Arbuckle Mountain area and on into the Anadarko Basin, where thicknesses greater than 300 feet are present (Amsden, 1975b, panel 7; panel 1, this report). Graptolites (Decker and Huffman, 1953, p. 451), chitinozoans, and acritarchs (Jenkins, 1970) are present, but the sessile and vagrant benthos are almost entirely absent from the Sylvan Shale (see prior section on Anadarko Basin). Sylvan sedimentation probably continued with little interruption into earliest Hunton (Keel-Pettit) time.

Hunton carbonate deposition began in Late Ordovician time and continued through Early Devonian time, interrupted by periods of uplift and erosion. In most places deposition was initiated by oolitic sediments, interrupted a break in deposition, followed by organo-detrital carbonates; this type of depositional cycle continued through Chimneyhill (Wenlockian) time. Chimneyhill strata in the Arbuckle Mountains–Criner Hills area occur in a limestone lithofacies, which, to the north and east, grades into dolomitic limestones, calcitic dolomites, and crystalline dolomites (panel 4). Both the limestones and the dolomites bear marine fossils. Chimneyhill deposition closed with an increase in terrigenous detritus (early Ludlovian), producing the mud-supported marlstones of the Late Silurian Henryhouse Formation and Early Devonian Haragan–Bois d'Arc (Cravatt Member) Formations. The flood of terrigenous detritus was then greatly reduced, and a sequence of organo-detrital limestones was deposited (Bois d'Arc, Fittstown Member, and Frisco Formation). A second flood of terrigenous quartz detritus gave rise to the sandy dolomites and sandy cherts of the late Early Devonian Sallisaw Formation. At present, Henryhouse–Haragan–Bois d'Arc marlstones are confined to the southwestern part of the area under study (panel 4; text-figs. 7, 17), although, for reasons discussed elsewhere, I infer that these strata were originally deposited over most if not all of this region, having been later removed by pre-Frisco and pre-Sallisaw erosion, as shown in text-figure 18 (see Haragan and Bois d'Arc Formations, Frisco Formation). The depositional pattern in the Arkoma Basin area was not like that of the Anadarko, which had a southern axis of increased subsidence and deposition. All data indicate that during Hunton time, as during Sylvan time, the Arkoma Basin area was a carbonate platform receiving a thin, uniform veneer of organo-detrital limestones and dolomites. At present, Hunton rocks form a thinly lenticular body of sediments that thin to zero along both the north and south margins (panels 2, 4, 5), a pattern that I believe is due largely to pre-Woodford (Chattanooga) erosion.

Prior to deposition of the Frisco Formation in middle Early Devonian time there was a period of uplift and erosion, during which time the Helderbergian Haragan–Bois d'Arc Formations and the Upper Silurian Henryhouse Formation were stripped away over most of eastern Oklahoma (text-figs. 7, 16, 17). At this time the exposed surface was subjected to dissolution, which produced many cavities. This period was followed by deposition of the Frisco, then another period of erosion, followed by deposition of the Sallisaw Formation. A long period of uplift and erosion preceded deposition of the Late Devonian Woodford (Chattanooga) Shale, during which time a southeast-flowing drainage system developed (panel 2; text-fig. 26). The evidence for these developments is derived primarily from the thickness and distribution of Hunton strata in the structural Arkoma Basin (panel 2). In this basin Hunton rocks thin to zero along the southern as well as the northern margins, a thinning that appears to be related directly to pre-Woodford truncation. The thickest Hunton strata lie in the center of the structural basin and consist of Lower Devonian rocks with successively older Silurian strata occupying the southern as well as the northern flanks (panel 4). The pattern of the zero Hunton isopach along the northern and, especially, the southern margin points to erosion by a drainage system like the one suggested in text-figure 26. Pre-Woodford erosion was accompanied by much dissolution, during which time an extensive network of cavities and crevices developed on the older limestone surface.

As the Woodford sea advanced westward it encountered residual insoluble debris derived by dissolution of the older carbonates, and this material was incorporated as a basal sediment (Sylamore and Misener Sandstones). These basal sands, locally conglomeratic, have an erratic distribution that appears related to the availability of detritus in the underlying rocks. The dark muds of the Woodford (Chattanooga), locally containing the Sylamore-Misener coarser clastics at their base, buried all the older strata. It should be emphasized that these sediments, unlike the older Hunton and Sylvan strata, thicken toward the south, from about 25 feet along the northern margin to more than 150 feet at the southern edge of the structural basin (panel 3), thus marking a change from the depositional pattern of the preceding Sylvan-Hunton sequence to the basinal sedimentation developed in the later Paleozoic. As noted in the discussion of the Anadarko Basin, the fauna and flora of the Woodford consist largely of spores, conodonts, and the alga *Tasmanites,* with very little sessile or vagrant benthos, suggesting restricted bottom circulation.

REGIONAL STRUCTURE AND THICKNESS OF HUNTON STRATA

The Hunton structure and isopach maps shown in text-figures 24 and 25 are simplified and somewhat generalized from my 1975 maps of the Anadarko Basin (Amsden, 1975b, panels 5, 6) and the Arkoma Basin maps of the present report (panel 2). Their primary purpose is to show the relationship of the two basins to each other and to the Criner Hills–Arbuckle Mountains, Hunton Arch, and Central Oklahoma Fault Zone. As noted in the section on Middle Paleozoic History of Anadarko and Arkoma Basins, I regard the central area separating the two basins to have been intermittently positive during middle Paleozoic time, as evidenced by local unconformities developed during Silurian and Early Devonian time. The complete Hunton sequence in the Arkoma Basin is, on the whole, thinner than in parts of the Arbuckle Mountains–Criner Hills, but this is due to the deletion of all Late Silurian and earliest Devonian strata by extensive pre-Frisco erosion. Chimneyhill rocks in eastern Oklahoma are considerably thicker than in the Arbuckle Mountains–Criner Hills area. Hunton rocks in northwestern Oklahoma, in the area north of the structurally deep part of the Anadarko Basin, are largely Silurian in age, the Lower Devonian rocks having been stripped away by pre-Woodford erosion. In this region both the Chimneyhill Subgroup and the *Kirkidium* biofacies of the Henryhouse Formation have thickened over the approximately correlative strata in the Arbuckle Mountains–Criner Hills, except for the northern margin, where sharp pre-Woodford truncation occurs. The thinning along the north-south belt separating the two basins is probably related in part to deposition, but it also appears to have been affected by the aforementioned local unconformities.

The distribution of Hunton oil and gas fields is summarized in the structure map, text-figure 24. These fields have their greatest concentration along the "positive" north-south belt separating the two basins. Oil and (or) gas production in this area has been reported throughout the Silurian and Devonian parts of the Hunton and from all formations. Strata in this belt are largely in a limestone or dolomitic-limestone lithofacies, although some crystalline dolomite is present in the northern part. Some porosity appears to have developed in the limestones during the early stages of diagenesis by incomplete cementation of the organic debris, and some is the result of fracturing, but most strata also show extensive evidence of dissolution, most of which probably took place during the time of pre-Frisco or pre-Woodford erosion. Production in western Oklahoma is almost entirely gas, and the individual fields are much more widely scattered than in the central area, judging from the distribution of known reservoirs. Most of the gas in this region is from porous zones in strongly dolomitized Silurian strata of the Chimneyhill Subgroup and the *Kirkidium* biofacies of the Henryhouse Formation. Hunton production in eastern Oklahoma is at present confined to a few widely scattered gas fields mostly from the Chimneyhill Subgroup, supplemented in places by Lower Devonian zones. In the Bonanza Field of western Arkansas, gas has been produced mainly from Chimneyhill porous crystalline dolomites, but east of this field some production has been developed in dolomitic limestones and calcitic dolomites, where dissolution of the carbonates has probably been a significant factor in the development of porosity.

The overall distribution pattern shown in text-figure 24 suggests that the "positive" area between the two basins served as the major structural control for the concentration of Hunton hydrocarbons, with the ultimate locus of individual reservoirs controlled by porous zones. In many cases hydrocarbon traps were formed in these porous zones by local structures, but it seems probable that some stratigraphic traps were produced by a pinchout of the porous zones, either against the Woodford Shale or by grading into nonporous strata, with the Hunton carbonate sequence itself forming an impervious seal for the underlying porous zone.

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APPENDIX

Cores from 13 wells and samples from 90 wells are described in this section. These wells are alphabetized by farm name and are shown on panels 1-4. Electric logs were examined for all wells (where available), but the principal study was by means of thin sections, supplemented in some cases by staining with Alizarin Red-S and chemical analyses. The Woodford-Hunton, Hunton-Sylvan, and Sylvan-Welling contacts are commonly well defined on the electric logs, and the tops for these units are taken from the logs unless otherwise noted. However, formation and member divisions within the Hunton are based on the samples and are so indicated (sample depth). Two of the cores described in the Appendix (1-5 Biller and 1 Brooks "B") are from wells in the Anadarko Basin and lie west of the area covered in this report. They are included because they provide information on the Frisco-Silurian boundary. Ten of the other cored wells are from eastern Oklahoma, and one, the 1 Western Coal & Mining Co., is from the Bonanza Gas Field in western Arkansas.

Most of the subsurface lithostratigraphic information provided in this report was obtained from samples from 90 wells. The samples were examined from the Woodford Shale through the Hunton Group, Sylvan Shale, and into the Welling Formation. The initial examination was with a binocular microscope, but the basic data for the carbonate strata were obtained from approximately 800 thin sections prepared from the samples. I believe this method provides maximum lithostratigraphic information, although it does not furnish any biostratigraphic data that can be utilized in correlation.

Formation tops were obtained from the well-completion cards (CC); from mechanical logs, mostly spontaneous-potential logs (SP) and gamma-ray logs (GR); and from a study of cores and samples. The lithologic descriptions are based entirely on a study of the cores and samples, primarily by means of thin sections. Supplemental information is from chemical analyses prepared by David Foster, chemical laboratory, Oklahoma Geological Survey (OGS). The strata are assigned to formations where possible, and included is a brief lithologic summary. Biostratigraphic information is provided (where available) for the cored strata.

GREENBRIAR 1 ALDRIDGE—NE¼NE¼NE¼ sec. 34, T. 11 N., R. 6 E., Seminole County, Oklahoma; elev. 900′ DF (895′ GL); TD 4550′ (Ordovician); compl. 6/23/52, D&A. Tops: Woodford 4111′ (−3211′) (SP log), Misener 4137′ (−3237) (sample depth), Hunton 4150′ (−3250′) (sample depth), Sylvan 4320′ (−3420′) (sample depth), Welling 4410′ (−3410′) (sample depth); Hunton thickness 170′. Samples examined from 4070′ to 4430′, good quality; 18 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 40′ of the Hunton is an organo-detrital crinoid-bryozoan sparite with no detrital quartz or dolomite. This is similar to the uppermost Hunton beds in the 1 Boley (see this report and Amsden, 1975b, p. 36, 81) and is here referred to the Frisco Formation. Underlying this formation is dolomitized pink crinoidal limestone, here referred to the Chimneyhill Subgroup (?Clarita Formation). The lowermost beds are glauconitic dolomite (?Cochrane-?Blackgum beds). No oolite observed in this section.

Woodford (Chattanooga) Shale 4111′-4150′ (SP log)
4111′-4142′ Black shale.
4142′-4165′ (sample depths) Misener Sandstone. Quartz sandstone with subangular to rounded quartz grains to 1.5 mm; minor carbonate cement.
Hunton Group 4150′ (SP log)-4314′ (sample depth)
4150′-4165′ No samples.
4165′-4205′ (sample depths) Lower Devonian; Frisco Formation. Organo-detrital crinoid-bryozoan sparite with no observed dolomite or quartz.
4205′-4314′ (sample depths) Silurian; ?Chimneyhill Subgroup.
4205′-4310′ (sample depths) ?Clarita Formation. Moderately to heavily dolomitized pink crinoidal micrite grading into porous crystalline dolomite. The upper part (4210′-4255′) is, for the most part, only moderately dolomitized; the lower part (4255′-4310′) is more heavily dolomitized and includes considerable amounts of porous crystalline dolomite. The entire interval shows very little detrital quartz. Parts with considerable bryozoan debris along with the crinoids.
4310′-4320′ (sample depths) ?Cochrane (?Blackgum) Formation. Glauconitic dolomite with a few corroded crinoids; some pyrite, chert.
Sylvan Shale 4320′-4410′ (sample depths)
Welling Formation 4410′ (sample depth)
4420′ (thin section) Organo-detrital limestone.

TRIDON PETROLEUM CO. (STEPHENS) 1 AMBRISTER—SE¼SE¼NW¼ sec. 7, T. 8 N., R. 10 E., Hughes County, Oklahoma; elev. 834′ DF (828′ GL); TD 4452′ (Ordovician); compl. 5/26/51, D&A. Tops: Woodford 4080′ (−3246′) (SP log), Hunton 4119′ (−3285′) (SP log), Sylvan 4248′ (−3413′) (SP log), Welling 4340′ (−3506′) (sample depth); Hunton thickness 129′. Samples examined from 4100′ to 4350′, excellent quality; 7 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 15′ of the Hunton is a crinoidal bryozoan sparite with no dolomite. This structure is provisionally referred to as the Frisco Formation on the basis of its stratigraphic position and lithology (cf. 1 Scott and 1 Hall). The underlying Hunton beds are moderately to heavily dolomitized pink crinoidal limestone with very little detrital quartz. The Hunton beds are here referred to the Chimneyhill Subgroup.

Woodford (Chattanooga) Shale 4080′-4119′ (SP log)
No Misener Sandstone observed.
Hunton Group 4119′-4248′ (SP log)
4119′ (SP log) -4135′ (sample depth) Lower Devonian; Frisco Limestone.
Light-gray organo-detrital crinoidal-bryozoan

sparite. No quartz or dolomite observed.

4135′ (sample depth) -4248′ (SP log) Silurian; Chimneyhill Subgroup. Moderately to heavily dolomitized pink crinoidal micrite with some sparite; includes byrozoans along with some ostracodes, trilobites, and brachiopods. No detrital quartz observed.

Sylvan Shale 4248′ (SP log) -4340′ (sample depth)
Welling Formation 4340′ (sample depth)

RIDDLE ET AL. 1 ATTERBERRY (FEE)—sec. 11, T. 3 N., R. 5 E., Pontotoc County, Oklahoma; cored 3932′-3937′ (all Hunton); chemical analyses, OU Core Library (no other information available). (Amsden, 1975b, p. 79.)

Hunton Group 3932′-3937′ (core) Lower Devonian; Haragan Formation.

3932′-3937′ Gray fossiliferous dolomitic marlstone; averages 19.35% $MgCO_3$, 18.69% HCl-acid insolubles. Brachiopods: *Coelospira virginia, Atrypina hami, Levenea* sp., *Atrypa* sp.

GRAVES 1-A BARTHOLET—SW¼SW¼SW¼ sec. 8, T. 14 N., R. 17 E., Muskogee County, Oklahoma; elev. unknown; TD 3044′ (Ordovician); compl. 10/4/66, no Hunton production reported. Tops: Hunton 2640′ (sample depth), Sylvan 2655′ (sample depth), Welling 2695′ (sample depth), Fite 2695′ (sample depth); Hunton thickness 15′. Samples examined from 2550′ to 2730′, satisfactory quality; 8 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma. This well drilled as W. D. Grant and completed 11/18/43; it was taken over by Bartholet for final completion 10/4/66.

This well includes only 15′ of Hunton strata, here assigned to the Chimneyhill Subgroup (?Blackgum Formation) on the basis of stratigraphic position, lithology, and thickness. It is weakly to heavily dolomitized.

Woodford (Chattanooga) Shale
Hunton Group 2640′-2655′ (sample depths)

2640′-2655′ (sample depths) Silurian; Chimneyhill Subgroup, ?Blackgum Formation. The upper 5′ is weakly dolomitized glauconitic crinoidal micrite with chert; very little detrital quartz. The basal 10′ is porous crystalline dolomite with some chert. No detrital quartz observed.

Sylvan Shale 2655′-2695′ (sample depths)
Welling Formation 2695′-2700′ (sample depths)

2695′-2700′ (thin section) Organo-detrital pelmatozoan sparite with some pellet limestone as below; no detrital quartz observed.

Fite Limestone 2695′ (sample depth)

2700′-2705′ (thin section) Pellet limestone with some spar cement, and dense ?algal limestone.

2710′-2715′ (thin section) Crystalline dolomite with angular to subrounded detrital quartz grains to 0.5 mm.

GOODNIGHT 1 BARTON—SE¼NE¼NW¼ sec. 13, T. 7 N., R. 4 E., Pottawatomie County, Oklahoma; elev. 910′ DF; TD 4133′ (Simpson); compl. unknown, Hunton production reported (perforated 3574′-3594′, 3753′-3763′). Tops: Hunton 3580′ (−2660′) (sample depth), Sylvan 3800′ (−2890′) (sample depth), Welling 3890′ (−2980′) (sample depth), Bromide 3910′ (−3000′) (sample depth); Hunton thickness 220′. Samples examined from 3530′ to 3930′; inferior-quality samples with considerable contamination; 16 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Although there is some sample contamination, a reasonably clear lithostratigraphic Hunton sequence can be established. The uppermost strata are organo-detrital ?limestones (?Lower Devonian; ?Frisco and/or ?Fittstown), underlain by marlstone (?Lower Devonian, ?Upper Silurian, ?Haragan and/or ?Henryhouse Formation) and with a basal pink crinoidal section (Silurian; Chimneyhill Subgroup). The Chimneyhill is relatively thin (60′) compared to that present in the 3 Richardson (120′) about 4 miles to the west. The cause of this apparent thinning is unknown. Hunton rocks in the 1 Barton are almost entirely low-magnesium limestones, whereas the lower part of the Hunton in the 3 Richardson is moderately to heavily dolomitized.

Woodford (Chattanooga) Shale
No Misener Sandstone observed.
Hunton Group 3580′-3800′ (sample depths)

3580′-3600′ (sample depths) ?Lower Devonian; ?Frisco Formation, ?Fittstown Member; Bois d'Arc Formation. Organo-detrital grain-supported sparite with minor micrite cement. Little or no detrital quartz or dolomite.

3600′-3740′ (sample depths) Silurian; Lower Devonian; ?Henryhouse-Haragan Formations undifferentiated. Fossiliferous marlstone; crinoids, ostracodes, and other shelly debris. Scattered subangular detrital quartz grains, rarely exceeding 0.1 mm. Only scattered crystals of dolomite.

3740′-3800′ (sample depths) Silurian; Chimneyhill Subgroup. No glauconitic limestone or oolite observed. Pink crinoidal micrite with minor spar. In addition to crinoid plates, there are ostracodes, bryozoans, and other shelly debris. Only weakly dolomitic; very little detrital quartz.

Sylvan Shale 3800′-3890′ (sample depths)
Welling Formation 3890′-3910′ (sample depths)

3895′-3900′ (thin section) Organo-detrital sparite and micrite; no detrital quartz or dolomite observed.

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 2379′ (−1417′) (CC), Hunton 2602′ (−1640′) (CC), Sylvan 2795′ (−1833′) (CC); Hunton thickness 193′. Cored 2687′-2745.5′ (all Hunton); 2 thin sections; chemical analyses, OU Core Library. (Amsden, 1975b, p. 79.)

Woodford (Chattanooga) Shale 2379′-2602′ (CC)
Hunton Group 2602′-2795′ (CC)

2602′-2686′ No core; samples not studied.

2686′-2737′ (core) Silurian; Henryhouse Formation. Greenish-gray marlstone with scattered fossils. Silt-size subangular quartz detritus (average HCl-acid insolubles 23.06%) and minor scattered dolomite crystals (average $MgCO_3$ 8.95%). Trilobite *Dalmanites rutellum* at 2688′ and 2712′, identified by K. S. W. Campbell.

2737′-2745′ (core) ?Chimneyhill Subgroup. Pinkish-gray organo-detrital limestone with micrite and spar cement. Very little detrital quartz (HCl-acid insolubles average 6.20%) and a few irregular areas of dolomite ($MgCO_3$ averages 5.20%). No identifiable fossils seen.

2745′-2795′ No core; samples not studied.

Sylvan Shale 2795′ (CC)

LOUIS 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 3893′ (−2924′) (CC), Hunton 4006′ (−3037′) (CC), Sylvan 4053′ (−3084′) (CC), Welling 4136′ (−3167′) (core); Hunton thickness 47′. Cored 4011′-4052′ (all Hunton); 6 thin sections; chemical analyses, OU Core Library. (Amsden, 1975b, p. 80, 119.)

Note that the glauconitic and dolomitic strata of the Hunton in this well occupy approximately the same stratigraphic position as the relatively low-magnesium pelmatozoan limestones of the 1 Tiger. No formation designation is attempted in either well.

Woodford (Chattanooga) Shale 3893′-4006′ (CC)

Hunton Group 4006′-4053′ (CC)

4006′-4053′ (CC) Silurian; Chimneyhill Subgroup. No diagnostic fossils observed; assigned on basis of lithology and stratigraphic position.

4006′-4011′ No core; samples not studied.

4011′-4028′ (core) Glauconitic and dolomitic limestone with very little quartz; fossiliferous. Average $MgCO_3$ 18.34%, HCl-acid insolubles 8.68%.

4028′-4052′ (core) Glauconitic organo-detrital limestone. Average $MgCo_3$ 6.9%, HCl-acid insolubles 1.80%.

4052′-4053′ No core; samples not studied.

Sylvan Shale 4053′-4136′ (CC)

Welling Formation 4136′ (core)

PURE 1 BEAUMAN UNIT—NE¼NE¼SW¼ sec. 29, T. 9 N., R. 16 E., Pittsburg County, Oklahoma; elev. 571′ DF (562′ GL); TD 5430′ (Simpson); compl. 12/24/58, no Hunton production reported (Cromwell gas production). Tops: Woodford 4989′ (−4418′) (SP log), Hunton 5017′ (−4446′) (SP log), Sylvan 5165′ (−4594′) (SP log), Welling 5224′ (−4653′) (SP log), Fite 5245′ (−4674′) (sample depth); Hunton thickness 148′. Samples examined from 4990′ to 5620′, excellent quality (note: core chips from 5320′ to 5430′, Simpson Group); 14 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The samples give a reasonably well-defined lithostratigraphic sequence of Woodford Shale, Misener Sandstone, Sallisaw Formation, Chimneyhill Subgroup, Sylvan Shale, and Viola Limestone. For a discussion on the distinction between Misener (Sylamore) and Sallisaw, see section on Sallisaw Formation in text. The Chimneyhill is provisionally divided into the Quarry Mountain-Tenkiller-Blackgum Formations. See discussion under Chimneyhill Subgroup in text. Silurian strata are moderately to heavily dolomitized throughout, although there is only a small amount of crystalline dolomite present. Silurian strata are 135′ thick.

Woodford (Chattanooga) Shale 4989′-5017′ (SP log) Approximately 10′ of Misener Sandstone present at base.

Hunton Group 5017′-5165′ (SP log)

5017′ (SP log) -5030′ (sample depth) Lower Devonian; Sallisaw Formation. Mostly crystalline dolomite with much fine (generally less than 0.1 mm), angular to subangular quartz detritus. Much chert with scattered detrital quartz grains and euhedral dolomite crystals; latter about same size as quartz grains.

5030′-5180′ (sample depths) Silurian; Chimneyhill Subgroup. Assigned to Chimneyhill on the basis of stratigraphic position and lithology.

5030′-5150′ (sample depths) ?Quarry Mountain Formation. Mostly strongly dolomitized organo-detrital limestone with many bryozoans and pelmatozoan plates; some crystalline dolomite. Very little detrital quartz. Minor chert throughout this interval.

5150′-5170′ (sample depths) ?Tenkiller Formation. Dolomitic pink crinoidal sparite-micrite. Dolomite abundant throughout, commonly replacing much of the matrix. Ostracodes abundant in some beds. Very little detrital quartz observed.

5170′-5180′ (sample depths) ?Blackgum Formation. Strongly dolomitized organo-detrital limestone; some glauconite and chert are present. Very little detrital quartz observed; no oolites observed.

Sylvan Shale 5165′-5224′ (SP log)

Welling Formation 5224′ (SP log) -5245′ (sample depth)

5230′-5240′ (thin section) Organo-detrital sparite with much crinoidal material; no detrital quartz and minor dolomite.

Fite Limestone 5245′ (sample depth)

5225′-5260′ (thin section) Mostly dense ?algal and pellet limestone with chert. Some dolomite and much well-rounded detrital quartz to 0.5 mm.

STEPHENS 1 B & F RANCH—SE¼SE¼NW¼SE¼ sec. 23, T. 11 N., R. 24 E., Sequoyah County, Oklahoma; elev. 731′ DF; TD 3575′; compl. 11/34/76, Hunton gas production reported. Tops: Hunton 3416′ (−2685′) (CC); no other tops available at the time this report was prepared.

I have not examined the samples from this well ana have no information other than that reported on the well-completion card. The card states that the upper 2′ of the Hunton was perforated. See remarks in text, Frisco Formation, Frisco Oil and Gas Production.

PAULEY 1 BENNETT—C SE¼NE¼ sec. 18, T. 10 N., R. 18 E., McIntosh County, Oklahoma; elev. 669′; compl. 1951. Tops: Hunton 4028′ (−3359′) (sample depth), Sylvan 4074′ (−3405′) (sample depth); Hunton thickness 46′. Samples examined from 4000′ to 4100′; 1 thin section. Well described by T. L. Rowland (see Amsden and Rowland, 1965, p. 149-150).

TENNECO 1-5 BILLER—C SE¼ sec. 5, T. 13 N., R. 6 W., Canadian County, Oklahoma; elev. 1245′ KB; TD 9030′ (Ordovician); compl. unknown, Hunton oil production reported. Tops: Woodford 8508′ (−7263′), Hunton 8598′ (−7353′) (core), Sylvan 8900′ (−7655′)

(GR log); Hunton thickness 302′. Cored 8590′–8676′ (Woodford-Hunton); 17 thin sections; chemical analyses, OU Core Library. Now shown on maps.

This is an interesting well that cored the basal Woodford (with some Misener Sandstone), 14′ of Frisco and 64′ of the *Kirkidium* (Henryhouse Formation) biofacies. The Frisco-*Kirkidium* boundary is a knife-sharp contact (pl. 9, figs. 3, 4) separating the light-gray low-magnesium low-insoluble organo-detrital limestones of the Frisco Formation (pl. 10, figs. 2, 3) from the dark dolomite and silty limestones of the *Kirkidium* biofacies (pl. 10, figs. 4, 5). Four spot samples of Frisco were analyzed and average 0.69% $MgCO_3$ and 0.71% HCl-acid insolubles. In contrast, 4 spot samples from the upper 22′ of the *Kirkidium* biofacies average 7.28% $MgCO_3$ and 10.83% HCl-acid insolubles (see chemical analyses in table that follows). Mr. David Campbell, Tenneco Oil Co., kindly provided porosity data from this core, which shows an abrupt decline in porosity at this contact. The 14 porosity tests from the Frisco range from 1.1% to 3.6%, averaging 2.54%. The 10 porosity tests from the upper 10 feet of the *Kirkidium* biofacies range from 0.7% to 2.1%, averaging 1.30%. Some of the porosity appears to result from incomplete cementation (Amsden, 1975b, p. 74). There is also considerable fracture porosity, with the cracks probably enlarged by solution (pl. 10, fig. 1).

The Frisco Formation is an organo-detrital limestone throughout, but most of the identifiable brachiopods came from a depth of 8600′ to 8602′. Specimens of *Kirkidium* were observed at 8613′, where they are associated with halysitid corals. The specimens were found at least as deep as 8667′, where they occur in a bed of oolites (see Amsden, 1975b, p. 32).

The Frisco-*Kirkidium* biofacies relationship in this well is similar to that in the Phillips 1 Brooks "B" (this report, pl. 9, figs. 1, 2, Appendix) and the Gulf 1 Streeter (Amsden, 1975b, p. 100, text-figs. 19, 41, pl. 15). The distribution of Frisco in my pre-Woodford geologic map (Amsden, 1975b, panel 9) needs to be extended west to take in the area of the 1-5 Biller and 1 Brooks.

The analyses in the following table of spot samples were prepared by Mr. David Foster in the chemical laboratory of the Oklahoma Geological Survey.

Woodford (Chattanooga) Shale 8508′–8598′

8508′–8590′ Black shale.

8590′–8598′ (core) Dark shale with some Misener Sandstone; conodonts present in latter.

Hunton Group 8598′–8900′ (core)

8598′–8612′ (core) Lower Devonian; Frisco Formation. Light-gray organo-detrital biosparite; much shelly debris including brachiopods, bryozoans, colonial corals. This is a low-magnesium, low-insoluble, grain-supported limestone; see chemical analyses and pl. 9, figs. 3, 4; pl. 10, figs. 1, 2. Brachiopods from 8600′ to 8602′ include *Leptostrophia magnifica*?, *Costispirifer* sp., *Rhipidomella*, cf. *R. musculosa*, and large terebratuloid brachiopods. Contact with underlying *Kirkidium* biofacies sharply defined.

8612′–8676′ (core) Silurian; *Kirkidium* biofacies.

8612′–8667′ (core) *Kirkidium* biofacies. Dark-gray to medium-gray dolomitic and silty micrite; much silt-size quartz detritus in upper part. The $MgCO_3$ in this interval averages 5.31%, and the HCl-acid insolubles average 7.57%. However, the dolomite decreases downward from 9.64% to 1.80% $MgCO_3$, and the HCl-acid insolubles from

TENNECO 1-5 BILLER

SPOT-SAMPLE ANALYSES

		Depth (ft)	$CaCO_3$(%)	$MgCO_3$(%)	Insoluble residue (%)	Recovery (%)
LOWER DEVONIAN	FRISCO FORMATION	8603	98.30	0.87	1.29	100.46
		8606	99.06	0.80	0.89	100.75
		8611	99.11	0.52	0.40	100.03
		8611	99.95	0.55	0.27	100.77
UPPER SILURIAN	*KIRKIDIUM* BIOFACIES (Henryhouse Formation)	8613	75.88	9.64	14.92	100.44
		9614–9615	76.15	7.94	16.17	100.26
		B6 8617	91.96	4.63	5.23	101.82
		B8 8634	86.91	6.90	7.07	100.88
		B9 8644	93.35	3.55	3.63	100.53
		8654	94.85	2.68	3.49	101.02
		B10 8655	95.71	1.80	2.50	100.01
		B13 8667	89.95	4.69	5.99	100.63
		8668	99.24	0.62	0.30	100.16
		B14 8670	98.94	0.81	0.72	100.47
		8674	84.30	5.23	11.43	100.96

14.92% to 2.50% (see analyses in preceding table). *Kirkidium* sp. observed throughout this interval.

8667′-8672′ (core) Mainly a crinoidal sparite with a 6″ bed of oolites near the top. For the most part, this is a low-magnesium, low-insoluble limestone. Specimens of *Kirkidium* sp. in the upper oolite; none observed below this. Contact with overlying and underlying units not sharply marked.

8672′-8676′ (core) Gray to greenish-gray silty and weakly dolomitic micrite. This is mainly a crinoidal micrite. 1 spot sample analyzed 5.23% $MgCO_3$ and 11.43% HCl-acid insolubles (see analyses in preceding table). No specimens of *Kirkidium* observed in this interval.

8676′-8900′ No core, samples not examined.

Sylvan Shale 8900′ (GR log)

INDIAN TERRITORY ILLUMINATING 1 BLAKE—C SW¼NW¼ sec. 3, T. 10 N., R. 21 E., Haskell County, Oklahoma; elev. 760′; compl. 1930. Tops: Hunton 2185′ (−1425′) (sample depth), Sylvan 2417′ (−1657′) (sample depth); Hunton thickness 232′. Samples examined from 2175′ to 2424′; 2 thin sections. Well described by T. L. Rowland (see Amsden and Rowland, 1965, p. 141-143).

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 4320′ (−3325′) (sample depth), Hunton 4353′ (−3368′) (core), Sylvan 4508′ (−3513′) (core); Hunton thickness 155′. Core (4353′-4373′; 4495′-4508′) and samples examined from 4300′ to 4508′; 10 thin sections prepared from well samples and 11 from the core; core, OU Core Library; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata were cored 4353′-4373′ (Frisco Formation), 4443′-4459′ (Chimneyhill Subgroup), 4495′-4508′ (Chimneyhill Subgroup, Keel Formation and Sylvan Shale). Additional information is given in Amsden (1975b, p. 19, 69, 72, 81; text-fig. 36).

The 1 Boley is significant because the upper part of the Hunton core yields Frisco brachiopods (Amsden, 1975b, p. 81). The Frisco strata are organo-detrital crinoid-bryozoan sparites with very little dolomites and rest directly on dolomitized pink crinoidal limestones. These lower strata are low in quartz detritus and are provisionally referred to the Chimneyhill Subgroup on the basis of lithologic character and stratigraphic position. Thus the Frisco represents an erosional remnant separated from the Frisco Formation lying to the west and southwest (Amsden, 1975b, panel 9; panel 4, this report) and to the east (panel 4, this report). In the 1 Boley, pre-Frisco erosion has removed earlier Devonian strata (Helderbergian) and probably all of the Upper Silurian Henryhouse-*Kirkidium* beds. This allowed the formation to rest directly on the Chimneyhill Subgroup (undifferentiated; no Cochrane-Blackgum type of lithology present). In the Arbuckle Mountain region the Frisco strata rest on the Lower Devonian Helderbergian strata (Bois d'Arc Formation) and in central Oklahoma on the Upper Silurian *Kirkidium* beds (Amsden, 1975b, panel 10; text-fig. 17, this report). In the eastern Oklahoma outcrops the Frisco rests on the Quarry Mountain Formation.

The Keel-Sylvan contact was cored, with the Keel consisting of a few inches of heavily dolomitized, scattered oolites, and the Sylvan a greenish-gray argillaceous dolomite. The basal 2″ of the Keel was analyzed as follows: $CaCO_3$ 62.56%, $MgCO_3$ 32.57%, HCl-acid insolubles 3.24%. The upper 2″ of the Sylvan was analyzed as follows: $CaCO_3$ 47.32%, $MgCO_3$ 30.84%, HCl-acid insolubles 20.23%.

Woodford (Chattanooga) Shale

4320′-4353′ (sample depths) Misener Sandstone. Calcareous dolomite with much angular to subangular quartz detritus to 0.5 mm.

Hunton Group 4353′-4508′ (core)

4353′-4390′ (core) Lower Devonian; Frisco Formation. Organo-detrital crinoid-bryozoan sparite; much shelly debris including brachiopods. No dolomite or quartz observed. The cored portion (4353′-4373′) yields Frisco (Deerparkian) brachiopods (Amsden, 1975b, p. 81).

4390′-4508′ (core) Silurian; Chimneyhill Subgroup.

4390′-4495′ (sample depths) Moderately to heavily dolomitized pink crinoidal sparite; much shelly debris with parts having a substantial amount of bryozoan material. Very little quartz observed. The cored portion (4353′-4495′) has numerous examples of what appear to be sediment-filled cavities similar to those present at the outcrop in eastern Oklahoma (Amsden and Rowland, 1965, p. 36-39). The dolomitization appears to become more intense in deeper samples. 4465′-4495′ includes considerable amounts of porous crystalline dolomite.

4495′-4508′ (core) Keel Formation. Dolomitized oolites set in spar. The ooids are preserved entirely in crystalline dolomite and are set in dolospar (pl. 11, fig. 8). The oolite-Sylvan Shale contact was cored and appears as a sharp lithologic boundary (a thin section spans this contact).

Sylvan Shale 4508′ (core)

The upper 4″ or 5″ of Sylvan was cored and is a light-green calcareous shale.

WESTERN 1 BRANDON—SE¼NW¼SE¼ sec. 17, T. 11 N., R. 16 E., McIntosh County, Oklahoma; elev. 639.5′; compl. 1959. Tops: Hunton 3460′ (−2821′) (sample depth), Sylvan 3480′ (−2841′) (sample depth); Hunton thickness 20′. Samples examined from 3450′ to 3490′. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 154-155).

PHILLIPS 1 BROOKS "B"—W¼E¼SW¼SE¼ sec. 30, T. 14 N., R. 6 W., Canadian County, Oklahoma; elev. 1243′ KB; TD 9120′ (Ordovician); compl. unknown, Hunton gas production reported. Tops: Woodford 8657′ (−7414′) (CC), Hunton 8705′ (−7462′) (CC), Sylvan 9057′ (−7814′) (CC); Hunton thickness 352′. Cored 8710′-8792′, 9000′-9042′, all Hunton; 3 thin sections; OU Core Library.

This well (not shown on maps) cored the upper part of the Hunton, starting just below the Woodford-Hunton contact, penetrating most of the Frisco Formation and continuing 60′ into the *Kirkidium* biofacies. It also cored 40′ of lower Hunton, the base of the core being about 15′ above the Hunton-Sylvan contact. This lower portion cuts into a part of the Clarita and Cochrane Formations. The Frisco is entirely a low-magnesium organo-detrital limestone, and the Silurian rocks are only moderately dolomitized. The *Kirkidium*-bearing strata are grain-supported organo-detrital limestones with some silt-size angular quartz debris (insoluble residues less than 10%). They include much crinoidal debris along with numerous *Kirkidium* shells and some halysitid corals. The Silurian part of the Hunton is approximately 290′ thick and is probably a reasonably complete section. The Hunton lithostratigraphic and biostratigraphic sequence is similar to that in the 1 Streeter (Amsden, 1975b, p. 100), and the Frisco-*Kirkidium* biofacies-lithofacies relationship is nearly identical. The Frisco-*Kirkidium* section is also similar to that present in the Tenneco 1-5 Biller (Appendix). In all 3 wells the Frisco-*Kirkidium* biofacies (=Henryhouse) contact, where there is close biostratigraphic control, is sharply defined (Amsden, 1975b, pl. 15; this report, pl. 9). No Helderbergian-age strata are present.

Dr. James Barrick and Dr. Gilbert Klapper, The University of Iowa, recovered the following conodonts from this core at a depth of 9016′: *Dapsilodus obliquicostatus, Panderodus unicostatus, Decoriconus fragilis, Walliserodus* sp. They state that this indicates an age equivalent to the Clarita or younger Silurian strata.

Woodford Shale 8657′-8705′ (CC)
8657′-8705′ No core.
8710′-8770′ (core) Lower Devonian; Frisco Formation. Light-gray organo-detrital limestone; low in dolomite and low in HCl-acid insolubles. Fossils recovered at 8737′, 8746′, and 8764′ include large snails, bryozoans, and brachiopods; specimen of *Costellirostra peculiaris* (Conrad) recovered at 8764′. Lower contact sharply defined.
8770′-8792′ (core) Upper Silurian; *Kirkidium* biofacies. Dark- to medium-gray organo-detrital limestone, weakly to moderately dolomitized; some silt-size angular quartz detritus. Three specimens tested for insoluble residues: 7.55%, 7.89%, 3.88%, averaging 6.44%. Contact with the overlying Frisco sharply defined (pl. 9, figs. 1, 2). Compare to the Frisco-*Kirkidium* contact in the Gulf 1 Streeter (Amsden, 1975b, p. 100, pl. 15).
8792′-9000′ No core, samples not studied.
9000′-9033′ (core) Silurian; Chimneyhill Subgroup, Clarita Formation. Pink crinoidal limestone with minor irregular dolomitized areas. Conodonts recovered at 9016′ (see above).
9033′-9042′ (core) Silurian; ?Cochrane Formation. Dark glauconitic limestone with much chert; lower 1′ to 2′ dolomite.
9042′-9057′ No core, samples not studied.
Sylvan Shale 9057′ (CC)

EARLSBORO (HALL-JONES) 1 BROTTON—SW¼NW¼SW¼ sec. 20, T. 9 N., R. 15 E., McIntosh County, Oklahoma; elev. 700′ KB (693′ GL); TD 5085′ (Sylvan); compl. 1/18/63, Cromwell-Pitkin-Hunton production reported, Hunton perforated 4919′-4973′, Sallisaw-Chimneyhill. Tops: Misener 4900′ (−4200′) (sample depth), Hunton 4913′ (−4213′) (SP log), Sylvan 5049′ (−4349′) (SP log); Hunton thickness 136′. Samples examined from 4850′ to 5085′, poor quality with considerable contamination from above; 8 thin sections; 9 stained with Alizarin Red-S; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata are assigned to the Sallisaw Formation and the Chimneyhill Subgroup. This well also includes Misener Sandstone. For a discussion on the distinction between the Misener and the Sallisaw lithologies, see Sallisaw Formation in text. Chimneyhill strata are provisionally assigned to the Quarry Mountain–Tenkiller–Blackgum Formations. See discussion under Chimneyhill Subgroup in text; also see descriptions of 1 Follansbee, 1 Graham, and 1 Dunagan.

Hunton production, judging from the perforated interval, is from the Sallisaw and upper Chimneyhill beds.

Woodford (Chattanooga) Shale
4900′ (sample depth)-4913′ (SP log) Misener Sandstone. Quartz sandstone; well-rounded grains with crystal overgrowths ranging up to 1 mm.
Hunton Group 4913′-5049′ (SP log)
4913′ (SP log)-4940′ (sample depth) Devonian; Sallisaw Formation. Dolomite with angular to subangular quartz grains up to 0.2 mm. Chert with scattered detrital quartz and euhedral dolomite crystals. Typical Sallisaw lithology. (See discussion in text under Sallisaw Formation).
4940′-5049′ (sample depths) Silurian; Chimneyhill Subgroup.
4940′-4975′ (sample depths) ?Quarry Mountain Formation. Limestone mixed with much dark shale; poor samples.
4975′-5020′ (sample depths) ?Quarry Mountain Formation. Weakly to strongly dolomitized organo-detrital crinoidal sparite with some porous crystalline dolomite. Some chert in lower part.
5020′-5050′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with minor spar; includes a rich shelly fauna with only moderate bryozoan debris. Weakly to moderately dolomitized; very little detrital quartz. Some chert.
5050′-5060′ (sample depths) ?Blackgum Formation. Weakly to moderately dolomitized crinoidal micrite and sparite. Minor detrital quartz; minor chert.
Sylvan Shale 5049′ (SP log)

CALVERT-MID AMERICA 1 BUNDY—NE¼NE¼SW¼ sec. 36, T. 9 N., R. 21 E., Haskell County, Oklahoma; elev. 485′; TD 5662′ (?Sylvan); compl. unknown; no Hunton production reported. Tops: Woodford 5370′ (−4885′) (CC), Hunton 5430′ (−4945′) (CC), Sylvan 5562′ (−5077′) (SP log); Hunton thickness 132′. Samples examined from 5100′ to 5600′, much sample lag, and only the sample at 5600′ may include Sylvan. Samples missing from 5600′ to TD, considerable sample contamination, considerable sample lag; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton strata are assigned to the Chimneyhill Subgroup on the basis of lithologic characteristics and stratigraphic position. The Quarry Mountain, Tenkiller, and Blackgum Formations are tentatively recognized. Most of the Chimneyhill strata are moderately to heavily dolomitized crinoidal limestones.

Woodford (Chattanooga) Shale 5370′-5430′ (CC)
Approximately 10′ of Misener-Sylamore Sandstone at the base: angular to rounded quartz grains to 1½ mm (could include some Sallisaw Formation).
Hunton Group 5430′-5562′ (CC)
5430′-5562′ (CC) Silurian; Chimneyhill Subgroup.
5430′ (CC)-5550′ (sample depth) ?Quarry Mountain Formation. Moderately to heavily dolomitized crinoidal limestone; some crystalline dolomite. No detrital quartz observed.
5550′-5575′ (sample depths) ?Tenkiller Formation. Weakly to heavily dolomitized pink crinoidal micrite; ostracodes and other shelly fossils, but very few bryozoans. Very little detrital quartz.
5575′-5600′ (sample depths) ?Blackgum Formation. Moderately to heavily dolomitized, glauconitic crinoidal micrite; some bryozoans present. Last sample has some angular quartz detritus to 1 mm.
Sylvan Shale 5562′ (SP log)

CLEARY 1 BURKE—SE¼SE¼SE¼ sec. 13, T. 13 N., R. 24 E., Sequoyah County, Oklahoma; elev. unknown; compl. 1959. Tops: Hunton 520′ (sample depth); Hunton thickness 250′. Samples examined from 510′ to 790′; 1 thin section. Well described by T. L. Rowland (Amsden and Rowland, 1965, p. 129–131).

MOBIL 1 BURRIS UNIT—C SW¼NE¼ sec. 15, T. 7 N., R. 19 E., Haskell County, Oklahoma; elev. 907′ KB; TD 7871′ (Viola); compl. 12/4/64, D&A. Tops: Hunton 7755′ (−6848′) (CC), Sylvan 7778′ (−6861′) (CC), Welling 7815′ (−6908′) (sample depth); Hunton thickness 23′. Samples examined from 7700′ to 7870′; cored 7749′-7808′, not examined; no samples 7815′-7850′; 1 thin section, OGS; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata are assigned to the Blackgum Formation on the basis of stratigraphic position and lithologic character. These rocks are only moderately dolomitized. Hunton strata are thin, and this well is probably near the southern truncated margin of the group.

Woodford (Chattanooga) Shale
Hunton Group 7755′-7778′ (CC)
Silurian; Chimneyhill Subgroup; ?Blackgum Formation. Weakly to moderately dolomitized organo-detrital micrite with glauconite. Very little detrital quartz observed.
Sylvan Shale 7778′-7815′ (CC)
Welling Formation 7815′-7871′ (TD) (sample depths) Organo-detrital limestone.

SINCLAIR 3 BURRIS—SW¼NE¼NW¼ sec. 27, T. 2 N., R. 7 E., Pontotoc County, Oklahoma; elev. 706′; TD 4295′ (Ordovician, Simpson); compl. 12/5/51, Chimneyhill production reported (perf. 3684′-3690′). Tops: Woodford 3234′ (−2528′) (CC), Hunton 3390′ (−2684′) (CC), Sylvan 3692′ (−2986′) (GR log), "Fervale" (?Welling) Formation 3825′ (−3119′) (sample depth); Hunton thickness 302′. Samples examined from 3270′ to 3870′, good quality; 17 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton sequence comprises an upper organo-detrital limestone (Frisco), a mixed marlstone-organo-detrital section (?Fittstown Member, Bois d'Arc Formation), a marlstone section (Henryhouse-Haragan undifferentiated), and a basal organo-detrital limestone (Chimneyhill Subgroup). The latter includes recognizable Clarita, Cochrane, and Keel stratigraphic units. This sequence, all low-magnesium limestone, is most similar to the section in the northeastern part of the Arbuckle outcrop area, the Lawrence Uplift south to old Hunton townsite (see Amsden, 1960, Appendix). Oil production (Fitts Field) is reported from the lower organo-detrital Chimneyhill strata.

Woodford (Chattanooga) Shale 3234′-3390′ (CC)
No Misener Sandstone recognized.
Hunton Group 3390′-3692′ (CC).
3390′ (CC)-3430′ (sample depth). Lower Devonian; Frisco Formation (may include some Fittstown Member, Bois d'Arc Formation). Organo-detrital sparite with some micrite; mostly pelmatozoans and bryozoans. Debris appears much broken up in places and with evidence of solution. Almost no quartz or dolomite observed.
3430′-3500′ (sample depths) ?Fittstown Member, Bois d'Arc Formation. Mixture of marlstone and organo-detrital limestone. Marlstone with much fine subangular quartz detritus and some scattered dolomite crystals. Fossils varied, including bryozoans, crinoids, brachiopods, trilobites, and ostracodes.
3500′-3660′ (sample depths) Silurian-Lower Devonian; Henryhouse-Haragan Formations undifferentiated (possibly includes some Cravatt Member, Bois d'Arc Formation, although no chert was observed). Sparingly fossiliferous marlstone; fossils mainly pelmatozoan plates and ostracodes. Considerable fine (to 0.1 mm) subangular quartz detritus. Scattered dolomite crystals; rock is a low-magnesium limestone (estimated less than 10% $MgCO_3$).
3660′ (sample depth) -3692′ (GR log) Silurian; Chimneyhill Subgroup.
3660′-3680′ (sample depths) Clarita Formation. Pink crinoidal sparite and micrite. Fossils include pelmatozoan plates, snails, ostracodes, trilobites, brachiopods, and bryozoans as common elements. Very little detrital quartz or dolomite.
3680′-3690′ (sample depths) Cochrane Formation. Glauconitic crinoidal micrite-sparite; chert. Very little dolomite or detrital quartz.
3690′-3700′ (sample depths) Keel Formation. Fossiliferous oolite, mainly with spar cement. Ooids with both radial and concentric structures; fossil nuclei. Very little dolomite or detrital quartz.
Sylvan Shale 3692′ (GR log) -3825′ (sample depth)
"Fernvale" Limestone 3825′ (sample depth)

3830′-3835′ (thin section) Welling Formation. Organo-detrital sparite with no observed detrital quartz or dolomite.
3850′-3855′ (thin section) Same, but with well-rounded detrital quartz grains to 0.3 mm.

ARKLA EXPLORATION 1-13 CARR ESTATE—1650′ FSL and 1650′ FEL sec. 13, T. 2 S., R. 10 E., Atoka County, Oklahoma; elev. 679′ KB (653′ GL); TD 12,095′ (Ordovician); compl. 6/21/77, D&A. Tops: Hunton 8200′ (−7521) (sample depth), Sylvan 8440′ (−7761′) (sample depth), Welling 8550′ (−7871′) (sample depth); Hunton thickness 240′. Samples examined from 8060′ to 9200′, excellent quality; 42 thin sections (17 Hunton); samples, OU Core Library.

The Hunton sequence consists of an upper marlstone (Henryhouse and/or Haragan Formation) and a lower organo-detrital limestone (Chimneyhill Subgroup). The strata are low-magnesium limestones throughout and appear to be typical in all respects of those in the eastern outcrops of the Arbuckle Mountains. The Sylvan Shale is about 110′ thick and is underlain by Welling ("Fernvale") organo-detrital limestone.

Woodford (Chattanooga) Shale
No Misener Sandstone observed.
Hunton Group 8200′-8440′ (sample depths)
8200′-8400′ (sample depths) ?Lower Devonian-?Silurian; Henryhouse and (or) Haragan Formation. Marlstone with scattered fossils; organic material includes pelmatozoan plates, trilobites, ostracodes, bryozoans, and brachiopods; concentration varies, but in general fairly sparse. Scattered, fine (less than 0.1 mm) angular to subangular detrital quartz and very little dolomite. Minor silicification in upper part.
8400′-8440′ (sample depths) Silurian; Chimneyhill Subgroup.
8400′-8430′ (sample depths) Clarita Formation. Light-pinkish-gray organo-detrital limestone. Abundant orange-pink pelmatozoan plates and numerous ostracodes, trilobites, and other shelly debris. Very little dolomite and very little detrital quartz.
8430′-8440′ (sample depths) Cochrane Formation. Organo-detrital limestone with glauconite; some chert present. Scattered dolomite crystals and minor detrital quartz.
Sylvan Shale 8440′-8550′ (sample depths)
Upper 10′ or so is a greenish-gray shale, underlain by dark-gray shale.
Welling Formation 8550′-8660′ (sample depths)
Organo-detrital sparite with minor micrite. Pelmatozoans abundant, generally accompanied by other shelly debris. Very little dolomite. Upper 50′ or so with little or no detrital quartz. Lower part with sparse to common well-rounded detrital quartz grains to 0.8 mm.

SHELL 1-10 CARTER—1420′ FSL and 1980′ FWL sec. 10, T. 6 N., R. 32 W., Sebastian County, Arkansas; elev. 586′ DF (571′ GL); TD 8300′ (Ordovician); compl. 15/6/64, no Hunton production reported. Tops: Hunton (?Penters Chert = Sallisaw Formation) 8049′ (−7463′) (Arkansas Geological Commission), Cason (=Sylvan) 8230′ (−7644′) (sample depth), ?Viola 8263′ (−7677′) (Arkansas Geological Commission); Hunton thickness 182′. This well air drilled to 8130′; samples studied from 8130′ to 8300′ (TD). Reasonable quality; 8 thin sections; samples, Arkansas Geological Commission, Little Rock, Arkansas.

This well was air drilled to 8130′, and the samples above this point are too fine for study. According to the completion report of the Arkansas Geological Commission, the Penters Chert (=Sallisaw Formation) is present, its top being at 8049′. The Commission also reported the Penters-Hunton contact (Sallisaw-?Chimneyhill contact, this report) at 8075′. I examined the Hunton strata from 8130′ to the Sylvan contact at 8220′. The samples are entirely crystalline dolomite, in part porous, and very strongly dolomitized crinoidal carbonates with sparse, widely scattered subangular detrital quartz up to 0.2 mm. This part of the Hunton is assigned to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position (see discussion under Shell 1 Western Coal & Mining Co. well). The Arkansas completion report gives the top of the Viola at 8263′. However, the samples in the interval from 8260′ to 8300′ (last sample) are almost entirely dark shale. At 8300′ the driller circulated for 120 minutes, and the samples are almost all dark shale with only a piece or two of dolomite.

Woodford (Chattanooga) Shale
Hunton Group 8049′ (CC) -8230′ (sample depth)
8049′-8075′ (CC) ?Lower Devonian; ?Penters Chert (=Sallisaw Formation). Information from Arkansas Geological Commission.
8075′ (CC) -8230′ (sample depth) ?Silurian; ?Chimneyhill Subgroup. Largely crystalline dolomite, parts having good visible porosity, with some very heavily dolomitized crinoidal carbonate. In the latter the only fossils remaining are corroded crinoid plates. Includes sparse, widely scattered subangular detrital quartz to 0.2 mm. In part the angularity is due to corrosion of the quartz grains by the dolomite. No chert observed. 8 thin sections.
Cason Shale (=Sylvan Shale) 8230′ (sample depth) -8263′ (CC)
Dark shale.
?Viola Limestone 8263′ (CC)
8230′-8300′ (sample depths) Almost entirely dark shale with only a few pieces of dolomite present.

AMBASSADOR 1 CHAPMAN—SW¼SW¼SW¼ sec. 9, T. 8 N., R. 9 E., Hughes County, Oklahoma; elev. 757′; TD 4311′ (Ordovician; Simpson); compl. 12/5/57, D&A. Tops: Woodford 3938′ (−3181′) (SP log), Hunton 3972′ (−3215′) (sample depth), Sylvan 4124′ (−3367′) (sample depth), Welling 4195′ (−3438′) (sample depth); Hunton thickness 152′. Samples examined from 3910′ to 4230′, good quality; 15 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

There is a stratigraphic problem concerned with the samples in this well. The upper part of the Hunton Group, 3972′-4010′, is an organo-detrital sparite with little or no detrital quartz or dolomite. This appears to be a part of the body of Frisco Limestone extending from the 1 Boley to the 1 Armbrister and the 1 Scott (panel 4). Beneath the Frisco are beds of carbonate

(4010′-4030′) including much dolomite and relatively coarse subangular quartz detritus (and some glauconite), whose stratigraphic relationships are uncertain. These strata, assuming they do not represent sample mixing, are not recognized elsewhere in this region. They may represent (1) cavings from the Misener above, (2) sedimentary infiltration from the overlying Misener along fissures and cavities, or (3) an unusually sandy facies of the Henryhouse-Haragan marlstone or of the Chimneyhill Subgroup. The latter seems the most reasonable explanation, as some beds are typically pink crinoidal limestone with irregular areas of dolomitization including some quartz detritus (although not as coarse or abundant in the strata in question). The underlying strata assigned to the Chimneyhill Subgroup appear to be typical, although no basal glauconitic beds are recognized.

Woodford Shale 3938′-3972′ (SP log)
A thin zone of Misener Sandstone at the base.
Hunton Group 3972′(SP log) -4124′ (sample depth)
3972′(SP log) -4010′ (sample depth) ?Lower Devonian; ?Frisco Formation. Organo-detrital sparite with many crinoids, bryozoans, and other shelly fossils. No detrital quartz or dolomite observed.
4010′-4030′ (sample depths) ?Silurian; ?Chimneyhill Subgroup. Fossiliferous carbonate with much crystalline dolomite and much subangular detrital quartz grains to over 1 mm in diameter.
4030′-4124′ (sample depths) Silurian; Chimneyhill Subgroup. Pink crinoidal micrite and sparite with bryozoans, ostracodes, trilobites, and other shelly fossils.
4030′-4045′ A pink crinoidal micrite with very little dolomite or detrital quartz.
4045′-4124′ Weakly to heavily dolomitized pink crinoidal micrite with very little quartz.
Sylvan Shale 4124′-4195′ (sample depths)
Welling Formation 4195′ (sample depth)
4198′ (thin section) Organo-detrital sparite with minor micrite; much pelmatozoan material. No detrital quartz or dolomite observed.
4225′-4230′ (thin section) Same as above but with well-rounded detrital quartz grains to 0.5 mm (pl. 11, fig. 4).

HARRIS 1 CHEEK—NE¼NE¼SW¼ sec. 19, T. 12 N., R. 25 E., Sequoyah County, Oklahoma; elev. 586.5′; compl. 1958. Tops: Hunton 2945′ (−2359′) (sample depth), Sylvan 3230′ (−2644′) (sample depth); Hunton thickness 285′. Samples examined from 2940′ to 3240′; 3 thin sections. Well described by T. L. Rowland (Amsden and Rowland, 1965, p. 135-138).

COOK & GRAY 2 COOK—C SW¼NE¼ sec. 8, T. 12 N., R. 24 E., Sequoyah County, Oklahoma; elev. 640′; compl. 1949. Tops: Hunton 715′? (est. electric log), Sylvan 970′ (sample depth); Hunton thickness estimated 244′. Samples examined from 750′ to 980′; 1 thin section. Well described by T. L. Rowland (Amsden and Rowland, 1965, p. 133-135).

CARTER & MANDELL (?TEXAS) 1 COWAN—SE¼SW¼SW¼ sec. 5, T. 11 N., R. 10 E., Okfuskee County, Oklahoma; elev. 819′; TD 3884′ (Ordovician); ?compl. 7/11/40, D&A. Tops: Hunton 3640′ (−2831′) (sample depth), Sylvan 3790′ (−2981′) (sample depth), Welling 3832′ (−3013′) (sample depth); Hunton thickness 150′. Examined samples and core chips from 3600′ to 3860′; consist of large samples and core chips; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The samples from this well agree very well with the data given on the completion card (CC) but differ in one respect from the SP log of the Texas 1 Cowan in the SW¼SW¼SW¼ sec. 5, T. 11 N., R. 10 E. (note difference in legal description). The Hunton top and Viola top on the SP log fit very well with the sample tops and the CC tops, but the Sylvan top on the SP log is clearly at 3740′, not 3790′. This could be due to sample lag (but note that the other tops agree), or it could be another well.

There is no recognizable marlstone in this well; the entire Hunton is represented by moderately to heavily dolomitized organo-detrital carbonate (including some porous crystalline dolomite). There is no well-defined lithostratigraphic break in the Hunton, and the entire section is tentatively referred to the Chimneyhill on the basis of stratigraphic position.

Woodford (Chattanooga) Shale
Misener Sandstone at the base.
Hunton Group 3640′-3790′ (sample depths)
See discussion above. Silurian; Chimneyhill Subgroup. Core chips from 3646′ to 3662′ include pink crinoidal micrite and sparite with numerous ostracodes. The remainder of the samples and chips consists of moderately to heavily dolomitized crinoidal sparite and micrite, including some porous crystalline dolomite. There is little to no detrital quartz in any of the samples. No chert observed.
Sylvan Shale 3790′-3832′ (sample depths)
Welling Formation 3832′ (sample depth)
3840′-3845′ (thin section) Organo-detrital sparite with many pelmatozoan plates; no detrital quartz and only minor dolomite observed.
3855′-3860′ (thin section) Same as above but with rounded quartz grains to 0.3 mm and 1 piece of pellet limestone (probably Bromide Formation).

SUNRAY-DX 1 C. DAVIS—NW¼SE¼SW¼ sec. 17, T. 5 N., R. 8 E., Pontotoc County, Oklahoma; elev. 772′; TD 4120′ (Simpson); compl. 11/22/62, no Hunton production reported. Tops: Woodford 3660′ (−2888′) (CC), Hunton 3817′ (−3045′) (CC), Sylvan 3844′ (−3072′) (CC), Welling 3950′ (−3178′) (sample depth); Hunton thickness 27′. Cored 3818′-3842′ (all Hunton); 6 thin sections; chemical analyses; OU Core Library (described, Amsden, 1975b, p. 83).

Woodford (Chattanooga) Shale 3660′-3817′ (CC)
Hunton Group 3817′-3844′ (CC)
3817′-3818′ No core; samples not studied.
3818′-3830.5′ (core) Silurian; Cochrane Formation. Cherty organo-detrital limestone, parts with substantial glauconite. Dolomite content variable, averaging 6.36% $MgCO_3$. The insoluble content is high, average HCl-acid 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.
3830.5′-3842′ (core) Keel Formation. Oolitic and

fossiliferous limestone with minor dolomite: $MgCO_3$ averages 6.05%, HCl-acid insolubles 4.46%. Some of the oolites appear deformed. Numerous specimens of *Brevilamnulella thebesensis* at 3835′. Assigned to Keel on the basis of these fossils, lithology, and stratigraphic position.
3842′-3844′ No core; samples not studied.
Sylvan Shale 3844′-3950′ (CC)
Welling Formation 3950′ (sample depth)

BLACKWOOD & NICHOLS 1 M. DAVIS—SW¼NW¼NE¼ sec. 16, T. 10 N., R. 6 E., Seminole County, Oklahoma; elev. 943′ DF (936′ GL); TD 4679′ (Ordovician); compl. 8/24/53, D&A. Tops: Hunton 4250′ (−3307′) (SP log), Sylvan 4420′ (−3477′) (SP log), Welling 4515′ (−3572′) (sample depth); Hunton thickness 170′. Samples examined from 4200′ to 4550′, good quality; 12 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 60′ of the Hunton is organo-detrital limestone with almost no dolomite or quartz and is here assigned to the Frisco Formation (cf. Shell 1 Boley). This rests on weakly to strongly dolomitized pink crinoidal micrite, which is assigned to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position. This could include equivalents of the *Kirkidium* biofacies in the upper part.

Woodford (Chattanooga) Shale
Misener Sandstone; about 10′ of chert and quartz sandstone at the base of the Woodford sequence.
Hunton Group 4250′-4420′ (SP log)
4250′-4330′ (sample depths) Lower Devonian; Frisco Formation. Organo-detrital crinoid-bryozoan sparite with minor micrite cement. The uppermost sample shows a few grains of rounded detrital quartz, which is almost certainly infiltration from the overlying Misener Sandstone; other than this, no quartz observed. Almost entirely free of dolomite.
4330′-4420′ (sample depths) Silurian; Chimneyhill Subgroup.
4330′-4340′ (sample depths) Almost entirely porous crystalline dolomite; a few corroded pink crinoid plates. No detrital quartz observed.
4340′-4425′ (sample depths) Weakly to heavily dolomitized pink crinoidal micrite with only a few bryozoans. A few widely scattered fine (to 0.1 mm) subangular quartz grains.
4425′-4440′ (sample depths) Porous crystalline dolomite.
Sylvan Shale 4420′ (SP log)-4515′ (sample depth)
Welling Formation 4515′ (sample depth)
4520′-4530 (thin section) Crinoidal sparite with minor micrite cement; no quartz or dolomite observed.
4540′-4550′ (thin section) Like above, but with a few scattered rounded quartz grains and a few dolomite crystals.

KRUMME 1 DIFFENBACH—NE¼NW¼SE¼ sec. 31, T. 11 N., R. 10 E., Okfuskee County, Oklahoma; elev. 842′ DF (837′ GL); TD 3958′ (Ordovician); compl. 11/3/56, no Hunton production reported. Tops: Misener 3684′ (−2844′) (sample depth), Hunton 3692′ (−2852′) (sample depth), Sylvan 3792′ (−2952′) (sample depth), Welling 3879′ (−3038′) (sample depth); Hunton thickness 100′. Samples examined from 3600′ to 3900′, good quality; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well includes about 10′ of well-defined Misener Sandstone. The top is underlain by pelmatozoan sparite and micrite and is here referred to the Chimneyhill Subgroup. The Chimneyhill ranges from almost no dolomite to heavily dolomitized limestone and in a few places crystalline dolomite. No glauconite observed, but the basal 20′ is pelmatozoan micrite with chert, which resembles some of the glauconite-bearing beds in this area.

Woodford (Chattanooga) Shale
3684′-3692′ (sample depths) Misener Sandstone.
Hunton Group 3692′-3792′ (sample depths)
3692′-3705′ (sample depths) Silurian; Chimneyhill Subgroup. Pelmatozoan micrite with some spar; some bryozoans, ostracodes, trilobites, and brachiopods. Only minor dolomite and very little quartz.
3705′-3770′ (sample depths) Weakly to moderately dolomitized pelmatozoan micrite and sparite with very little quartz.
3770′-3780′ (sample depths) Porous crystalline dolomite mixed with heavily dolomitized porous pelmatozoan sparite. Very little quartz.
3780′-3792′ (sample depths) Crinoidal micrite with much broken shelly debris, undolomitized to moderately dolomitized. Fossiliferous chert. No glauconite observed.
Sylvan Shale 3792′-3878′ (sample depths)
Welling Formation 3878′ (sample depths)
3880′-3890′ (thin section) Organo-detrital sparite with a few pieces of rounded detrital quartz; very little dolomite.

SHELL 1-4 DOUGLAS—1477′ FEL and 1446′ FSL sec 4, T. 6 N., R. 32 W., Sebastian County, Arkansas; elev. 615′ KB (597′ GL); TD 8227′ (Cason = Sylvan Shale); compl. 10/2/64, no Hunton production reported (Hale production reported). Tops: Woodford (Chattanooga) 7950′ (−7335′) (GR log), Hunton (may include Penters Chert = Sallisaw Formation) 8046′ (−7431′) (GR log), Cason (=Sylvan) 8220′ (−7605′) (sample depth); Hunton thickness 174′. This well air drilled to a depth of 8060′; satisfactory samples, 8060′-8070′; mixed samples 8070′-8110′, satisfactory samples 8110′-8220′ (last sample); 8 thin sections; samples, Arkansas Geological Commission, Little Rock, Arkansas.

There is only 1 satisfactory sample (8060′-8070′) in the upper 60′ of the Hunton Group, making it difficult to verify the presence or absence of the Penters Chert (=Sallisaw Formation). However, the 8060′-8070′ sample is entirely crystalline dolomite, which shows no detrital quartz, suggesting that from here down the Hunton is entirely Chimneyhill Subgroup. On the other hand, the gamma-ray log of this interval has a moderately strong high and suggests the presence of some sand and (or) shale. The Penters Chert is known to be present in the Bonanza Field; see Shell 1 Western Coal & Mining Co. well.

All the Hunton examined is strongly dolomitized and is tentatively referred to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position. See discussion of Shell 1 Western Coal & Mining Co., Shell 1-34 Grober, Shell 1-10 Carter.

Woodford (Chattanooga) Shale 7950′–8046′ (GR log)
Hunton Group 8046′ (GR log)–8220′ (sample depth)
8046′ (GR log)–8060′ (sample depth) Air drilled. ?Penters Chert (=Sallisaw Formation).
8060′–8220′ (sample depths) ?Silurian; ?Chimneyhill Subgroup.
8060′–8070′ (sample depths) Mostly porous crystalline dolomite with minor heavily dolomitized crinoidal limestone. No chert or detrital quartz observed.
8070′–8110′ (sample depths) Samples mixed and not used. See discussion above.
8110′–8220′ (sample depths) Mostly crystalline dolomite with some very heavily dolomitized crinoidal carbonate. Some of the dolomite appears porous, and some of the holes have a linear arrangement, suggesting fracture control. No detrital quartz observed.
Cason Shale (Sylvan Shale) 8220′ (sample depth)

MIDCO 1 DUNAGAN—SE¼SE¼NE¼ sec. 31, T. 11 N., R. 19 E., Muskogee County, Oklahoma; elev. 810′; compl. 1938; production unknown. Tops: Hunton 2320′ (−1510′) (sample depth), Sylvan 2500′ (−1690′) (sample depth), Welling 2546′ (−1736′) (sample depth); Hunton thickness 180′. Hunton samples were described by T. L. Rowland, who had 3 thin sections prepared (Amsden and Rowland, 1965, p. 145–147). In 1976 I examined the samples from 2300′ to 2570′ and had an additional 21 thin sections prepared. The description that follows does not differ in any significant respect to that given by T. L. Rowland. Sample quality is good; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma. See also Frezon (1962, pl. 2).

In this well the dolomite content of the Quarry Mountain Formation is substantially reduced over that in the outcrop area. Only 17′ of "Barber" is recognized, whereas that member is about 50′ thick at the type locality (and at OGS core hole 3). (See panel 4.) The Quarry Mountain Formation, Tenkiller Formation, Blackgum Formation, and Pettit Oolite are reasonably well defined.

Woodford (Chattanooga) Shale
Some Sylamore Sandstone; may be included in the Sallisaw Formation.
Hunton Group 2320′–2500′ (sample depths)
2320′–2327′ (sample depths) Lower Devonian; Sallisaw Formation. Light-gray to tan sandy (quartz) dolomite-dolomitic sandstone and sandy (quartz) chert. Most of the detrital quartz is in angular to subangular grains ranging up to 0.5 mm. There are also chips of quartz sandstone composed of well-rounded detrital quartz with quartz overgrowths ranging up to 15 mm. The latter may represent Sylamore Sandstone (see discussion of Sallisaw Formation in text).
2327′–2500′ (sample depths) Silurian; Chimneyhill Subgroup.
2327′–2471′ (sample depths) Quarry Mountain Formation. Light-gray organo-detrital limestone, in part with pink crinoid plates, becoming dolomitic in the lower part. The limestones are composed in large part of pelmatozoan plates set in a finely crystalline matrix (?recrystallized); little or no detrital quartz present.
2327′–2405′ (sample depths) Pale-gray crinoidal limestone with very little dolomite.
2405′–2454′ (sample depths) Crinoidal limestone as above, but with moderate dolomitization of the matrix.
2454′–2471′ (sample depths) Heavily dolomitized crinoidal limestone with the matrix largely replaced by crystalline dolomite, only the crinoids left as corroded remnants (Barber Member).
2471′–2486′ (sample depths) Tenkiller Formation. Gray to pinkish-gray organo-detrital limestone. Many orange-pink crinoid plates, together with much other organic debris, including many ostracodes, set in a micrite matrix. Very little detrital quartz or dolomite.
2486′–2494′ (sample depths) Blackgum Formation. Gray organo-detrital limestone with glauconite; chert. Mostly pelmatozoan plates, many with an orange-pink color set in a micrite matrix, partly dolomitic.
2494′–2500′ (sample depths) Pettit oolite. Gray to dark-gray silicified and nonsilicified oolite with some glauconitic dolomite and opaque chert.
Sylvan Shale 2500′–2546′ (sample depths)
Greenish-gray to gray shale.
Welling Formation 2546′ (sample depth)
2546′–2556′ and 2561′–2568′ (thin sections) Organo-detrital limestone, mostly with micrite cement; no detrital quartz observed and very little dolomite.

CALVERT FUNDS 1 DYER—C SW¼NE¼ sec. 35, T. 10 N., R. 23 E., Haskell County, Oklahoma; elev. 554′ GL; TD 6652′ (Sylvan); compl. 2/18/69, D&A. Tops: Woodford 6356′ (−5781′) (GR log), Hunton 6410′ (−5845′) (GR log), Sylvan 6633′ (−6068′) (GR log); Hunton thickness 223′. Samples examined from 6370′ (Woodford) to 6652′ (TD), good quality; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The interval from 6410′ to 6420′ comprises limestone and chert with subangular detrital quartz. It is tentatively assigned to the Sallisaw Formation, although it could be in part or entirely Sylamore; see discussion below and under Sallisaw Formation in the text. The underlying Hunton beds are moderately to very heavily dolomitized organo-detrital limestones, including considerable amounts of porous crystalline dolomite. These strata are assigned to the Chimneyhill Subgroup on the basis of stratigraphic position, thickness, and lithology. No Tenkiller or Blackgum type of lithology was recognized.

Woodford (Chattanooga) Shale 6356′–6410′ (GR log)
Hunton Group 6410′–6633′ (GR log)
6410′ (GR log)–6420′ (sample depth) ?Lower Devonian; ?Sallisaw Formation. Limestone, in part dolomitic, and chert with fine (to 0.1 mm) subangular detrital quartz; could be Sylamore, but the

detritus is finer and more angular than is common with that formation. This interval includes some organo-detrital limestone with no quartz or dolomite.

6420′–6633′ (sample depths) Silurian; Chimneyhill Subgroup.

6420′–6480′ (sample depths) Organo-detrital limestone (some finely crystalline, ?recrystallized) matrix, which is moderately to heavily dolomitized; dolomite, which is confined to matrix, corrodes but does not replace the fossil clasts. The fossils are mainly pelmatozoans and bryozoans but include some ostracodes and others.

6480′–6570′ (sample depths) This interval includes much crystalline porous dolomite; there is also some heavily dolomitized pelmatozoan-bryozoan organo-detrital limestone. No detrital quartz observed.

6570′–6633′ (sample depths) This is mostly heavily dolomitized pelmatozoan limestone, with minor porous crystalline dolomite. No detrital quartz observed.

Sylvan Shale 6633′ (GR log)

HUBER 1 FARGO—SE¼NW¼ sec. 4, T. 10 N., R. 24 E., Sequoyah County, Oklahoma; elev. 495′ KB (481′ GL); TD 3381′ (Ordovician; Viola); compl. 12/4/63, D&A. Tops: Woodford 3010′ (−2515′) (GR log), Hunton 3080′ (−2585′) (GR log), Sylvan 3330′ (−2833′) (GR log), Welling 3360′ (−2867′) (GR log); Hunton thickness 250′. Both samples and core examined for this well as follows: samples 3010′–3090′; core 3090′–3108′; samples 3108′–3118′; sample skip 3118′–3140′; samples 3140′–3170′; sample skip 3190′–3240′; last samples 3240′–3385′. 12 thin sections from the core and 21 thin sections from the samples; hand specimens of core and sample thin sections stained with Alizarin Red-S. Core, OU Core Library; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The calcareous quartz sandstone directly beneath the Woodford black shale, provisionally assigned to the Misener (Sylamore), is underlain by dolomitic sandstone, provisionally assigned to the Sallisaw Formation. The distinction between these two units, which is difficult to maintain on the basis of subsurface data, is discussed more fully in the text. It is here drawn between the upper sandstone (?Misener), which is composed mostly of well-rounded quartz grains ranging up to 0.5 mm in diameter, and the lower sandstone (Sallisaw), which is composed of slightly finer (to 0.1 or 0.2 mm) more angular quartz. Both units have much chert. The cored portion includes the lower part of the Sallisaw Formation and an underlying organo-detrital limestone, with very little dolomite or quartz, assigned to the Frisco Formation. This unit includes large terebratuloid brachiopods (large punctate shells, at least in part exfoliated) and shells provisionally referred to *Acrospirifer murchisoni* (large costate spiriferoids that are exfoliated so they do not show fine ornamentation, if such were originally present). On the basis of these fossils, as well as lithology, this unit appears reasonably assigned to the Frisco Limestone.

The Frisco is underlain by heavily dolomitized organo-detrital limestones and porous crystalline dolomites. These are assigned to the Chimneyhill Subgroup on the basis of stratigraphic position and lithology (based entirely on samples; cored portion includes only lower Sallisaw and Frisco).

Woodford (Chattanooga) Shale 3010′–3080′ (GR log)

3028′–3080′ (GR log) Misener Sandstone (Sylamore). Mostly dolomitic to calcitic quartz sandstone; subrounded to rounded quartz grains to 0.5 mm; much chert. This may be in part, perhaps entirely, Sallisaw.

Hunton Group 3080′–3330′ (GR log)

3080′ (GR log)–3102′ (core) Lower Devonian; Sallisaw Formation. Dolomitic light-gray "brecciated" chert and dark-gray dolomitic sandstone. The sandstone is composed almost entirely of crystalline dolomite and angular to subangular detrital quartz to about 0.2 mm; the quartz has been partly "corroded" and replaced by the dolomite. The quartz and dolomite are roughly equal, and the rock probably grades back and forth between sandy dolomite and dolomitic sandstone. The lower 2′ lacks chert, and the basal 2″ has inarticulate brachiopods.

3102′–3109′ (core) Frisco Limestone. Organo-detrital micrite and sparite with little or no detrital quartz or dolomite. The dominant fossils are pelmatozoan plates, but most thin sections show much bryozoan debris. Large brachiopods and snails are also common. The fossils in this rock show some breakage, although not as much as is common for the Frisco. They also exhibit considerable solution, with the contacts between adjoining fossils commonly a solution seam. The rock does not show much visible porosity. The presence of large terebratuloid brachiopods and large costate spirifers, such as *?Acrospirifer murchisoni,* indicates the Frisco, and the lithologic characteristics are fully compatible with such an assignment.

3109′–3340′ (sample depths) Silurian; Chimneyhill Subgroup.

3109′–3320′ (sample depths) Quarry Mountain Formation. This formation assignment is based on stratigraphic position and lithology.

3109′–3175′ (sample depths) Mostly porous crystalline dolomite with some heavily dolomitized crinoidal limestone. No detrital quartz observed.

3175′–3275′ (sample depths) Moderately to heavily dolomitized crinoidal limestone. Some bryozoans and other fossils present. No quartz observed.

3275′–3320′ (sample depths) Mostly porous crystalline dolomite. No detrital quartz observed.

3320′–3335′ (sample depths) Tenkiller Formation. Weakly to moderately dolomitized pink crinoidal limestone; many ostracodes. No detrital quartz observed. The lithology and stratigraphic position indicate an approximate correlation with the Tenkiller Formation. The contact with the overlying heavily dolomitized crinoidal limestone is probably not stratigraphically significant; see discussion in text.

3335′–3340′ (sample depths) Blackgum Formation. Weakly dolomitic limestone with much glauconite. Some detrital quartz.

Sylvan Shale 3330′–3360′ (GR log)

Greenish-gray shale.
Welling Formation 3360′ (GR log)
3375′–3380′ (thin section) (sample depths) Organo-detrital sparite with scattered dolomite crystals; no detrital quartz observed.

HUMBLE 1 FARMERS FLAG UNIT—SW¼NW¼SE¼ sec. 3, T. 8 N., R. 23 E., Le Flore County, Oklahoma; elev. 737′ KB (724′ GL); TD 6746′ (Simpson, Ordovician); compl. 9/3/64, no Hunton production reported. Tops: Woodford 6250′ (−5513′) (GR log), Hunton 6348′ (−5611′) (core), Sylvan 6440′ (−5703′) (sample depth), Welling 6472′ (−5735′) (GR log); Hunton thickness 92′. This well studied as follows: samples 6320′–6348′, core 6348′–6396′, samples 6396′–6510′; 15 thin sections prepared from core (not stained), selected parts of cut core stained with Alizarin Red-S; 5 thin sections prepared from samples, stained with Alizarin Red-S. Core, OU Core Library; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The cored portion extends from just beneath the Woodford-Hunton contact down to 6396′. No diagnostic megafossils were observed, but Dr. James Barrick and Dr. Gilbert Klapper (The University of Iowa) examined parts of the core for conodonts and provided the results shown in the following table:

HUMBLE 1 FARMERS FLAG UNIT

Depth (ft)	Grams dissolved	Specimen type	Number of specimens
6348	625	*Panderodus unicostatus*	7
		Walliserodus sp.	3
6353	955	*Panderodus unicostatus*	7
		Ozarkodina excavata (Pa.)	1
6364	1260	*Panderodus unicostatus*	4
		Walliserodus sp.	3
		Dapsilodus obliquicostatus	1
6369	770	*Panderodus unicostatus*	14
		Walliserodus sp.	5
		Dapsilodus obliquicostatus	3
		Ramiform elements (indet.)	2

The presence of *Dapsilodus obliquicostatus* in the lower 2 samples (6364′–6369′) indicates that the samples probably are equivalent to the Marble City Formation or younger Silurian strata. However, isolated specimens of *D. obliquicostatus* are known high in the type Tenkiller, where they are associated with *Panderodus celloni*. The element of *Ozarkodina excavata* suggests a Marble City or younger Silurian position for the sample at 6353′. The species is known to range into the Lower Devonian outside Oklahoma. (Barrick and Klapper, letter, May 18, 1976.)

The foregoing conodont data, combined with the thickness, stratigraphic position, and lithology, strongly suggest that at least the upper 20′ of the Hunton is correlative with the Marble City Member of the Quarry Mountain Formation. On the basis of lithologic character, the basal pink crinoidal beds are assigned to the Tenkiller Formation. No Blackgum strata or Pettit oolite are recognized.

The upper 12′ of the Hunton is heavily dolomitized (27.40% $MgCO_3$), and the entire cored interval averages 14.54% $MgCO_3$, as shown in the analyses in the following table prepared by Mr. David Foster, chemical laboratory, Oklahoma Geological Survey.

The part of the Hunton represented by samples is estimated to have about the same magnesium content as the lower 36′ of the core. The insoluble detritus is very low throughout the Hunton.

Woodford (Chattanooga) Shale 6250′–6348′ (GR log)
No Misener Sandstone observed.
Hunton Group 6348′–6440′ (core)
6348′–6440′ Silurian; Chimneyhill Subgroup (6348′–6396′ core depths; 6396′–6440′ sample depths).
6348′–6430′ (core) Quarry Mountain Formation (base uncertain).
6348′–6360′ (core) Heavily dolomitized organo-detrital limestone ranging into crystalline dolomite. Crinoids make up most of the recognizable organic material; fossils generally retain their microtexture, with only a few replaced by spar. Conodonts present; those from 6364′ to 6369′ are similar to those from the Marble City Formation. Very low in detrital quartz. Not much visible porosity. $MgCO_3$ 27.40%, HCl-acid insolubles 1.99%.
6360′–6382′ (core) Light-gray organo-detrital micrite and sparite; fossils dominated by crinoidal material; includes much shelly debris including a number of brachiopods, bryozoans, ostracodes, and others. This rock is weakly to moderately dolomitized, the dolomite appearing as widely scattered dolomite crystals in the matrix; in some beds they are concentrated into small areas of fairly solid dolomite. $MgCO_3$ averages 8.14%, HCl-acid insolubles average 0.56%.
6382′–6396′ (core) Heavily dolomitized organo-detrital limestone; fossil debris mainly crinoid plates. This is moderately to heavily dolomitized (not as much dolomite as in the 6348′–6330′ interval above); some of the matrix is crystalline dolomite. Little or no detrital quartz. $MgCO_3$ 13.62%, HCl-acid insolubles 0.51%.
6396′–6430′ (sample depths) Moderately to heavily dolomitized crinoidal limestone with little or no quartz. Similar to that present in the lower 36′ of the cored interval.
6430′–6440′ (sample depths) ?Tenkiller Formation. Moderately to heavily dolomitized pink crinoidal micrite; numerous ostracodes and bryozoans also present. No glauconitic or oolitic beds observed.
Sylvan Shale 6440′ (sample depth) -6472′ (GR log)
Welling Formation 6472′ (sample depth)
6500′–6510′ (sample depth) (thin section) Organo-detrital sparite and micrite with a few scattered dolomite crystals; no detrital quartz observed.

HUMBLE 1 FARMERS FLAG UNIT CORE

Interval (ft)	Field number	Lab number	Percentage of total rock: $CaCO_3$	$MgCO_3$	Insoluble residue	Recovery
6348-6360	1	12,869	71.60	27.40	1.99	100.99
6360-6370	2	12,870	91.61	8.43	0.67	100.71
6370-6382	3	12,871	92.24	7.84	0.44	100.52
6382-6396	4	12,872	85.83	13.83	0.51	99.96
Weighted Average			85.08	14.54	0.90	

MACKELLAR 1 FERGUSON—C SW¼NE¼ sec. 35, T. 24 N., R. 21 W., Woodward County, Oklahoma; elev. 2030′ KB; TD 10,406′ (Ordovician); compl. 8/30/66; D&A. Tops: Hunton 9738′ (−7708′) (core), Sylvan ?9769′ (−7739′) (core), Viola ?9821 (−7791′) (core); Hunton thickness 31′ (?). Cored 9738′-9844′; 12 thin sections; OU Core Library.

A columnar section of this core is illustrated in text-fig. 15, and it is discussed in the section on the Ordovician-Silurian boundary in the text. Gilbert Klapper and James Barrick, The University of Iowa, report the following conodont fauna from 9742′ to 9744′:

Dapsilodus obliquicostatus	1 specimen
Panderodus unicostatus	1
P. recurvatus	1
Walliserodus sp.	1
Distomodus sp. indet.	1

According to these authors, this indicates an age equivalent to the lower part of the Clarita Formation (Prices Falls Member to lowermost Fitzhugh Member).

Chemical analyses of spot samples from the core are given as follows:

MACKELLAR 1 FERGUSON

depth (ft)	Percentage of total rock: $CaCO_3$	$MgCO_3$	Insoluble residue	Recovery
9744	97.18	0.46	0.10	97.74
9749	99.36	0.36	0.33	100.05
9759	59.52	39.90	2.41	101.83
9769	43.45	24.21	29.15	96.81
9770	46.75	28.19	22.37	97.31
9772	50.67	30.64	17.99	99.30
9774	47.45	29.66	19.68	96.79
9775	57.63	5.28	35.58	98.49
9776	46.46	22.30	30.18	98.94
9792	48.58	17.20	32.44	98.22
9797	51.47	13.43	33.56	98.46
9804	59.51	5.46	33.50	98.47
9810	51.98	12.45	33.66	98.09
9817	61.03	15.26	21.60	97.89

SOUTHERN UNION 1 FOLLANSBEE—SW¼NW¼SW¼ sec. 18, T. 9 N., R. 15 E., McIntosh County, Oklahoma; elev. 660′; TD 5461′ (Arbuckle); compl. 3/15/56, Cromwell and Hunton production reported (perforated 4826′-4872′; Chimneyhill Subgroup, probably including some basal Sallisaw beds). Tops: Woodford 4792′ (−4132′) (CC), Hunton 4808′ (−4148′) (CC), Sylvan 4935′ (−4275′) (CC), Welling 5000′ (−4340′) (sample depth); Hunton thickness 127′. Samples examined from 4720′ to 5120′, good quality; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata include fairly typical Sallisaw beds (see discussion of Sallisaw Formation) underlain by strata here referred to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position. Lithologically, the Chimneyhill strata can be subdivided into the Quarry Mountain, Tenkiller, and Blackgum Formations. This is about the most westerly well in which these units can be recognized with reasonable certainty. (See also descriptions of the 1 Brotton, 1 Beauman, 1 Graham, and 1 Dunagan.) Most of the Silurian strata are only weakly to moderately dolomitized, although there is some crystalline dolomite in the 4880′-4890′ interval.

Woodford (Chattanooga) Shale 4792′-4808′ (CC)
The basal part of the Woodford includes some Misener quartz and sandstone.

Hunton Group 4808′-4935′ (CC)

4808′ (CC)-4830 (sample depth) Lower Devonian; Sallisaw Formation. Crystalline dolomite with much subangular to subrounded detrital quartz up to 0.2 mm. Some chert with euhedral crystals of dolomite and detrital quartz.

4830′-4880′ (sample depths) ?Quarry Mountain Formation. Organo-detrital crinoidal sparite with only minor dolomite and very little detrital quartz.

4880′-4900′ (sample depths) Crystalline dolomite and heavily dolomitized crinoidal limestone with little or no detrital quartz.

4900′-4930′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with very little dolomite and very little detrital quartz.

4930′-4940′ (sample depths) ?Blackgum Formation. Moderately to heavily dolomitized glauconitic crinoidal limestone with much shelly debris, including bryozoans. Very little detrital quartz. Some chert.

Sylvan Shale 4935′ (CC) -5000′ (sample depth)
Gray shale.
Welling Formation 5000′ (sample depth)
5000′-5005′ (thin section) Organo-detrital sparite and micrite; no detrital quartz observed and only traces of dolomite.

GIBRALTAR 1 FRANKS—SW¼NW¼NE¼ sec. 32, T. 13 N., R. 10 E., Okfuskee County, Oklahoma; elev. 827′; TD 3663′ (Ordovician); compl. unknown, no Hunton production reported. Tops: ?Misener 3490′ (−2663′) (sample depth), Hunton 3520′ (−2663′) (sample depth), Sylvan 3530′ (−2703′) (sample depth), Welling 3610′ (−2783′) (sample depth), Fite 3625′ (−2798′) (sample depth); Hunton thickness 10′. Samples examined from 3400′ to 3666′ (TD); considerable mixing of samples; 6 thin sections, OGS; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The samples just beneath the Woodford dark shale include much subangular quartz silt and are provisionally referred to the Misener. However, these include some moderately fossiliferous marlstone, which is relatively low in silt content and could represent Hunton strata. The sample just above the Sylvan (3520′-3530′) is typical pink crinoidal micrite and is assigned to the Chimneyhill Subgroup. It has very little dolomite.

Woodford (Chattanooga) Shale
3490′-3520′ (sample depths) Misener Sandstone. Carbonate with some crystalline dolomite and much subangular silt-size (to 0.5 mm) quartz detritus; some micrite with scattered fossils and widely distributed fine quartz silt.
Hunton Group 3520′-3530′ (sample depths)
Silurian; Chimneyhill Subgroup. Pink crinoidal micrite with ostracodes and bryozoans; very little quartz detritus and very little dolomite.
Sylvan Shale 3530′-3610′ (sample depths)
Shale; upper 20′ greenish gray, lower part medium gray.
Welling Formation 3610′-3625′ (sample depths)
3610′-3620′ (thin section) Organo-detrital sparite; no detrital quartz or dolomite observed; minor chert.
Fite Limestone 3625′ (sample depth)
3630′-3640′ (thin section) Pellet limestone and dense ?algal limestone; scattered dolomite crystals; no detrital quartz observed (pl. 11, fig. 1).
3646′ (thin section) Similar to above texture, but more crystalline dolomite.

CLAYBROOK 1 GARRETT—NE¼NE¼SE¼ sec. 8, T. 8 N., R. 10 E., Hughes County, Oklahoma; elev. 743′ DF (738′ GL); TD 4153′ (Ordovician); compl. 11/2/55, Hunton oil production reported. Tops: Woodford 3750′ (−3007′) (sample depth), Hunton 3795′ (−3052′) (sample depth), Sylvan 3890′ (−3147′) (sample depth), Welling 3986′ (−3248′) (sample depth); Hunton thickness 95′. Samples good quality, examined from 3700′ to 4020′; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata comprise weakly to moderately dolomitized organo-detrital limestones, which are assigned to the Chimneyhill Subgroup on the basis of lithologic character and stratigraphic position. They can be divided into an upper pink crinoidal limestone (?Clarita, ?Tenkiller) and a lower glauconitic limestone (?Cochrane, ?Blackgum). Note that the lower glauconitic limestones have not been recognized in the nearby 1 Ambrister.

A well-defined cherty sandstone is present between the Chimneyhill and the Woodford. This is tentatively assigned to the Misener Sandstone, although it could be partly or entirely Sallisaw (see Sallisaw Formation in text).

Woodford (Chattanooga) Shale 3750′-3795′ (CC)
3785′-3795′ (sample depths) Misener Sandstone. Angular fine (to 0.2 mm) quartz grains set in a silicified matrix and mixed with chert; underlying sample has 1 piece of sandstone with larger (to 0.1 mm) rounded quartz grains.
Hunton Group 3795′-3890′ (sample depths)
3795′-3890′ (sample depths) Silurian; Chimneyhill Subgroup.
3795′-3880′ (sample depths) ?Clarita Formation, ?Tenkiller Formation. Pink crinoidal micrite with minor spar. Pelmatozoan plates dominate, but bryozoans and other shelly debris are also present. Very little detrital quartz. Mostly weak to moderate dolomitization, but some beds with substantial dolomite.
3880′-3890′ (sample depths) ?Cochrane, ?Blackgum. Organo-detrital micrite with much glauconite. Moderate to strong dolomitization. Very little quartz.
Sylvan Shale 3890′-3986′ (sample depths)
Upper 20′ greenish-gray shale; medium-gray below.
Welling Formation 3986′ (sample depth)
4015′-4020′ (thin section) Organo-detrital pelmatozoan sparite with bryozoans, trilobites, and other shelly debris. A few well-rounded detrital quartz grains to 0.4 mm. No dolomite observed.

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 3565′ (−2858′) (CC), Misener 4077′ (−3370′) (CC), Sylvan 4125′ (−3418′) (CC); no Hunton present. Cored 4095′-4117′ (Misener); 3 thin sections; no analyses; OU Core Library.

Woodford (Chattanooga) Shale 3365′-4125′ (CC)
4077′-4127′ (CC) Misener Sandstone.
4077′-4095′ No core.
4095′-4117′ (core) Dark-gray to brown fine-grained dolomitic and glauconitic siltstone. This core described by Amsden (1975b, p. 87).
4117′-4125′ No core.
Sylvan Shale 4125′ (CC)

CARTER 1 GRAHAM—NW¼SE¼NE¼ sec. 3, T. 9 N., R. 16 E., McIntosh County, Oklahoma; elev. 713′; compl. 1951, production unknown. Tops: Hunton 4630′ (−3917′) (sample depth), Sylvan 4795′ (−4082′) (sample depth), Welling 4845′ (−4132′) (sample depth); Hunton thickness 165′. Hunton samples were described by T. L. Rowland using two prepared thin sections (Amsden and Rowland, 1965, p. 151-152; thin section illustrated pl. 18, fig. 5). In 1975 I examined the samples from 4600′ to 4880′ and had an additional 16 thin sections prepared. The description which follows does not differ in any significant respect from that given by T. L. Rowland, except for the provisional recognition of the Sallisaw. The sample quality is good; samples, OGS Core Library (see also Frezon, 1962, pl. 2).

Upper Hunton beds are provisionally assigned to the Sallisaw; see remarks following. The lower 10′ of the Quarry Mountain Formation (4755′–4765′) is heavily dolomitized, and Rowland assigned this to the "Barber Member." It should be noted, however, that the overlying beds are also rather heavily dolomitized. In fact, almost the entire Quarry Mountain has substantial dolomite. The Quarry Mountain, Tenkiller, and Blackgum lithostratigraphic sequence is reasonably well defined, although precise correlation with the outcrop area of eastern Oklahoma is uncertain (see panel 4, and discussion of the Chimneyhill Subgroup). All depths given are from the samples.

Woodford (Chattanooga) Shale
Strata assigned to the Sallisaw may be in part or entirely the Sylamore Sandstone.
Hunton Group 4630′–4795′ (sample depths)
4630′–4655′ (sample depths) ?Lower Devonian; ?Sallisaw Formation. Dolomitic sandstone; detrital quartz in subangular to rounded grains (some with overgrowths to 0.75 mm). The grain size, concentration, and degree of rounding are suggestive of the Sylamore. The high carbonate content is suggestive of the Sallisaw. The regional relations suggest that at least some Sallisaw is present (panel 4).
4655′–4795′ (sample depths) Silurian; Chimneyhill Subgroup.
4655′–4765′ (sample depths) Quarry Mountain Formation. Pale-gray organo-detrital pelmatozoan limestone (with many pink crinoid plates), much of which is moderately to heavily dolomitized; little or no detrital quartz. Pelmatozoan plates strongly dominate the fossils.
4655′–4750′ (sample depths) Most chips show the matrix to be partly to largely replaced by dolomite.
4750′–4765′ (sample depths) Barber Member. The matrix is almost completely replaced by crystalline dolomite, leaving only corroded remnants of crinoids.
4765′–4775′ (sample depths) Tenkiller Formation. Gray to pinkish-gray organo-detrital limestone, weakly to moderately dolomitized.
Pelmatozoan plates, commonly with an orange-pink color, are the dominant fossil. Much other organic debris is present, including many ostracodes. The matrix is dominantly micrite with only minor spar. Insoluble detritus low.
4775′–4795′ (sample depths) Blackgum Formation. Organo-detrital crinoidal limestone grading into dolomite, glauconitic. Pale-gray chert. No oolite observed.
Sylvan Shale 4795′–4845′ (sample depths)
Greenish-gray shale in upper part, medium-gray shale below.
Welling Formation 4845′ (sample depth)
4850′–4855′ (thin section) Organo-detrital pelmatozoan micrite and sparite with much shelly debris; no detrital quartz observed and very little dolomite.
4870′–4875′ (thin section) Like above, but with a few widely scattered detrital quartz grains.

BELL 1 GRANT—C S½SE¼NE¼ sec. 17, T. 11 N., R. 17 E., McIntosh County, Oklahoma; elev. 664′; compl. 1959, production unknown. Tops: Hunton 2795′ (−2131′) (sample depth), Sylvan 2825′ (−2161′) (sample depth); Hunton thickness 30′. Samples examined from 2785′ to 2835′. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 153–154).

SHELL 1-34 GROBER—NW¼SE¼ sec. 34, T. 7 N., R. 32 W., Sebastian County, Arkansas; elev. 537′ DF (521′ GL); TD 8231′ (Ordovician); compl. 3/3/64, Hunton gas production reported 7914′–7950′. Tops: Woodford 7800′ (−7263′) (GR log), ?Penters Chert (=Sallisaw Formation) 7872′ (−7335′) (GR log), Cason (=Sylvan) 8096′ (−7559′) (GR log), Welling 8114′ (−7577′) (GR log); Hunton thickness 224′ (presumably includes the Penters Chert). Air drilled to a depth of 7940′; samples examined from 7940′ to 8200′, good quality; 15 thin sections; samples, Arkansas Geological Commission, Little Rock, Arkansas.

This is 1 of the producing wells in the Bonanza Gas Field (text-fig. 11). It was air drilled to a depth of 7940′ and the samples above this point are unsatisfactory for study. Below 7940′ the cuttings are large and appear to have minimum contamination. The uppermost Hunton sample studied (7940′–7950′) is composed entirely of crystalline dolomite with no chert, and if the Penters Chert (=Sallisaw Formation) is present it must occupy some part of the interval between 7872′ (Hunton top from the GR log) and 7940′. The gamma-ray log shows a break at 7840′, which might represent the Penters Chert-?Chimneyhill boundary. The interval from 7040′ to 8040′, which is entirely crystalline dolomite, is tentatively correlated with the upper part of the Chimneyhill Subgroup (=?Quarry Mountain Formation) of eastern Oklahoma; see Chimneyhill Subgroup, Eastern Outcrops. This part of the Chimneyhill in eastern Oklahoma is moderately to heavily dolomitized (panel 4), although it should be noted that the presence of detrital quartz in the 1-34 Grober is anomalous, as upper Chimneyhill strata are commonly very low in insoluble detritus. The Hunton strata studied in the 1-34 Grober are similar in lithology and lithostratigraphic sequence to the 1 Western Coal & Mining Co. well about 2 miles east (described in Haley and Frezon, 1965, and in the present report). The assignment of the Hunton strata in the Bonanza Field to the Chimneyhill Subgroup is based entirely on lithological similarity and stratigraphic position. It is possible that these beds include some younger Silurian and (or) Lower Devonian equivalents (see Chimneyhill Subgroup, Subsurface).

Woodford (Chattanooga) Shale 7800′–7872′ (GR log)
Hunton Group 7872′–8096′ (GR log)
7872′ (GR log) -7940′ (sample depth) This part was air drilled, and the samples were not studied; probably includes some Penters Chert (=Sallisaw Formation).

7940′–8040′ (sample depths) Almost entirely gray crystalline dolomite, in part porous. Thin sections show a few pieces with subrounded to well-rounded detrital quartz grains to 1 mm. No chert observed.
8040′–8080′ (sample depths) Weakly to heavily dolomitized organo-detrital sparite with minor micrite; minor crystalline dolomite. Fossils include pelmatozoan plates and numerous bryozoans. Only 1 fragment observed with fine detrital quartz. No chert observed.
8080′–8096′ (sample depths) Mostly crystalline dolomite; minor chert. No detrital quartz observed.
Cason Shale (=Sylvan Shale) 8096′–8114′ (GR log)
Samples with shale to 8140′. Upper part is a greenish-gray dolomitic shale underlain by dark shale.
Welling Formation ("Viola") 8114′ (GR log)
8150′–8160′ (thin section) Entirely crystalline dolomite.
8170′–8180′ (thin section) Weakly to strongly dolomitized dense organo-detrital micrite ranging into crystalline dolomite.
8190′–8200′ (thin section) Like above. Also shows some dense limestone and minor rounded detrital quartz. Chert.

CAMPBELL 1 HAGGARD—NW¼NW¼NE¼ sec. 6, T. 12 N., R. 16 E., McIntosh County, Oklahoma; elev. unknown; compl. 1955, production unknown. Tops: Hunton 3080′ (sample depth), Sylvan 3120′ (sample depth); Hunton thickness 40′. Samples examined from 3070′ to 3130′. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 156–157).

OKLAHOMA NATURAL GAS 1 HALE—C NE¼SW¼NW¼ sec. 7, T. 9 N., R. 14 E., McIntosh County, Oklahoma; elev. 761′ GL; TD 4400′; compl. 6/27/65, no Hunton production reported. Tops: Hunton 4062′ (−3301′) (sample depth), Sylvan 4205′ (−3444′) (sample depth), Welling 4280′ (−3519′) (sample depth); Hunton thickness 143′. Samples examined from 4000′ to 4330′, excellent quality; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata include about 40′ of fossiliferous marlstone in the upper part. This rock is largely free of quartz detritus and is unlike the strata assigned to the Sallisaw Formation in the nearby 1 Brotten and 1 Follansbee. It is similar to the uppermost Hunton strata in the 1 Schrimscher. Lithologically these marlstones resemble the Henryhouse-Haragan beds in the Arbuckle Mountains, but similar marlstones are also known to be present in the Clarita Formation. The thickness and regional relations suggest that these beds are facies of the Chimneyhill Subgroup. This is the most easterly extension of any known marlstone in Oklahoma.

Woodford (Chattanooga) Shale
Hunton Group 4062′–4205′ (sample depths)
4062′–4205′ (sample depths) Silurian; Chimneyhill Subgroup.
4062′–4100′ (sample depths) Fossiliferous marlstone with very little detrital quartz. Mostly pelmatozoan plates, some ostracodes, bryozoans, brachiopods, etc. A few pieces of grain-supported carbonate like below, but mainly mud supported. Provisionally referred to the Chimneyhill.
4100′–4200′ (sample depths) ?Quarry Mountain Formation. Weakly to heavily dolomitized pelmatozoan biosparite and biomicrite. Some porous crystalline dolomite. Very little detrital quartz. Some pink crinoidal type of lithology but no well-defined lithostratigraphic unit.
4200′–4205′ (sample depths) ?Blackgum Formation. Glauconitic biomicrite with considerable shelly debris; some dolomitized limestone; some chert.
Sylvan Shale 4205′–4280′ (sample depths)
Upper 20′ greenish-gray shale, lower part dark-gray.
Welling Formation 4280′–4300′ (sample depths)
4280′–4290′ (thin section) Organo-detrital pelmatozoan sparite with minor micrite and much shelly debris. Subangular to rounded detrital quartz, very little dolomite (pl. 11, fig. 3).
Fite Limestone 4300′ (approximate sample depth)
4320′–4330′ (thin section) Mostly dense ?algal limestone with sparry areas and some pellet limestone. Chert. Organo-detrital sparite with many well-rounded quartz grains to 0.8 mm.

SINCLAIR 1 G. B. HALL—N½S½SW¼ sec. 17, T. 5 N., R. 16 E., Pittsburg County, Oklahoma; elev. 735′ GL; TD 13, 428′ (Arbuckle); compl. 8/23/62, D&A. Tops: Woodford 12,093′ (−11,341′) (interval transit time log), Sylvan 12,333′ (−11,581′) (interval transit time log), Welling 12,407′ (−11,655′) (samples and interval transit time log); no Hunton present. Samples examined from 11,980′ to 12,480′; samples appear to show some mixing; 8 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford-Sylvan contact is not clearly marked in the samples, both formations being composed of dark shale. This contact is, however, well defined on the interval transit log. The light-green shale so characteristic of the upper Sylvan throughout most of the Arkoma Basin is absent here and in the 1 Manschrick, possibly owing to pre-Woodford erosion. (See 1 Price, 1 Jones-Bonas Unit, 1 Rosendahl.)

2 thin sections from the Welling interval, 12,410′–12,420′ are organo-detrital limestone with much rounded detrital quartz and very little dolomite; 12,440′–12,450′ interval same as above.

WOLFE 1 HALL—SW¼SW¼NW¼ sec. 6, T. 9 N., R. 10 E., Hughes County, Oklahoma; elev. unknown, TD 3890′ (?Hunton); compl. unknown, production unknown. No electric log or completion card observed. Tops: Woodford 3795′ (sample depth), Hunton 3830′ (sample depth), last sample, 3885′–3890′, may include Sylvan. Samples examined from 3750′ to 3890′ (TD), good quality; 7 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

There is approximately 10′ of Misener Sandstone at the base of the Woodford. The upper 20′ of the Hunton is light-gray organo-detrital crinoidal-bryozoan sparite with no observed dolomite or quartz. This resembles the upper 10′ of the Hunton in the 1 Scott and the 1 Armbrister. On the basis of its stratigraphic position and lithology (note the absence of any dolomite), these beds are provisionally referred to the Frisco Formation (cf. 1 Reed and 1 Boley). The underlying strata are moderately to strongly dolomitized pink crinoidal micrite here referred to the Chimneyhill Subgroup.

Woodford (Chattanooga) Shale 3795′-3830′ (sample depths)
3795′-3820′ Black shale.
3820′-3830′ (sample depths) Misener Sandstone. Mostly quartz sandstone, the quartz grains with overgrowths.
Hunton Group 3830′-3890′ (sample depths)
3830′-3850′ ?Lower Devonian; ?Frisco Formation. Light-colored organo-detrital crinoidal-bryozoan sparite. No dolomite or quartz observed.
3850′-3890′ (sample depths) Silurian; Chimneyhill Subgroup. Moderately to strongly dolomitized pink crinoidal micrite. No detrital quartz observed.

BEACH 1 HARBER—S½NE¼NW¼ sec. 3, T. 9 N., R. 6 E., Seminole County, Oklahoma; elev. 1062′ KB (1055′ GL); TD 4335′ (Viola); compl. 8/10/58, production unknown. Tops: Hunton 4080′ (−3018′) (sample depth), Sylvan 4175 (−3113′) (sample depth), Welling 4280′ (−3218′) (sample depth); Hunton thickness 95′. Samples examined from 4050′ to 4310′, good quality; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton rocks are assigned to the Chimneyhill Subgroup, although the upper 30′ have a modest amount of fine angular silt-size quartz detritus. The cement is micrite, but the texture appears to be all organo-detrital grain supported rather than marlstone. This could be the Henryhouse and (or) Haragan marlstone, but the general textural characters and relationship to other wells in this area suggest Chimneyhill (cf. 10A Rentie and 1 Davis). The remainder of the Hunton is crinoidal micrite with some spar, weakly to strongly dolomitized. Only widely scattered quartz grains.

Woodford (Chattanooga) Shale
Hunton Group 4080′-4175′ (sample depths)
4080′-4175′ (sample depths) Silurian; Chimneyhill Subgroup.
4080′-4105′ Weakly to moderately dolomitized crinoidal micrite with scattered angular quartz grains to 0.1 mm.
4105′-4150′ Moderately to strongly dolomitized (including some crystalline dolomite) crinoidal micrite with some spar; a few widely scattered fine angular quartz grains.
4150′-4175′ Weakly to moderately dolomitized pink crinoidal limestone with a few widely scattered fine angular quartz grains.
Sylvan Shale 4175′-4280′ (sample depths)
Pale-green shale in upper 20′, becoming dark-greenish-gray below.
Welling Formation 4280′ (sample depth)
4280′-4285′ (thin section) Organo-detrital sparite with no quartz or dolomite.
4295′-4300′ (thin section) Organo-detrital limestone as above, but with 1 or 2 well-rounded quartz grains.

TENNESSEE 1 HARGROVE-HUDSON S.W.D.—125′ NE of C NE¼NW¼ sec. 7, T. 1 N., R. 10 E., Coal County, Oklahoma; elev. 726′; TD 8657′ (Ordovician); compl. unknown, no Hunton production reported. Tops: Hunton 7134′ (−6408′) (sample depth), Sylvan 7366′ (−6640′) (sample depth), Welling 7480′ (−6754′) (sample depth); Hunton thickness 232′. Samples examined from 7100′ to 7520′, good quality; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata are all low-magnesium limestones with a stratigraphic sequence similar to that in the Arbuckle Mountain outcrops (cf. 1-6 Johnson). The uppermost beds are low-magnesium organo-detrital limestones (Frisco, possibly including some Fittstown Member, Bois d'Arc Formation), underlain by marlstones (Henryhouse-Haragan undifferentiated). The basal strata are organo-detrital limestones resembling the Chimneyhill Subgroup at its type locality.

Woodford (Chattanooga) Shale
No Misener Sandstone observed.
Hunton Group 7134′-7366′ (sample depths)
7134′-7170′ (sample depths) Devonian; Frisco Formation, possibly including some Bois d'Arc Formation (Fittstown Member). Organo-detrital limestone with chert. Pelmatozoan plates and some trilobites, ostracodes, bryozoans, and a few brachiopod fragments. Very little detrital quartz and very little dolomite.
7170′-7320′ (sample depths) Silurian-Devonian; Henryhouse and Haragan Formations undifferentiated. Fossiliferous marlstone; relatively few crinoid plates but some ostracodes, trilobites, bryozoans, and brachiopods. From 7170′ to 7200′ much silt-size (to 0.2 mm) subangular quartz detritus; below this the quartz content is considerably reduced. Some dolomite present, especially in the upper, more silty parts.
7320′-7366′ (sample depths) Silurian; Chimneyhill Subgroup, 40′ thick.
7320′-7350′ (sample depths) Clarita Formation. Pink crinoidal sparite with some micrite. In addition to pelmatozoans, includes ostracodes, trilobites, and some bryozoans and brachiopods. Very little detrital quartz and very little dolomite.
7350′-7366′ Cochrane Formation. Glauconitic organo-detrital sparite and micrite. Much pelmatozoan material. Very little detrital quartz and only minor dolomite.
Sylvan Shale 7366′-7480′ (sample depths)
Upper few feet an apple-green shale, underlain by dull-gray to slightly greenish-gray shale.
Welling Limestone 7480′ (sample depth)
7480′-7490′ (thin section) Organo-detrital sparite and minor micrite with no quartz detritus.
7510′-7520′ (thin section) Similar to above but bearing numerous rounded quartz grains.

WOODS 1 HENDERSON—C NE¼NW¼NW¼ sec. 18, T. 4 N., R. 6 E., Pontotoc County, Oklahoma; elev. 971′ RT (968′ GL); TD 3125′ (Ordovician, Simpson); compl. 11/13/52, production unknown. Tops: Hunton 2162′ (−1191′) (sample depth), Sylvan 2230′ (−1259′) (sample depth), Welling 2364′ (−1393′) (sample depth); Hunton thickness 68′. Samples examined from 2080′ to 2390′, good quality; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton Group in this well appears to be in the typical Arbuckle Mountain lithofacies consisting of an upper marlstone (Henryhouse and/or Haragan), underlain by Chimneyhill Subgroup (including Clarita, Cochrane, and Keel Formations). It is all low-magnesium limestone.

Woodford (Chattanooga) Shale
No Misener Sandstone recognized.
Hunton Group 2162′-2330′ (sample depths)
2162′-2210′ (sample depths) Silurian-?Devonian; Henryhouse Formation possibly including some Haragan beds. Weakly fossiliferous marlstone. Sparse, scattered subangular detrital quartz to 0.2 mm; only weakly dolomitized throughout.
2210′-2230′ (sample depths) Chimneyhill Subgroup (thickness 20′).
2210′-2215′ (sample depths) ?Clarita Formation. Pink crinoidal micrite with minor spar; ostracodes and trilobites common. Very little detrital quartz and very little dolomite.
2215′-2220′ (sample depths) Cochrane Formation. Glauconitic organo-detrital spar and micrite. Very little detrital quartz; moderate scattered dolomite crystals. Chert.
2220′-2230′ (sample depths) Keel Formation. Oolites with radial and banded structure set in a matrix partly spar, partly micrite. Fossiliferous, including fossils forming the core of the oolites (some oolites not well rounded, taking the shape of its fossil nucleus). Very little detrital quartz and very little dolomite.
Sylvan Shale 2230′-2364′ (sample depths)
Welling Formation 2364′ (sample depth)
2368′-2370′ (thin section) Organo-detrital sparite, minor micrite, with no observed detrital quartz and very little dolomite.
2385′-2390′ (thin section) Crystalline dolomite with numerous well-rounded quartz grains to 0.7 mm.

PAN AMERICAN 1 ZOE HOLT UNIT—C N½NE¼SW¼ sec. 20, T. 9 N., R. 25 E., Le Flore County, Oklahoma; elev. 531′; TD 8342′ (Ordovician); compl. 11/23/62, production unknown. Tops: Woodford 7965′ (−7421′) (GR log), Hunton 8041′ (−7510′) (GR log), Sylvan 8212′ (−7681′) (GR log), Welling 8240′ (−7709′) (sample depth); Hunton thickness 170′. Samples examined from 7990′ to 8280′; cuttings small (not air drilled) and with considerable dark shale contamination; 13 thin sections, OGS; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Only 1 piece of quartz sandstone identified in the upper part of this well, and the ?Misener (?Sallisaw) must be very thin. The Hunton in this well has less dolomite than does the 1 Reinhardt. Some parts are represented by crystalline dolomite; the 1 Holt is more similar to the 1 Dyer in this respect. Hunton strata are tentatively assigned to the Chimneyhill Subgroup (on the basis of stratigraphic position and thickness).

Woodford (Chattanooga) Shale 7965′-8041′ (GR log)
?Thin Misener Sandstone at base.
Hunton Group 8041′-8212′ (GR log)
8041′-8080′ (sample depths) Silurian; Chimneyhill Subgroup. Weakly to strongly dolomitized, pelmatozoan limestone with little if any detrital quartz.
8080′-8125′ (sample depths) Mostly crystalline dolomite, parts porous. Little if any detrital quartz.
8125′-8195′ (sample depths) Weakly to heavily dolomitized pelmatozoan limestone. Little if any detrital quartz.
8195′-8212′ (sample depths) Heavily dolomitized limestone.
Sylvan Shale 8212′ (GR log) -8240′ (sample depth)
Welling Formation 8240′ (sample depth)
8240′-8245′ (thin section) Mostly pelmatozoan sparite with some brachiopod and bryozoan debris; scattered, relatively coarse (to 1 mm). Euhedral dolomite crystals; no detrital quartz observed.

PINE 1 S. JOHNSON—NE¼SW¼SE¼ sec. 9, T. 3 N., R. 7 E., Pontotoc County, Oklahoma; elev. 852′ KB (846′ GL); TD 2286′ (Ordovician; Simpson); compl. 3/20/51, D&A. Tops: Woodford 1430′ (−578′) (GR log), Hunton 1509′ (−657′) (GR log), Sylvan 1898′ (−1046′) (sample depth), Welling 2030′ (−1178′) (sample depth); Hunton thickness 389′. Samples examined from 1450′ to 2060′, some contamination and mixing; 25 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata comprise a well-defined lithostratigraphic sequence consisting of an upper light-colored organo-detrital limestone (Frisco, possibly including some Fittstown beds), gray marlstone (Henryhouse-Haragan undifferentiated), and a basal organo-detrital crinoidal limestone (Chimneyhill Subgroup, including identifiable Clarita and Cochrane units). This sequence is similar to that in the northeastern Arbuckle outcrops (Lawrence Uplift south to old Hunton townsite; see Amsden, 1960, Appendix). It is also similar to that in the 3 Burris. Hunton strata are almost entirely low-magnesium limestones, estimated at less than 10% $MgCO_3$.

Woodford (Chattanooga) Shale 1430′-1509′ (GR log)
Misener Sandstone. A little spicular chert with subangular detrital quartz at the base.
Hunton Group 1509′-1898′ (GR log)
1509′ (GR log)-1590′ (sample depth) Lower Devonian Frisco Formation (may include some Fittstown Member, Bois d'Arc Formation). Light-gray organo-detrital sparite and micrite. Crinoids are the dominant fossils, but most beds contain many bryozoans; also some brachiopods, ostracodes, trilobites, etc. Very low in dolomite and detrital quartz; a few widely scattered subrounded grains of quartz in the 1565′-1570′ interval.
1590′-1860′ (sample depths) Lower Devonian-Silurian Henryhouse-Haragan undifferentiated. Gray marlstone with scattered fossils. Crinoids are probably the dominant fossils, but bryozoans are common; other megafossils are also present. Silt-size (to 0.1 mm) subangular detrital quartz is present throughout, ranging from sparse to abundant; for the most part it is only moderately common. Scattered dolomite crystals are also present throughout most of this interval; lithology varies, but for the most part it consists of low-magnesium limestones. This interval is lithologically well defined, with no evidence of gradation above or below.

1860′-1898′ (sample depths) Silurian; Chimneyhill Subgroup.
1860′-1885′ (sample depths) Clarita Formation; pink crinoidal micrite with many ostracodes; also snails, trilobites, and other shelly fossils are present. Some scattered detrital quartz and dolomite in the upper part; below, very little.
1885′-1900′ (sample depths) Cochrane Formation. Glauconitic crinoidal micrite with chert. Some scattered silt-size detrital quartz; low in dolomite.
Sylvan Shale 1898′-2030′ (sample depths)
Welling Formation 2030′ (sample depth)
2035′-2040′ (thin section) (sample depths) Organo-detrital sparite with no observed quartz or dolomite.
2060′-2065′ (thin section) (sample depths) Same as above, no quartz or dolomite observed.

TENNECO 1-6 JOHNSTON (formerly AMERADA 1 JOHNSTON)—SW¼SE¼SW¼ sec. 6, T. 1 N., R. 10 E., Coal County, Oklahoma; elev. 690′ DF; TD 8566′ (Ordovician); compl. unknown, production unknown. Tops: Woodford 6972′ (−6282′) (CC), Hunton 7154′ (−6464′) (sample depth), Sylvan 7385′ (−6695′) (sample depth), Welling 7493′ (−6803′) (sample depth); Hunton thickness 231′. Samples examined from 7050′ to 7530′, excellent quality; 14 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well, which is only a few miles east of the Arbuckle Mountain outcrops, has a Hunton lithostratigraphic sequence similar to that in the eastern Arbuckle Mountain outcrop (cf. also 1 Hargrove-Hudson). The uppermost beds are organo-detrital limestones (Frisco Formation, possibly including some Fittstown Member, Bois d'Arc Formation), underlain by marlstone (Henryhouse-Haragan Formations undifferentiated), which are in turn underlain by Chimneyhill organo-detrital limestones (Clarita, Cochrane, and Keel stratigraphic units recognizable). All these strata are low in dolomite and, with the exception of the marlstones, low in insoluble detritus.
Woodford (Chattanooga) Shale 6972′ (CC)-7154′ (sample depth)
No Misener Sandstone recognized.
Hunton Group 7154′-7385′ (sample depths)
7154′-7200′ (sample depths) Lower Devonian; Frisco Formation; possibly includes some Fittstown Member, Bois d'Arc Formation. Organo-detrital sparite and micrite. Very little detrital quartz and only widely scattered dolomite crystals.
7200′-7340′ (sample depths) Silurian-Devonian; Henryhouse and Haragan Formations undifferentiated. Fossiliferous marlstone; common fossils are crinoid plates, bryozoans, ostracodes, and brachiopods. Scattered subangular quartz detritus to 0.1 mm and a little mica. Minor dolomite.
7340′-7385′ (sample depths) Silurian; Chimneyhill Subgroup (45′ thickness).
7340′-7360′ (sample depths) Clarita Formation. Pink crinoidal micrite and sparite. Low in insoluble detritus and with very little dolomite.
7360′-7380′ (sample depths) Cochrane Formation. Glauconitic organo-detrital sparite; pink crinoids and many ostracodes. Very little detrital quartz or dolomite.
7380′-7385′ (sample depths) Keel Formation. Well-formed oolites with radial and concentric structure set in a spar matrix; fossiliferous. Very little quartz or dolomite.
Sylvan Shale 7385′-7493′ (sample depths)
Dark shale.
Welling Formation 7493′ (sample depth)
7490′-7495′ (thin section) Organo-detrital sparite-micrite with minor dolomite; no detrital quartz.
7505′-7510′ (thin section) Same as above.

APACHE 1 JONES-BINAS UNIT—NW¼SW¼SW¼ sec. 33, T. 6 N., R. 10 E., Hughes County, Oklahoma; elev. 763′ KB (749′ GL); TD 6348′; compl. 7/4/65, no Hunton present. Woodford Shale rests directly on the Sylvan Shale. Tops: Sylvan 5520′ (−4757′) (sample depth), Welling 5610′ (−4847′) (sample depth). Samples examined from 5470′ to 5900′, good quality; 5 thin sections, all Ordovician; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford-Sylvan contact is reasonably well defined in the samples, as the uppermost Sylvan is a greenish-gray shale, contrasting with the very dark shale of the Woodford; it is also well defined on the conductivity log. See description of the 1 G. Hall and the 1 Manschrick.

The Sylvan Shale is underlain by the Welling Formation (5610′-5640′) organo-detrital limestones. A thin section at 5610′-5620′ is organo-detrital sparite with minor micrite and no detrital quartz. A thin section at 5630′-5640′ has similar texture but includes rounded grains of detrital quartz. Underlying the Welling is the Bromide (Corbin Ranch), which is dense pellet limestone (5640′) with some ?algal limestone and scattered ostracodes; some dolomite crystals.

FERGUSON 1 KANNADY—C NW¼NE¼ sec. 26, T. 9 N., R. 26 E., Le Flore County, Oklahoma; elev. 450′ KB (436′ GL); TD 7988′ (last sample; log gives 7869′ at TD; last sample includes two pieces of Sylvan Shale); compl. unknown, no Hunton production reported. Tops: Woodford 7704′ (−7254′) (GR log), Hunton 7792′ (−7342′) (GR log), Sylvan 7988′ (−7538′) (sample depth); Hunton thickness 196′. Samples examined from 7760′ to TD; very fine, air-drilled samples to 7860′; no samples 7860′ to 7900′, good-quality samples from here to bottom of hole; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The samples from 7792′ to 7850′ (just beneath the Woodford Shale) are air drilled, very fine, and difficult to study. Much of this material is chert with fine subangular quartz grains and is provisionally assigned to the Sallisaw Formation, although it could be in part Sylamore Sandstone (see discussion of Sallisaw Formation in text). No samples are available from 7860′ to 7905′. From 7905′ to 7988′ (TD) the samples are large and of reasonable quality. These samples are heavily dolomitized pelmatozoan limestones ranging into porous crystalline dolomite and are assigned to the Chimneyhill Subgroup on the basis of stratigraphic position and thickness.

Woodford (Chattanooga) Shale 7704′–7792′ (GR log)
Hunton Group 7792′ (GR log)–7988′ (sample depth)
7792′ (GR log)–7850′ (sample depth) ?Lower Devonian; ?Sallisaw Formation. Mostly chert with scattered fine angular to subangular detrital quartz (? = Penters Chert; see discussion of Bonanza Gas Field in text).
7850′–7905′ No samples.
7905′–7988′ (sample depths) Silurian; Chimneyhill Subgroup. Heavily dolomitized pelmatozoan limestone grading into porous crystalline dolomite.
Sylvan Shale 7988′ (sample depth)
The last sample at 7988′ (circulated) had two pieces of greenish-gray shale.

MOBIL 1 KASINER UNIT—C SE¼NW¼ sec. 22, T. 8 N., R. 20 E., Haskell County, Oklahoma; elev. 540′ DF; TD 7800′ (Ordovician); compl. 6/8/65, D&A. Tops: Woodford 6512′ (−5972′) (SP log), Hunton 6590′ (−6050′) (SP log), Sylvan 6643′ (−6103′) (SP log), Welling 6686′ (−6146′) (SP log); Hunton thickness 53′. Samples examined from 6500′ to 6750′, good quality; 5 thin sections, OGS; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton strata are referred to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position. These are moderately to heavily dolomitized rocks but with little or no crystalline dolomite. The lower part includes pink crinoidal lithology (?Tenkiller Formation); no glauconite or oolite observed, although the basal beds do include some chert.

Woodford (Chattanooga) Shale 6512′–6590′ (SP log)
Hunton Group 6590′–6643′ (SP log)
6590′–6643′ (SP log) Silurian; Chimneyhill Subgroup.
6590′ (SP log)–6640′ (sample depth) ?Quarry Mountain Formation. Weakly to heavily dolomitized pelmatozoan limestone; no detrital quartz observed.
6640′–6660′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with many ostracodes and other fossils. The lower 10 feet with chert and increased dolomite. (?Blackgum Formation).
Sylvan Shale 6643′–6686′ (SP log)
Welling Formation 6686′ (SP log)
6710′–6720′ (thin section) (sample depths) Organo-detrital pelmatozoan sparite with little or no detrital quartz or dolomite crystals.
6740′–6750′ (thin section) (sample depths) Organo-detrital limestone like above but with scattered rounded quartz grains to 0.5 mm and similar-sized dolomite crystals.

HUMBLE 1 KATES UNIT—C SE¼NW¼ sec. 29, T. 10 N., R. 22 E., Haskell County, Oklahoma; elev. 667′ KB (656′ GL); TD 4421′ (Sylvan); compl. 12/30/62, D&A. Tops: Woodford 4161′ (−3496′) (CC), Hunton 4170′ (−3514′) (sample depth), Sylvan 4410′ (−3754′) (sample depth); Hunton thickness 240′. Examined samples from 4100′ to 4425′, excellent quality; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The well samples show a reasonably well-defined sequence from Woodford Shale to Sallisaw Formation, Frisco Formation, Chimneyhill Subgroup, and Sylvan Shale. Chimneyhill strata can be provisionally separated into the Quarry Mountain, Tenkiller, and Blackgum strata. Silurian strata are in a limestone, dolomitic-limestone, dolomite lithofacies similar to that in the Marble City outcrop area.

Woodford (Chattanooga) Shale 4161′ (CC)–4170′ (sample depth)
Hunton Group 4170′–4410′ (sample depths)
4170′–4200′ (sample depths) Lower Devonian; Sallisaw Formation. Dolomitic quartz sandstone; estimated to be approximately 50% crystalline dolomite and 50% angular to subangular detrital quartz (to 0.2 mm); minor fossil debris including brachiopod fragments. Much chert with scattered dolomite crystals and detrital quartz.
4200′–4210′ (sample depths) Lower Devonian; Frisco Formation. Organo-detrital limestone; no dolomite or detrital quartz observed.
4210′–4410′ (sample depths) Silurian; Chimneyhill Subgroup.
4210′–4330′ (sample depths) ?Quarry Mountain Formation. Moderately to heavily dolomitized pelmatozoan-bryozoan sparite with little if any detrital quartz.
4210′–4300′ (sample depths) Only minor crystalline dolomite.
4300′–4330′ (sample depths) Much crystalline dolomite.
4330′–4380′ (sample depths) ?Tenkiller Formation. Pink crinoidal spar and micrite with some dolomite in the matrix. Very little detrital quartz.
4380′–4410′ (sample depths) ?Blackgum Formation. Organo-detrital glauconitic crinoidal micrite with moderate dolomite. Some detrital quartz. No oolites observed.
Sylvan Shale 4410′–4425′ (sample depths)

ALLIED ET AL 1-D KEEGAN—SE¼NE¼NE¼ sec. 5, T. 13 N., R. 5 E., Lincoln County, Oklahoma; elev. 841′ DF (836′ GL); TD 4900′ (Ordovician); compl. 10/27/52, D&A. Tops: Woodford 4513′ (−3672′) (SP log), Hunton 4592′ (−3751′) (SP log), Sylvan 4684′ (−3843′) (SP log), Welling 4790′ (−3949′) (sample depth), Bromide 4810′ (−3969′) (sample depth); Hunton thickness 92′. Samples examined from 4500′ to 4820′, good quality; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

On the basis of lithology and thickness, all of the Hunton is provisionally assigned to the Chimneyhill Subgroup (the presence of crystalline dolomite in the uppermost Hunton would seem to preclude the possibility of any Frisco Limestone). Except for the middle 30′ or so, the Hunton is heavily dolomitized, and the basal part is mostly porous crystalline dolomite.

Woodford (Chattanooga) Shale 4513′–4492′ (SP log)
No Misener Sandstone observed.
Hunton Group 4592′–4684′ (SP log)
4592′–4684′ (SP log) Silurian; ?Chimneyhill.
4592′ (SP log) –4550′ (sample depth) Almost all crystalline dolomite with little or no detrital quartz.
4550′–4560′ (sample depths) Weakly to heavily dolomitized pink crinoidal limestone with minor crystalline dolomite.

4560′-4700′ (sample depths) Almost entirely porous crystalline dolomite with little or no detrital quartz.

Sylvan Shale 4684′ (SP log) -4790′ (sample depth) Gray shale; no green shale at the top.

Welling Formation 4790′-4810′ (sample depths) Organo-detrital crinoidal sparite with minor micrite. No detrital quartz or dolomite; thin dense pellet limestone.

Bromide Formation (Pooleville Member; Corbin Ranch) 4810′ (sample depth) 4810′-4820′ (thin section) Mix of organo-detrital limestone like above (a few pieces with detrital quartz) and dense pellet limestone. Latter marks top of the Bromide.

SNEE & EBERLY 1 KENNEDY—NE¼SW¼ NE¼SW¼ sec. 4, T. 10 N., R. 13 E., McIntosh County, Oklahoma; elev. 748′; TD 3945′ (Ordovician); compl. unknown, no Hunton production reported. Tops: Hunton 3702′ (−2954′) (CC), Sylvan 3752′ (−3004′) (sample depth), Welling 3817′ (−3069′) (sample depth); Hunton thickness 50′. Samples examined from 3600′ to 3850′, good quality; 7 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata penetrated in this well are unusual for this region in having very little dolomite. The upper 10′ ranges from weakly to moderately dolomitized, but the remainder of the beds have very little dolomite.

Woodford (Chattanooga) Shale

No Misener-Sylamore Sandstone observed.

Hunton Group 3702′ (CC) -3752′ (sample depth)

3702′ (CC) -3752′ (sample depth) Silurian; Chimneyhill Subgroup.

3725′-3740′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with minor spar; some ostracodes and other shelly debris, but relatively few bryozoans. The upper part is weakly to moderately dolomitized, but the rest is almost free of dolomite. No detrital quartz.

3740′-3755′ (sample depths) Cochrane-?Blackgum Formation. Glauconitic crinoidal micrite with some spar; some shelly debris but very few bryozoans. Chert present. Very little dolomite or detrital quartz observed.

Sylvan Shale 3755′-3817′ (sample depths)

Upper 10′ includes some greenish-gray shale; rest is a medium-gray shale.

Welling Formation 3817′ (sample depth)

3825′-3830′ (thin section) Organo-detrital crinoidal sparite with no observed detrital quartz or dolomite.

3835′-3840′ (thin section) Similar to the above, but has scattered rounded detrital quartz grains to 0.8 mm.

HUMBLE 1 KERR (SAMEDAN 1 TURNIPSEED)—C NE¼SW¼NE¼ sec. 17, T. 6 N., R. 25 E., Le Flore County, Oklahoma; elev. 522′ KB (505′ GL); TD 15,838′ (Ordovician); comp. 2/11/64, D&A. Tops (all tops from GR log): Woodford 14,330 (−13,808′), Hunton 14,562′ (−14,040′), Sylvan 14,652′ (−14,130′), Welling 14,700′ (−14,178′); Hunton thickness 90′. Well air drilled, and samples not satisfactory for study.

ALLYN JR. 1 KIKER—NW¼NW¼SE¼ sec. 3, T. 10 N., R. 7 E., Seminole County, Oklahoma; elev 931′ DF (924′ GL); TD 4517′ (Ordovician); compl. 4/7/50, D&A. Tops: Misener 4180′ (−3249′) (sample depth), Hunton 4187′ (−3256′) (SP log), Sylvan 4312′ (−3382′) (SP log); Hunton thickness 125′. Samples examined from 4140′ to 4350′, good quality; tops from SP log; slight sample lag; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford Shale appears to be thin in this well (25′ or less); typical Misener Sandstone underlies the Woodford. Hunton strata, all of which are assigned to the Chimneyhill Subgroup, consist of weakly to strongly dolomitized pink crinoidal micrite and sparite with a thin glauconitic unit at the base. Presumably the upper crinoidal beds include Clarita-Quarry Mountain equivalents, possibly with some Tenkiller-age beds in the lower part, and the basal glauconitic beds may correlate with the Cochrane-Blackgum strata. The upper part of the Hunton could include Frisco correlatives, but the presence of substantial dolomite strongly suggests that the entire section is Silurian.

Woodford (Chattanooga) Shale

4180′ (sample depth) -4187′ (SP log) Misener Sandstone. Sandstone with well-rounded quartz grains to 1½ mm; some quartz overgrowths.

Hunton Group 4187′-4312′ (SP log)

4187′-4312′ (SP log) Silurian; Chimneyhill Subgroup.

4187′ (SP log) -4230′ (sample depth) Weakly to strongly dolomitized (some crystalline dolomite), mostly micrite cement, minor spar. Some pink crinoids, along with bryozoans, ostracodes, trilobites, etc. Little or no quartz.

4230′-4270′ (sample depths) Weakly to strongly dolomitized pink crinoidal limestone; mostly micrite cement, minor spar. In addition to crinoids the micrite includes many bryozoans. Little or no detrital quartz.

4270′-4300′ (sample depths) Weakly dolomitic pink crinoidal limestone; mixture of spar and micrite cement. Many bryozoans. Very little detrital quartz.

4300′ (sample depth) -4312′ (SP log) Glauconitic dolomite with some chert. Some pelmatozoan material, but much is crystalline dolomite. Very little detrital quartz.

Sylvan Shale 4312′ (SP log)

Upper 10′ greenish-gray shale, medium-gray below.

SNEE & EBERLY 1 KILLIAN—NE¼NE¼SW¼ sec. 10, T. 9 N., R. 21 E., Haskell County, Oklahoma; elev. 671′ DF (661′ GL); TD 4915′ (Sylvan); compl. 8/21/64, D&A. Tops: Hunton 4744′ (−4073′) (SP log), Sylvan 4895′ (−4224′) (SP log); Hunton thickness 151′. Samples examined from 4700′ to 4915′ (TD), good quality; 12 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

All the Hunton in this well is assigned to the Chimneyhill Formation and probably correlates with the lower part of the ?Quarry Mountain Formation-?Tenkiller-?Blackgum Formations (see the Humble 1 Kates Unit and the Calvert-Mid-America 1 Bundy).

There is no lithologic evidence for any Sallisaw or Frisco strata in this well; if originally present, these beds have been removed by pre-Woodford erosion. The strata in the upper part of the Hunton (?Quarry Mountain Formation) are heavily dolomitized, the upper 50′ being almost entirely porous crystalline dolomite. The lowest Hunton bed is an oolite tentatively correlated with the Pettit Oolite and the Keel Formation.

Woodford (Chattanooga) Shale
No Misener Sylamore Sandstone observed.
Hunton Group 4744′-4895′ (SP log)
4744′-4895′ (SP log) Silurian; Chimneyhill Subgroup. Strata from 4744′ to 4875′ provisionally assigned to Quarry Mountain Formation.
4744′ (SP log) -4800′ (sample depth) Almost entirely porous crystalline dolomite; no detrital quartz observed.
4800′-4875′ (sample depths) Weakly to heavily dolomitized crinoidal micrite-sparite with some porous crystalline dolomite. Shelly debris in addition to the crinoids, but very few bryozoans. No detrital quartz observed, but 1 or 2 fragments of chert.
4875′-4900′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with only minor spar; shelly debris includes some bryozoans. No detrital quartz observed and very little dolomite.
4900′-4910′ (sample depths) ?Blackgum Formation. Weakly to heavily dolomitized glauconitic pink crinoidal micrite with a little spar; ranges into crystalline dolomite. Shelly debris in addition to the crinoids, but only a few bryozoans. No detrital quartz observed.
4910′-4915′ (sample depths) ?Pettit oolite; ?Keel Formation. Oolites with well-marked radial structure set in sparite; few fossils. Oolites with scattered euhedral dolomite crystals. No detrital quartz observed.
Sylvan Shale 4895′-4915′ (SP log)

MOHAWK 1 KOLAR—NE¼SE¼NW¼ sec. 11, T. 12 N., R. 6 E., Lincoln County, Oklahoma; elev. 1001′ DF (996′ GL); TD 4665′ (Ordovician); compl. 7/4/59, D&A. Tops: Woodford 4337′ (−3336′) (CC), Hunton 4364′ (−3363′) (SP log), Sylvan 4472′ (−3471′) (SP log), Welling 4570′ (−3569′) (sample depth); Hunton thickness 108′. Samples examined from 4300′ to 4600′, poor quality with considerable mixing of Hunton with dark shale (no samples, 4470′-4490′); 6 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The uppermost Hunton sample is an organo-detrital pink crinoidal limestone with only a small amount of dolomite; this could represent the Frisco (cf. 1 Boley), but the thickness and presence of some dolomitization suggests that it is all Chimneyhill. The rest of the Hunton is heavily dolomitized including considerable crystalline dolomite.

Woodford (Chattanooga) Shale 4337′ (CC) -4364′ (SP log)
No Misener Sandstone observed.
Hunton Group 4364′-4472′ (SP log)
Silurian; ?Chimneyhill Subgroup. The upper 10′ is an organo-detrital pink crinoidal sparite with only a small amount of dolomite. The remainder is moderately to strongly dolomitized pink crinoidal sparite including much crystalline dolomite. The bottom 10′ is almost entirely porous crystalline dolomite.
Sylvan Shale 4472′ (SP log) −4570′ (sample depth)
4470′-4490′ No samples.
Welling Formation 4570′ (sample depth)
4590′-4595′ (thin section) Organo-detrital sparite with little or no dolomite or detrital quartz.

SUPERIOR 1 LACKEY—SE¼SE¼NW¼ sec. 14, T. 12 N., R. 16 E., McIntosh County, Oklahoma; elev. 642′; compl. 1959, production unknown. Tops: Hunton 2940′ (−2298′) (sample depth), Sylvan 2970′ (−2328′) (sample depth); Hunton thickness 30′. Samples examined from 2930′ to 2980′; 1 thin section. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 155-156).

TEXAS EASTERN & ANDERSON-PRICHARD 1 LEWIS—C NE¼SW¼ sec. 31, T. 2 S., R. 11 E., Atoka County, Oklahoma; elev. 616′ KB (599′ GL); TD 11,833′ (Ordovician); compl. 3/15/58, no Hunton production. Tops: Woodford 9390′ (−8791′) (SP log), Hunton 9680′ (−9081′) (SP log) (may include some Misener in the upper 20′), Sylvan 9790′ (−9191′) (SP log) Welling 9940′ (−9349) (SP log); Hunton thickness 110′. Samples examined from 9640′ to 10,000′; cuttings fine (air drilled?) but usable; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is within 1 mile or so of the Choctaw Fault and presumably is in proximity to the Ouachita province. Hunton strata, however, represent the Arbuckle Mountain lithofacies with an upper fossiliferous marlstone (the uppermost 20′ or so is silty and dolomitic and may include Misener Sandstone), underlain by pink crinoidal sparite. These beds are low-magnesium limestones with only scattered dolomite crystals.

Woodford (Chattanooga) Shale 9390′-9680′ (SP log)
May include some Misener Sandstone (see below).
Hunton Group 9680′-9790′ (SP log)
9680′ (SP log) -9750′ (sample depth) Silurian; ?Henryhouse Marlstone (may include some Devonian Haragan marlstone). Sparingly fossiliferous marlstone; upper 20′-30′ with some fine (to 0.2 mm) subangular quartz detritus and dolomite crystals (may include Misener), the underlying beds having little silt or dolomite. Referred to the Silurian on the basis of lithology and stratigraphic position.
9750′ (sample depth) -9790′ (SP log) Chimneyhill Subgroup, ?Clarita Formation. Pink crinoidal organo-detrital sparite with some micrite; parts with many ostracodes. Very little dolomite or quartz. Some chert in the lower 10′-15′.
Sylvan Shale 9790′-9940′ (SP log)
Welling Formation 9940′ (SP log)
9980′-9990′; 9990′-10,000′ (thin sections) Organo-detrital sparite with subrounded quartz grains.

FOSTER 1 McBEE—SW¼SW¼NE¼ sec. 15, T. 13 N., R. 25 E., Sequoyah County, Oklahoma; elev. 1135′; compl. 1959. Tops: Hunton 855′ (+480′) (electric log), Sylvan 1,105′ (+230′) (electric log); Hunton thickness 250′. Samples examined from 850′ to 1120′; 2 thin sections; this well described by T. L. Rowland (Amsden and Rowland, 1965, p. 127, 129).

MAGNOLIA 1 MANSCHRICK—C SE¼NE¼ sec. 28, T. 6 N., R. 17 E., Pittsburg County, Oklahoma; elev. 963′ KB (950′ GL); TD 12,915′ (Ordovician); compl. 9/23/54, D&A. Tops: Woodford 11,412′ (−10,450′) (CC), Sylvan 11,495′ (−10,553′) (SP log), Welling 11,552′ (−10,590′) (SP log); no Hunton present. Samples examined from 11,340′ to 11,620′, good quality; 3 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford and Sylvan Shales are separated by about 10′ of quartz sandstone, sandy chert, and dolomite, here referred to the Misener Sandstone (14,490′-14,495′, sample depth). The uppermost Sylvan is a dark calcareous shale similar in appearance to the lower part of the Woodford Shale. The greenish-gray shale characteristic of the uppermost Sylvan over much of the Arkoma Basin is not present here (or in the 1 G. Hall), possibly having been removed by pre-Woodford erosion (see 1 Price, 1 Jones-Binas Unit, 1 Rosendahl). The Woodford-Sylvan contact is marked in the SP and resistivity logs.

A thin section from the uppermost Welling Formation, 11,555′-11,560′ (sample depths), is organo-detrital sparite with widely scattered dolomite crystals; no detrital quartz observed.

YINGLING 1 McCURDY—C SE¼SE¼SW¼ sec. 15, T. 5 N., R. 4 E., Pontotoc County, Oklahoma; elev. 1044′; TD 2690′ (Ordovician); compl. unknown, no Hunton production reported (Viola production). Tops: Woodford 2336′ (−1292′) (CC), Hunton 2386′ (−1342′) (SP log), Sylvan 2554′ (−1510′) (SP log), Welling 2614′ (−1570′) (SP log); Hunton thickness 168′. Samples examined from 2330′ to 2630′, some mixing and contamination; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata make up a well-marked sequence of marlstone (Henryhouse and/or Haragan Formation) and pink crinoidal micrite (Chimneyhill Subgroup; Clarita-Cochrane-Keel; lithostratigraphic division not recognized). A moderate amount of dolomite is present in the lower part of the marlstone and the lower part of the Chimneyhill. However, this is a low-magnesium limestone section comparable to that in the Arbuckle outcrop area.

Woodford (Chattanooga) Shale 2336′-2386′ (SP log) Poorly defined in samples. No Misener Sandstone recognized.

Hunton Group 2386′-2554′ (SP log)

2386′ (SP log) -2500′ (sample depth) Silurian-Devonian; Henryhouse-Haragan Formations undifferentiated. Sparingly fossiliferous marlstone; fossils mainly pelmatozoan plates, ostracodes, brachiopods, and bryozoans. Widely scattered subangular detrital quartz grains lo 0.1 mm. Scattered dolomite crystals, sparse in the upper part, becoming slightly more abundant in the lower part.

2500′ (sample depth) -2554′ (SP log) Silurian; Chimneyhill Subgroup. Pink crinoidal micrite; many ostracodes present, but some beds with substantial mollusks, mainly gastropods; also brachiopods, bryozoans, and trilobites are present. A few scattered detrital quartz grains in the upper 5′; below, very little. Very little dolomite except in the lower sample, where there is a moderate amount.

Sylvan Shale 2554′-2614′ (SP log)

Welling Formation 2614′ (SP log)

2630′-2635′ (thin section) (sample depths) Organo-detrital sparite; no observed dolomite or detrital quartz.

2660′ (thin section) (sample depth) As above, but with scattered subrounded to well-rounded detrital quartz grains; some quartz sandstone.

BUNKER 2 McELVANEY—C S½NE¼NW¼ sec. 10, T. 12 N., R. 5 E., Lincoln County, Oklahoma; elev. 883′ KB (876′ GL); TD 4593′ (Ordovician); compl. 8/26/75, D&A. Tops: Woodford 4250′ (−3374′) (GR log), Misener 4314′ (−3438′) (core), Hunton 4318′ (−3442′) (core), Sylvan 4375′ (−3499′) (GR log), Welling 4465′ (−4589′) (GR log); Hunton thickness 57′. Cored 4305′ (Woodford) to 4328′ (Hunton), OU Core Library; 14 thin sections. Core report by Core Laboratories, Inc., Dallas, Texas, including porosity-permeability, fluid-saturation, and grain-density report. Samples studied from 4328′ to 4520′; 6 thin sections from Hunton strata, 13 from the Ordovician.

The core laboratory report and logs were furnished by Mr. Robert Northcut.

Core samples from 4317′, 4318′, and 4381′ were sent to Dr. Gilbert Klapper, The University of Iowa, for conodont examination. (Dr. Klapper and Dr. James Barrick reported their findings in a letter dated December 11, 1975.)

4317′ *Ploygnathus cristatus* Hinde, *P. dubius* Hinde.

According to Klapper and Barrick, these are Misener-type conodonts, with no evidence of Silurian conodonts. Thin sections of this unit show much quartz sand dispersed through the limestone, and accordingly it is assigned to the Misener.

4318′ *"Distacodus" obliquicostatus* Branson and Mehl, *Penderodus unicostatus* (Branson and Mehl) *Schmidtognathus hermanni* Ziegler, *Polygnathus latifossatus* Wirth.

According to Klapper and Barrick, *"D." obliquicostatus* has not been observed below the Prices Falls Member, and it ranges as high as the Henryhouse; *S. hermanni* and *P. latifossatus* are Misener forms and suggest leakage into the Silurian. This interval is a marlstone, and, since a similar lithology appears in the underlying unit (4319′), I am assigning it to the Clarita rather than the Henryhouse.

4319′ *Panderodus unicostatus, Pseudooneotodus biocornis* Drygant, *Decoriconus fragilis* (Branson and Mehl), *"Distacodus" obliquicostatus, Walliserodus* sp. indet.

According to Klapper and Barrick, the most important element in this fauna is *P. bicornis,* which ranges throughout the Fitzhugh Member of the Clarita Formation.

4319.5′ *Panderodus unicostatus.*

Klapper and Barrick state this to be indeterminate for age.

The foregoing indicates that the Misener-Hunton contact is located at 4317.5′ and that the uppermost Hunton is correlative with the Fitzhugh Member of the Clarita Formation. The possible exception is the uppermost 18″ marlstone bed, which could be Henryhouse (here tentatively assigned to the Fitzhugh; see remarks above). It should be emphasized that the entire cored section has been exposed to intensive solution, which developed numerous cracks and crevices. These were later filled from above with Misener sand; clearly defined "veins" of sandstone are present through the cored position. The Misener (4314′-4317.5′) is interesting because it includes beds of crinoidal limestone with only scattered quartz sand grains.

The Chimneyhill is in a dolomitic facies with all parts of the core showing at least some dolomitization. The strata from 4320′ to 4323′ are porous crystalline dolomite. The pores are largely fossils that have been removed by solution, leaving only molds (mostly crinoidal debris). Core Laboratories' core report shows a grain density of 2.8 for 4318′-4427′ and a porosity ranging from less than 1.6% up to 23%.

Chimneyhill strata in the 2 McElvaney are at least 55′ thick. If the upper marlstone bed is assigned to the Fitzhugh as is herein suggested, it exceeds 57′.

Woodford (Chattanooga) Shale 4250′-4318′ (GR log)
4250′-4305′ Black shale.
4305′-4314′ (core) Mostly dark shale with minor sandstone.
4314′-4318′ (core) Misener Sandstone. Calcareous quartz sandstone and organo-detrital limestone with scattered quartz grains; quartz grains usually rounded (many with overgrowths), up to 1 mm in diameter. Misener conodonts.

Hunton Group 4318′ (core) -4375′ (GR log)
4318′ (core) -4375′ (GR log) Chimneyhill Subgroup; Clarita Formation; extends down to at least 4319′.
4318′-4319′ (core) Banded pale-gray and greenish-gray marlstone.
4319′-4320′ (core) Dolomitized organo-detrital crinoidal limestone; conodonts present, discussed above. Much evidence of solution and Misener Sandstone infiltration.
4320′-4323′ (core) Porous crystalline dolomite; see discussion above.
4323′-4327′ (core) Dolomitized organo-detrital limestone.
4327′-4328′ (core) Weakly dolomitized organo-detrital limestone; much solution and Misener Sandstone infiltration.
4328′ (core) -4390′ (sample depth) Moderately to heavily dolomitized organo-detrital limestone and crystalline dolomite.

Sylvan Shale 4390′-4490′ (sample depth); Sylvan top, 4375′ (GR log).

Welling Formation 4490′ (sample depth); 4465′ (GR log)
Organo-detrital limestone.

AMAX 1 MORRISON—C SE¼NW¼ sec. 34, T. 9 N., R. 16 E., Pittsburg County, Oklahoma; elev. 666′ KB (651′ GL); TD 6357′ (Hunton); compl. 9/12/67, no Hunton production reported (Cromwell gas production). Tops: Woodford 6150′ (−5484′) (sample depth), Hunton 6215′ (−5549′) (SP log); Hunton thickness 135′ plus (TD Hunton). Samples examined from 6050′ to TD, poor quality with considerable contamination; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is interpreted to have penetrated both Sylamore and Sallisaw Formations. The problems in identifying these 2 stratigraphic units is discussed in the text. No Frisco strata identified in this well. The Silurian, which is weakly to heavily dolomitized, is tentatively assigned to the Quarry Mountain and Tenkiller Formations.

Woodford (Chattanooga) Shale 6150′ (sample depth) -6215′ (SP log)
A few feet of Sylamore Sandstone is present.

Hunton Group 6215′-6357′ (SP log)
6215′ (SP log) -6250′ (sample depth) Lower Devonian; Sallisaw Formation (may include some Sylamore Sandstone). Mostly chert with fine subangular to subrounded detrital quartz and euhedral dolomite crystals.
6250′-6357′ (sample depths) Silurian; Chimneyhill Subgroup.
6250′-6350′ (sample depths) ?Quarry Mountain Formation. Moderately to heavily dolomitized organo-detrital sparite with abundant pelmatozoan plates and bryozoans; some crystalline dolomite present. Very little detrital quartz.
6350′-6357′ (TD) ?Tenkiller Formation. Weakly to heavily dolomitized pink crinoidal sparite and micrite; very little detrital quartz observed. Minor chert.

WHITTAKER 1 MOWDY (originally drilled by Delphi to a depth of 12,063′)—SE¼NE¼SE¼ sec. 10, T. 2 N., R. 11 E., Coal County, Oklahoma; elev. 670′ DF (671′ KB); TD 12,510′ (Ordovician); compl. 3/22/54, no Hunton production reported. Tops: Hunton 11,010′ (−10,340′) (sample depth), Sylvan 11,055′ (−10,385′) (sample depth), Welling 11,170′ (−10,500′) (sample depth); Hunton thickness 45′. Samples examined from 10,900′ to 11,200′, good quality; core chips start at 11,178′; 8 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata are represented by fairly typical Arbuckle Mountain lithofacies with only minor dolomite. The section comprises an upper marlstone (Silurian, Henryhouse, possibly including some Devonian Haragan beds), pink crinoidal limestone (Clarita Formation), and a basal glauconitic limestone (Cochrane Formation). No oolite observed.

Woodford (Chattanooga) Shale
Misener Sandstone at the base; fossiliferous, heavily

dolomitized carbonate with numerous subangular to subrounded quartz grains.

Hunton Group 11,010′-11,055′ (sample depths)

11,010′-11,035′ (sample depths) Silurian; Henryhouse Formation; may include some Lower Devonian Haragan beds. Fossiliferous marlstone with much bryozoan debris along with ostracodes, trilobites, and other shelly debris; relatively few crinoid plates. Widely scattered subangular silt-size detrital quartz; minor dolomite crystals.

11,035′-11,055′ (sample depths) Chimneyhill Subgroup, 20′ thick.

11,035′-11,050′ (sample depths) Clarita Formation. Pink crinoidal micrite and sparite with numerous ostracodes, some trilobites, bryozoans and other shelly debris. A few irregular areas with dolomite crystals. Very little detrital quartz.

11,050′-11,055′ (sample depths) Cochrane Formation. Glauconitic biosparite and biomicrite; much crinoidal material. Very little detrital quartz or dolomite.

Sylvan Shale 11,055′-11,170′ (sample depths)

Welling Formation 11,170′ (sample depth)

11,176′ (thin section) Organo-detrital biosparite with very little dolomite and no observed detrital quartz.

11,180′-11,181′ (thin section) Organo-detrital sparite with numerous rounded quartz grains about 1 mm.

CARTER-GRAGG 1 MULLINS—C SE¼SW¼ sec. 29, T. 4 N., R. 14 E., Pittsburg County, Oklahoma; elev. 718.5′ KB (705′ GL); TD 12,605′ (Ordovician Arbuckle); compl. 12/31/61, no Hunton production reported (Cromwell and Simpson gas). Tops: Woodford 11,294′ (−10,575′) (GR log), Hunton 11,411′ (−10,692′) (GR log), Sylvan 11,430′ (−10,711′) (GR log), Welling 11,509′ (−10,790′) (GR log), Fite 11,545′ (−10,826′) (sample depth); Hunton thickness 19′. Samples examined from 11,370′ to 12,510′, good quality; 6 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well is about 5 miles northwest of the Choctaw Fault. Hunton strata are in a fairly typical low-magnesium pink crinoidal facies. There appears to be very little detrital quartz, but some small (less than 0.5 mm) elongate crystals are present, which may be quartz. No glauconite or oolite observed. Hunton strata referred to the Chimneyhill on the basis of lithology and stratigraphic position.

Woodford (Chattanooga) Shale 11,294′-11,411′ (GR log)

Hunton Group 11,411′-11,430′ (GR log)

11,411′-11,430′ Silurian; Chimneyhill Subgroup. Pink crinoidal organo-detrital micrite with only scattered dolomite and very little detrital quartz. Some small crystals of questionable quartz. Considerable bryozoan material with the pelmatozoan plates.

Sylvan Shale 11,430′-11,509′ (GR log)

Gray-green shale at the top, becoming dark-gray below.

Welling Formation 11,509′ (GR log) -11,545′ (sample depth)

11,530′ (thin section) Organo-detrital crinoidal sparite with some micrite; scattered dolomite crystals and subangular to well-rounded quartz grains to 0.5 mm.

Fite Limestone 11,545′ (sample depth)

11,550′-11,560′ (thin section) Pellet limestone and dense limestone with spar (?algal).

SUN 1 MURRAY—NE¼NE¼SW¼ sec. 29, T. 10 N., R. 27 E., Le Flore County, Oklahoma; elev. 432′ KB (418′ GL); TD 7258′ (Hunton); compl. 3/20/64, D&A. Tops: Woodford 7010′ (−6579′) (GR log), Hunton 7060′ (−6629′) (GR log); Hunton thickness 198′ plus. Samples examined from 7000′ to TD, good quality; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 110′ of the Hunton consists of dolomite and chert with fine detrital quartz and is assigned to the Sallisaw Formation largely on the basis of the size and angularity of the quartz grains. This could be in part or entirely Sylamore Sandstone (see discussion under Sallisaw Formation in text). This unit is separated from the Chimneyhill by a sharp lithologic change at 7170′ (sample depth), which probably correlates with a change on the gamma-ray log at 7150′.

Woodford (Chattanooga) Shale 7010′-7060′ (GR log)

Hunton Group 7060′-7258′ (GR log) (TD)

7060′ (GR log) -7170′ (sample depth) Lower Devonian; Sallisaw Formation. Strongly dolomitized pelmatozoan limestone and porous crystalline dolomite with scattered subangular to subrounded detrital quartz grains to 0.2 mm. Much chert with dolomite crystals and detrital quartz similar to that of the dolomite.

7170′-7258′ (sample depths) Silurian; Chimneyhill Subgroup. This is a mixture of heavily dolomitized pelmatozoan limestone and porous crystalline dolomite with very little detrital quartz. Minor chert as above probably represents float from above.

GARR-WOOLEY 1 NEAL—SW¼NW¼NE¼ sec. 3, T. 5 N., R. 4 E., Pottawatomie County, Oklahoma; elev. 931′ KB (929′ GL); TD 3934′ (Ordovician); compl. unknown, D&A. Tops: Woodford 3390′ (−2461′) (SP log), Hunton 3545′ (−2816′) (SP log), Sylvan 3732′ (−2803′) (SP log), Welling 3845′ (−2916′) (SP log); Hunton thickness 187′. Samples examined from 3530′ to 3890′, considerable mixing and contamination from above; 14 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in this well comprise an upper marlstone sequence (Henryhouse-Haragan Formations undifferentiated) and a lower Chimneyhill Subgroup. The lithologic distinction between these two is reasonably well defined, although there are some organo-detrital micrites in the marlstone (sample 3600′-3605′) and some marls in the Chimneyhill. Some dolomite is present in both the marlstones and the Chimneyhill. These strata are generally weakly dolomitized, and the lithofacies are similar to Hunton rocks in the Arbuckle outcrop area.

Woodford (Chattanooga) Shale 3390′-3545′ (SP log)
No Misener Sandstone observed.
Hunton Group 3545′-3732′ (SP log)
3545′ (SP log) -3695′ (sample depth) Silurian-?Lower Devonian; Henryhouse-Haragan Formations undifferentiated. Sparingly fossiliferous marlstone; pelmatozoans the dominant fossils with a moderate number of ostracodes. Scattered subangular detrital quartz to 0.1 mm, increasing slightly downward; scattered dolomite crystals.
3695′ (sample depth) -3732′ (SP log) Chimneyhill Subgroup.
3695′-3740′ (sample depths) Clarita Formation. Pink crinoidal micrite; also many ostracodes. Some fine subangular detrital quartz in the upper few feet. Only scattered dolomite crystals.
3740′ (sample depths) -3732′ (SP log) Cochrane Formation. Glauconitic organo-detrital micrite; pelmatozoans present, but dominant fossil probable ostracodes. Low in detrital quartz, but fair amount of dolomite is present.
Sylvan Shale 3732′-3845′ (SP log)
Upper 10′ greenish-gray shale, medium-gray shale below.
Welling Formation 3845′ (SP log)
3855′-3860′ (thin section) Organo-detrital sparite with a few widely scattered rounded detrital quartz grains; no dolomite observed.
3880′-3885′ (thin section) Organo-detrital sparite and micrite; no detrital quartz or dolomite observed.

OKLAHOMA GEOLOGICAL SURVEY DIAMOND CORE HOLE OGS 1—SW¼SE¼SW¼ sec. 4, T. 14 N., R. 24 E., Adair County, Oklahoma; compl. 8/23/62, no Hunton production. This core starts in the upper part of the Hunton Group (Marble City Member, Quarry Mountain Formation, Chimneyhill Subgroup) and extends into the upper part of the Sylvan Shale; approximately 130′ of Hunton strata penetrated. A lithostratigraphic description and chemical analyses of the strata in this core are given in Amsden and Rowland (1965, p. 102–105, 160, 166).

OKLAHOMA GEOLOGICAL SURVEY DIAMOND CORE HOLE OGS 2—SE¼NW¼NE¼ sec. 2, T. 14 N., R. 23 E., Cherokee County, Oklahoma; compl. 8/25/62, no Hunton production. This core starts in the Hunton Group (Barber Member, Quarry Mountain Formation, Chimneyhill Subgroup) and extends into the upper Sylvan Shale; it penetrates approximately 72′ of Hunton strata. A lithostratigraphic description and chemical analyses of this core are given in Amsden and Rowland (1965, p. 105–108, 161, 166). In June 1977, the upper 2″ of the Sylvan Shale was analyzed: $CaCO_3$ 38.74%, $MgCO_3$ 24.25%, HCl-acid insolubles 35.54%.

OKLAHOMA GEOLOGICAL SURVEY DIAMOND CORE HOLE OGS 3—SE¼SE¼NE¼ sec. 20, T. 13 N., R. 21 E., Sequoyah County, Oklahoma; compl. 8/30/62. This core starts in the upper part of the Hunton Group (Marble City Member, Quarry Mountain Formation, Chimneyhill Subgroup), penetrating the Hunton, Sylvan Shale, Welling Formation and Fite Limestone, ending in the Tyner Formation. A lithostratigraphic description and chemical analyses of this core are given in Amsden and Rowland (1965, p. 108–113, 162, 166).

U.S. SMELTING, REFINING & MINING 1 PADGETT—C NW¼NW¼ sec. 29, T. 13 N., R. 20 E., Muskogee County, Oklahoma; elev. 595′; compl. 1958, production unknown. Tops: Hunton 905′ (−310′) (sample depth), Sylvan 1020′ (−425′) (sample depth); Hunton thickness 115′. Samples examined from 890′ to 1040′; 3 thin sections. Well described by T. L. Rowland (Amsden and Rowland, 1965, p. 143–145).

SELLERS 1 PAYNE—SW¼SE¼SW¼ sec. 34, T. 12 N., R. 5 E., Lincoln County, Oklahoma; elev. 1055′ DF (1050′ GL); TD 4941′ (Ordovician); compl. 5/12/60, D&A. Tops: Hunton 4680′ (−3625′) (SP log), Sylvan 4755′ (−3700′) (SP log), Welling 4845′ (−3790′) (SP log); Hunton thickness 75′. Samples examined from 4560′ to 4890′ (no samples, 4580′ to 4665′), good quality; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata are assigned to the Chimneyhill Subgroup on the basis of lithologic character, stratigraphic position, and thickness. The rocks are mainly heavily dolomitized pink crinoidal strata, showing some visible porosity.

Woodford (Chattanooga) Shale
No Misener Sandstone observed.
Hunton Group 4680′-4755′ (SP log)
4680′-4755′ (SP log) Silurian; Chimneyhill Subgroup.
4680′-4730′ (sample depth) Mostly crystalline dolomite with scattered corroded pink crinoid plates; some porous crystalline dolomite. A few fragments of crinoidal sparite with little or no dolomite. No detrital quartz observed.
4730′-4760′ (sample depths) Moderately to heavily dolomitized pink crinoidal micrite with minor spar; some bryozoan debris. No visible quartz.
4760′-4770′ (sample depths) Mostly porous crystalline dolomite with scattered corroded crinoid plates. No visible quartz.
Sylvan Shale 4755′-4845′ (SP log)
Welling Formation 4845′ (SP log)
4865′-4870′ (thin section) (sample depth) Organo-detrital crinoid micrite with some spar; no visible quartz or dolomite.
4885′-4890′ (thin section) (sample depth) Like above but with subangular to subrounded detrital quartz.

CHAMPLIN 1 PRICE—SW¼SW¼ sec. 21, T. 7 N., R. 10 E., Hughes County, Oklahoma; elev. 824′ KB (814′ GL); TD 5829′ (Ordovician); compl. 12/8/66, no Hunton production. Tops: Sylvan 4765′ (−3841′) (SP log and samples), Welling 4855′ (−4031′) (SP log and samples); no Hunton present; Woodford rests directly on the Sylvan Shale. Samples examined from 4720′ to 4880′; no thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford-Sylvan contact is reasonably well defined in the samples, as the uppermost Sylvan is a pale-green shale, contrasting with the dark shale of the overlying Woodford. It is also fairly well marked on the SP log. (See 1 Jones-Binas Unit, 1 Manschrick, and 1 G. Hall.)

PAN AMERICAN 1 RAMM—SE¼NW¼ sec. 17, T. 11 N., R. 24 E., Sequoyah County, Oklahoma; elev. 488′; TD 4950′ (Sylvan); compl. 4/24/63, D&A. Tops: Woodford 4600′ (−4112′) (GR log), 4620′ (sample depth); Hunton 4624′ (−4236′) (GR log), 4620′ (sample depth); Sylvan 4924′ (−4436′) (GR log), 4930′ (sample depth); Hunton thickness 300′. Samples examined from 4600′ to 4950′, good quality; 15 thin sections, OGS; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford Shale is apparently interbedded with Misener Sandstone (Sylamore Sandstone) throughout, as the samples are a mixture of dark shale and quartz sandstone. The Sallisaw Formation, which has a thickness of approximately 50′, can be distinguished from the Misener by its finer grained, more angular quartz detritus and its high concentration of dolomite. The Silurian beds, all of which are assigned to the Chimneyhill Subgroup, are mostly moderately to heavily dolomitized organo-detrital limestones with some beds grading into crystalline dolomite. The beds just below the Sallisaw sandy dolomite are dolomitic, indicating that no Frisco is present. The basal 20′ is pink crinoidal limestone, with some glauconite in the lower 10′ and is tentatively correlated with at least a part of the Tenkiller and Blackgum Formations of the outcrop area.

Woodford (Chattanooga) Shale 4600′-4624′ (GR log)
The samples in this interval comprise a mixture of black shale and quartz sandstone (Misener), the latter having well-rounded quartz grains up to 1.5 mm. Some silicification and some chert.
Hunton Group 4624′-4924′ (GR log)
4624′ (GR log) -4740′ (sample depth) Lower Devonian; Sallisaw Formation. Chert mixed with silty dolomite; the chert has scattered dolomite crystals and subangular quartz detritus; the crystalline dolomite has grains of subangular quartz detritus up to 0.4 mm.
4740′-4924′ (sample depths) Silurian; Chimneyhill Subgroup.
4740′-4910′ (sample depths) ?Quarry Mountain Formation. Weakly to strongly dolomitized organo-detrital limestone and crystalline dolomite with little or no detrital quartz; no chert observed.
4740′-4760′ (sample depths) Crystalline dolomite with some organo-detrital limestone.
4760′-4850′ (sample depths) Mostly moderately to strongly dolomitized organo-detrital limestone.
4850′-4910′ (sample depths) Like above, but with substantial crystalline dolomite.
4910′-4920′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with many ostracodes. Scattered dolomite crystals and very little detrital quartz.
4920′-4930′ (sample depths) ?Blackgum Formation. Organo-detrital limestone with some glauconite. No oolites observed.
Sylvan Shale 4924′-4950′ (TD) (GR log)
Greenish-gray shale.

HARPER 1 RAMSEY—SE¼SW¼ sec. 22, T. 7 N., R.10 E., Hughes County, Oklahoma; elev. 892′ DF; TD 6073′ (Ordovician); compl. unknown, D&A. Tops: Woodford 4857′ (−3965′) (CC), Hunton 4976′ (−4084′) (CC), 4990′ (sample depth), Sylvan 5059′ (−4176′) (sample depth), Welling 5150′ (−4258′) (sample depth); Hunton thickness 82′. Samples examined from 4870′ to 5190′, excellent quality; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata appear to be dominantly in limestone facies. The Chimneyhill is lithologically divisible into an upper crinoidal limestone (?Clarita Formation) and a lower glauconitic limestone (?Cochrane); no basal oolite observed.

Woodford (Chattanooga) Shale 4857′-4976′ (CC)
Hunton Group 4976′-5059′ (CC)
4990′-5059′ (sample depths) Silurian; Chimneyhill Subgroup.
4990′-5030′ (sample depths) The upper 20′ is organo-detrital sparite and organo-detrital micrite; mostly pelmatozoan plates with bryozoans and some ostracodes and brachiopods; scattered beds with dolomite crystals, and in the interval from 5010′ to 5020′ some heavily dolomitized limestone. The basal 10′ is a pink crinoidal micrite with ostracodes, bryozoans, etc.; very little dolomite. The entire interval has very little detrital quartz.
5030′-5059′ (sample depths) Organo-detrital limestone with glauconite; mainly pelmatozoan plates with some ostracodes, etc. This interval has considerable dolomite.
Sylvan Shale 5059′-5150′ (sample depths)
Upper 20′ greenish-gray shale, dark shale below.
Welling Formation 5150′ (sample depth)
5150′-5160′ (thin section) Organo-detrital sparite with many pelmatozoan plates and some brachiopods, bryozoans, and other shelly debris; no detrital quartz; minor dolomite.
5180′-5190′ (thin section) Like above, but with some rounded quartz grains and increased dolomite.

GOBER 1 READY—NW¼SW¼SW¼ sec. 1, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; elev. unknown; compl. 1961, production unknown. Tops: Hunton 20′ (well started in alluvium), Sylvan 184′; Hunton thickness indeterminate. Samples examined from the surface to 201′. This well described by T. L. Rowland (Amsden and Rowland, 1965, p. 132–133).

FALCON-SEABOARD 1 REED—NW¼NW¼NE¼ sec. 16. T. 9 N., R. 7 E., Seminole County, Oklahoma; elev. 1009′ DF (1004′ GL); TD 4458′ (Ordovician); compl. 10/28/52, D&A. Tops: Woodford 4063′ (−3054′) (CC), Hunton 4091′ (−3082′) (SP log), Sylvan 4223′ (−3214′) (SP log), Welling 4316′ (−3307′)

(SP log); Hunton thickness 132′. Samples examined from 4090′ to 4350′, good quality; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 15′ (to 4115′, sample depth) is an organo-detrital crinoid-bryozoan sparite showing no trace of dolomite or quartz. This is provisionally assigned to the Frisco Limestone on the bases of lithology and stratigraphic position (cf. 1 Boley). Beneath this is weakly to moderately dolomitized pink crinoidal micrite here assigned to the Chimneyhill Subgroup on the basis of lithology and stratigraphic position; some fine angular quartz detritus, especially in the upper part. Much of this is lithologically similar to the micritic facies of the Clarita Formation in the Arbuckle Mountains, including degree of dolomitization.

Woodford (Chattanooga) Shale 4063′-4091′ (CC)
No Misener Sandstone observed.
Hunton Group 4091′-4223′ (SP log)
4091-4115′ (sample depths) Lower Devonian; Frisco Formation. Organo-detrital crinoid-bryozoan sparite with some arthropods, brachiopods, etc. No dolomite or quartz observed. Some matrix porosity.
4115′-4190′ (sample depths) Silurian; Chimneyhill Subgroup. Weakly to moderately dolomitized pink crinoidal micrite with ostracodes, trilobites, brachiopods, bryozoans, etc. Some fine (to 0.1 mm) angular quartz detritus, mostly in the upper 20′.
4190′-4200′ (sample depths) Moderately to heavily dolomitized pink crinoidal micrite with very little quartz. Parts have the matrix composed entirely of crystalline dolomite with some porosity and only scattered corroded pelmatozoan plates.
4200′-4240′ (sample depths) Pink crinoidal micrite with a moderate amount of spar cement. Weakly dolomitic and with very little quartz.
Sylvan Shale 4223′-4316′ (SP log)
Upper 10′-20′ greenish-gray shale, underlain by medium-gray shale.
Welling Formation 4316′ (SP log), 4325′ (sample depth)
4330′-4335′ and 4345′-4350′ (thin sections) Organo-detrital sparite with minor micrite; mostly crinoid plates with other shelly debris. A few scattered quartz grains and minor dolomite.

CONTINENTAL 1 REINHARDT—C SW¼NE¼ sec. 10, T. 10 N., R. 26 E., Sequoyah County, Oklahoma; elev. 433′ KB; TD 7357′ (Simpson); compl. 5/10/66, no Hunton production reported. Tops: Woodford 6342′ (−5909′) (GR log), Hunton 6374′ (−5941′) (GR log), Sylvan 6672′ (−6239′) (sample depth), Welling 6710′ (−6277′) (sample depth); Hunton thickness 298′. Samples examined from 6420′ (air drilled above this point) to 7357′; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This well was air drilled to a depth of 6420′. The samples above this point are too fine to be useful (GR log indicates Woodford-Hunton contact at 6374′). From 6420′ to 6450′ the samples are a mixture of dark shale and chert, possibly with some carbonate (presumably with quartz sand grains). This interval is assigned to the Sallisaw Formation (GR log indicates the Sallisaw-Chimneyhill contact to be at 6454′). Hunton strata from 6454′ to the Sylvan Shale are almost entirely crystalline dolomite and are provisionally assigned to the Chimneyhill on the basis of lithology and stratigraphic position (see following discussion).

Woodford (Chattanooga) Shale 6342′-6374′ (GR log)
Hunton Group 6374′ (GR log) -6672′ (sample depth)
6374′-6452′ (GR log) ?Lower Devonian; ?Sallisaw Formation. Probably all chert and carbonate with quartz sand.
6452′ (GR log) -6672′ (sample depth) ?Silurian; ?Chimneyhill Subgroup. Almost all crystalline dolomite with only minor dolomitized organo-detrital limestone. Much appears to be porous, and some is impregnated with a dark material. No detrital quartz observed. These strata occupy the stratigraphic position of the Chimneyhill, and the regional biostratigraphic and lithostratigraphic relations suggest that the entire interval represents this subgroup. The absence of detrital quartz and the high degree of dolomitization seem to rule out the presence of either Sallisaw or Frisco. (See Chimneyhill Subgroup in text; also 1 Western Coal & Mining Co. well in Appendix.)
Sylvan Shale 6672′-6710′ (sample depths)
Greenish-gray (above) and dark-gray (below) shale.
Welling Formation 6710′-6730′ (sample depths)
6710′-6720′ (thin section) Organo-detrital sparite with no detrital quartz or dolomite observed.
Fite Limestone 6730′ (sample depth)
6740′ (thin section) Pellet sparite and dense ?algal limestone with well-formed dolomite crystals.

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 3956′ (−2980′) (CC), Hunton 4029′ (−3053′) (CC), Sylvan 4104′ (−3128′) (core); Hunton thickness 75′. Cored 4030′-4110′ (Hunton-upper Sylvan); 8 thin sections, chemical analyses, porosity tests, Earlougher Engineering Co., Tulsa, Oklahoma; OU Core Library; Described in Amsden (1975b, p. 97, 149, 161-171).

This is a dolomitized organo-detrital limestone with a variable $MgCO_3$ content; seventeen chemical analyses show a range in $MgCO_3$ content from 1.59% to 21.94%, averaging 7.9%. It is low in insoluble detritus throughout, averaging 2.07%. It appears to have been subjected to extensive solution, producing numerous cavities and some recrystallization; reasonably good porosity is developed throughout. Described in Amsden (1975b, p. 161-171).

James Barrick recovered conodonts from 3 samples in the upper 40′ of the cored interval and reports a fauna as given in the following table:

SUNRAY DX 10-A RENTIE

Depth (ft)	Grams dissolved	Specimen type	Number of specimens
4030	970	*Panderodus unicostatus*	35
		Walliserodus sp.	4
		Dapsilodus obliquicostatus	1
		Ramiform elements (indet.)	2
4035	750	*Panderodus unicostatus*	8
		Walliserodus sp.	1
		Ramiform elements (indet.)	1
4040	1000	*Panderodus unicostatus*	17
		Panderodus sp.	1
		Walliserodus sp.	2
		Dapsilodus obliquicostatus	11
		Belodella sp.	2
		Pseudoneotudus sp.	1
		Ramiform elements (indet.)	1

Barrick states (letter, May 18, 1976) that the fauna indicates a Clarita Formation (*Kockelella amsdeni* zone; Barrick and Klapper, 1976, p. 65-67) or younger zone. On the basis of this evidence, the upper part of the cored strata is assigned to the Clarita Formation of the Chimneyhill Subgroup. No lithologic subdivisions have been recognized in the core, and the presence of other Chimneyhill Subdivisions is conjectural.

Woodford (Chattanooga) Shale 3956′-4029′ (CC)
Hunton Group 4029′ (CC) -4104′ (core)
4029′-4030′ No core; samples not examined.
4030′-4104′ (core) Silurian; Chimneyhill Subgroup. Dolomitic organo-detrital crinoidal limestone, some beds having substantial bryozoan and other shelly debris. The HCl-acid insolubles are low throughout. Clarita conodonts 4030′-4040′.
Sylvan Shale 4104′-4110′ (core)
4104′-4110′ (core) Calcareous shale with 15.11% $MgCO_3$ and 57.20% HCl-acid insolubles.

SHERROD & APPERSON 3 RICHARDSON—SW¼SW¼SE¼ sec. 17, T. 7 N., R. 4 E., Pottawatomie County, Oklahoma; elev. 981′ DF; TD 4132′ (SP log); (samples only go to 4003′) (Ordovician); compl. unknown. Hunton production reported (perf. 3912′-3924′). Tops: Woodford 3738′ (−2757′) (CC), Hunton 3830′ (−2848′) (sample depth), Sylvan 3995′ (−3014′) (sample depth); Hunton thickness 165′. Samples examined from 3680′ to 4003′ (last sample), poor quality with considerable contamination; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

There appears to be some sample contamination, but the Hunton sequence is reasonably clear. It consists of an upper marlstone (Henryhouse and/or Haragan) underlain by pink crinoidal limestone (Chimneyhill Subgroup, Clarita Formation) with about 15′ of glauconitic and dolomitic limestone at the base (Cochrane Formation). The upper part of the Hunton has very little dolomite. The basal 50′ is moderately to heavily dolomitized.

This well is in the St. Louis Field.

Woodford (Chattanooga) Shale 3738′ (CC) -3830′ (sample depth)
Hunton Group 3830′-3995′ (sample depths)
3830′-3880′ (sample depths) Silurian; Henryhouse Formation (may include some Lower Devonian Haragan beds). Weakly to moderately dolomitized fossiliferous marlstone; crinoids common along with ostracodes, bryozoans, and others. Scattered fine (to 0.2 mm) subangular quartz detritus.
3880′-3995′ (sample depths) Chimneyhill Subgroup (assigned on the basis of lithologic character and stratigraphic position).
3880′-3980′ (sample depths) ?Clarita Formation. Pink crinoidal micrite with minor spar; bryozoans common, and some ostracodes and other groups.
3880′-3950′ (sample depths) Very little dolomite.
3950′-3980′ (sample depths) Moderately to heavily dolomitized. A few scattered fine subangular quartz grains throughout.
3980′-3995′ (sample depths) ?Cochrane Formation. Moderately to heavily dolomitized biomicrite and biosparite with glauconite. Crinoids common, along with bryozoans and some arthropods. Very little detrital quartz. Considerable ?pyrite.
Sylvan Shale 3995′ (sample depth)
Greenish-gray shale.

MIDWEST 1 ROBBS UNIT—1980′ FEL & 1980′ FSL sec. 26, T. 7 N., R. 26 E., Le Flore County, Oklahoma; elev. 646.7′ KB (524.5 GL); TD 13,271′; ?13,440′ (GR log); compl. 9/13/63, D&A. Tops: Woodford 13,020′ (−12,473′) (CC), Hunton 13,260′ (−12,713′) (CC).

This well was air drilled, and the samples were too fine for study.

ROBERT R. BINKLEY, JR., 1 ROGERS—C NE¼SW¼SE¼ sec. 14, T. 9 N., R. 8 E., Hughes County, Oklahoma; elev. 856′ KB (849′ GL); TD 4391′ (Ordovician); compl. 6/4/65, no Hunton production reported. Tops: Woodford 4079′ (−3225′) (SP log), Hunton 4126′ (−3272′) (sample depth), Sylvan 4228′ (−3374′) (SP log), Welling 4314′ (−3460′) (SP log); Hunton thickness 102′. Samples examined from 4020′ to 4330′, good quality; 11 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in this well include no marlstone. All of the beds are weakly to heavily dolomitized organo-detrital crinoidal limestones. The stratigraphic sequence suggests the Quarry Mountain (pink crinoidal limestone)-Blackgum (glauconitic limestone). However, the distinction between the Quarry Mountain and the Tenkiller is too poorly defined to be useful (note that it cannot be recognized in other wells in this region; see panel 4).

Woodford (Chattanooga) Shale 4079′-4126′ (SP log)
Misener Sandstone at the base; quartz sand composed of well-rounded grains to 2 mm with quartz overgrowths.

Hunton Group 4126′-4228′ (SP log)
4126′-4228′ (SP log) Silurian; Chimneyhill Subgroup.
4126′-4180′ (sample depths) ?Quarry Mountain Formation. Weakly to heavily dolomitized organo-detrital limestone. Crinoids are strongly predominant, but other shelly fossils are present. No detrital quartz observed. Parts are heavily dolomitized, but only a small quantity of crystalline dolomite observed.
4180′-4215′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite-sparite; parts with many bryozoans. Only weakly dolomitic. No detrital quartz observed.
4215′-4228′ (sample depths) ?Cochrane-Blackgum Formation. Glauconitic dolomite with a few remnants of crinoid plates. No detrital quartz observed, but considerable pyrite.

Sylvan Shale 4228′-4314′ (SP log)
Upper 10′-15′ greenish-gray shale, medium-gray below.

Welling Formation 4314′ (SP log)
4310′-4315′ (thin section) (sample depth) Organo-detrital sparite with no observed quartz or dolomite.
4325′-4330′ (thin section) (sample depth) Organo-detrital sparite with numerous well-rounded detrital quartz grains.

HORWITZ 1 ROSE—NE¼NW¼SW¼ sec. 10, T. 11 N., R. 7 E., Seminole County, Oklahoma; elev. 851′ DF (844′ GL); TD 4629′ (Ordovician); compl. 5/21/52, production unknown. Tops: Woodford 4285′ (−3434′) (SP log), Hunton 4315′ (−3464′) (SP log), Sylvan 4420′ (−3569′) (SP log), Welling 4510′ (−3659′) (SP log), Fite 4540′ (−3689′) (sample depth); Hunton thickness 105′. Samples examined 4280′-4550′, good quality; 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata, which are provisionally referred to the Chimneyhill Subgroup, consist of moderately to heavily dolomitized (including some porous crystalline dolomite) crinoidal micrite-sparite with a few feet of glauconitic dolomite at the base. The uppermost Hunton could include some Frisco, but the presence of crystalline dolomite indicates that this is almost certainly not the case. The upper crinoidal micrite-sparite presumably includes Clarita-Quarry Mountain equivalents, possibly with some Tenkiller strata in the lower part. The basal glauconitic strata may be correlative with the Cochrane-Blackgum beds, but these lithostratigraphic correlations are too tenuous to be of much significance.

Woodford (Chattanooga) Shale 4285′-4315′ (SP log)
Hunton Group 4315′-4420′ (SP log)
4325′-4420′ (sample depth) Silurian; ?Chimneyhill Subgroup. Note lag.
4325′-4360′ (sample depths) Moderately to heavily dolomitized crinoidal limestone. This includes considerable porous crystalline dolomite. Little or no detrital quartz.
4360′-4420′ (sample depth) Weakly to heavily dolomitized pink crinoidal sparite-micrite; includes some crystalline dolomite. Little or no detrital quartz.
4420′-4430′ (sample depths) Glauconitic dolomite; no detrital quartz observed.

Sylvan Shale 4420′ (SP log) -4510′ (sample depth)
Greenish shale in top, becoming gray below.

Welling Formation 4510′-4540′ (sample depths)
4520′-4530′ (thin section) Organo-detrital pelmatozoan sparite with much other shelly debris. No detrital quartz or dolomite observed.

Fite Limestone (?Bromide Formation, Pooleville Member) 4540′ (sample depth) Pellet sparite and dense limestone with some ostracodes. No detrital quartz or dolomite observed.

HARPER 1 ROSENDAHL—C NW¼SE¼ sec. 7, T. 11 N., R. 15 E., McIntosh County, Oklahoma; elev. 670′; TD 3635′ (Ordovician); compl. 6/23/58, no Hunton production. Tops: Misener 3288′ (SP log), Sylvan 3296′ (SP log), Welling 3348′ (SP log); no Hunton present. Samples examined from 3200′ to 3380′, good quality; 4 thin sections (2 Misener Sandstone, 2 Welling Formation); samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford Shale is separated from the Sylvan Shale by about 8′ of chert (in part dolomitic) and dolomite. The latter shows some silicification and a few rounded quartz grains. All the chert-carbonate interval is assigned to the Misener Sandstone. No Hunton recognized. The upper part of the Sylvan is a greenish-gray shale, becoming dark below. The Woodford-Misener-Sylvan contacts are also well marked on the SP log. The upper 30′ of the Welling Formation is organo-detrital limestone with a little fine quartz sand in the 3370′-3375′ interval (2 thin sections, 3350′-3355′, 3370′-3375′).

FALCON SEABOARD 1 RUSHING—C NW¼NE¼ sec. 18, T. 2 N., R. 10 E., Coal County, Oklahoma; elev. 708′ DF (698′ GL); TD 8172′ (Ordovician); compl. 3/8/59, D&A. Tops: Woodford 6786′ (−6088′) (SP log), Hunton 6940′ (−6235′) (SP log), Sylvan 7145′ (−6435′) (SP log), Welling 7235′ (−6530′) (sample depth); Hunton thickness 205′. Samples examined from 6900′ to 7270′, good quality, large pieces; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The samples are of excellent quality and show a well-defined lithostratigraphic sequence of Woodford Shale, Hunton Limestone, Sylvan Shale, and Welling Formation. Hunton rocks can be further subdivided into an upper marlstone (Henryhouse, possibly including some Lower Devonian Haragan, although the thickness makes this unlikely), pink crinoidal limestone (Clarita Formation), glauconitic limestone (Cochrane Formation), and oolite (Keel Formation). All units contain some dolomite crystals, but the rock probably does not exceed 15% $MgCO_3$ at any place. The lithostratigraphic sequence is similar to that in the Arbuckle Mountains–Criner Hills, with which it can be correlated with reasonable certainty. The Silurian sequence in this well is similar to that in the 1 Hargrove-Hudson. Hunton strata have been thinned by pre-Woodford erosion (also cf. 1 Mullin).

Woodford (Chattanooga) Shale 6786′–6940′ (SP log)
Hunton Group 6940′–7145′ (SP log)
6940′ (SP log) -7120′ (sample depth) Silurian; Henryhouse Formation (may include some Haragan). Medium-gray marlstone composed of finely divided carbonate plus a variable quantity of insoluble terrigenous detritus, most of which is fine subangular to angular quartz to 0.2 mm. Fossils scattered through the matrix, variable in quantity, but almost all the rock appears to be mud supported. Pelmatozoan plates are the most common, along with ostracodes, bryozoans, brachiopods, and other shelly debris. Dolomite ranges from sparse to moderate, only uncommonly abundant. Dolomite and quartz are slightly more abundant in the upper part. This is typical marlstone texture.
7120′ (sample depth) -7145′ (SP log) Silurian; Chimneyhill Subgroup.
7120′–7135′ (sample depths) Clarita Formation. Pink crinoidal micrite with only minor spar. Fossils abundant; appears to be entirely grain supported. Pelmatozoan plates abundant; many ostracodes and other shelly debris. Very little quartz detritus or dolomite.
7135′–7143′ (sample depths) Cochrane Formation. Organo-detrital micrite and sparite with much glauconite. Some beds with moderate dolomite and a little detrital quartz. Chert.
7143′–7150′ (sample depths) Keel Formation. Oolites set in a spar matrix. Ooids with radial and concentric structure, commonly showing a fossil nucleus. Very little dolomite or quartz.
Sylvan Shale 7145′ (SP log) -7235′ (sample depth)
Welling Formation 7235′ (sample depth)
7250′ (thin section) Low-magnesium organo-detrital sparite with a few rounded quartz grains to 0.8 mm.

CHAPMAN & POLAND 1 SCHRIMSHER—SW¼SE¼NE¼ sec. 19, T. 10 N., R. 15 E., McIntosh County, Oklahoma; elev. 781 KB (775′ GL); TD 4580′ (the last sample is from 4580′; Lane Wells logged a total depth of 4429′, but the well must have been deepened after the log was run); compl. unknown. (Lane Wells logged this well 2/20/60, D&A?) Tops: Hunton 4343′ (−3568′) (SP log), Sylvan 4423′ (−3648′) (SP log), Welling 4490′ (−3715′) (sample depth); Hunton thickness 80′. Samples examined from 4300′ to 4580′, fair quality, but with some contamination from above; 10 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in this well include about 10′ of marlstone at the top. This has widely scattered fossils, mostly ostracodes, along with minor fine angular detrital quartz but very little dolomite. This rock resembles the marlstone beds in the upper part of the Oklahoma Natural Gas 1 Hale, about 7 miles to the southwest. Lithologically these strata resemble the Henryhouse-Haragan marlstones of the Arbuckle Mountain region. A similar marlstone lithology is also known to be present in the Clarita Formation of the Arbuckle Mountains, and the thickness and regional relations suggest that this is the case in the 1 Schrimsher. This is the farthest known eastward extension of any marlstone in the Silurian of Oklahoma and is here referred to the Chimneyhill with question. The underlying Hunton beds are heavily dolomitized crinoidal beds that are tentatively correlated with the strongly dolomitic facies of the Quarry Mountain Formation.

Woodford (Chattanooga) Shale
No Misener (Sylamore) Sandstone recognized.
Hunton Group 4343′–4423′ (SP log)
4343′ (SP log) -4350′ (sample depth) ?Silurian; ?Chimneyhill Subgroup. Ostracodal marlstone with a few widely scattered fine (to 0.1 mm) angular detrital quartz grains; very little dolomite. This appears to be a mud-supported rock with fairly typical marlstone texture.
4350′–4400′ (sample depths) Silurian; Chimneyhill Subgroup. ?Quarry Mountain Formation. Heavily dolomitized crinoidal carbonate and porous crystalline dolomite. Little or no detrital quartz.
4400′–4430′ (sample depths) ?Tenkiller Formation. Pink crinoidal micrite with only traces of spar; ostracodes and other shelly fossils common, but only a few bryozoans. Weakly to moderately dolomitized. No detrital quartz observed.
4430′–4440′ (sample depths) ?Blackgum Formation. Mixture of pink crinoidal micrite like above and heavily dolomitized crinoidal carbonate. Chert present, but no glauconite observed. Some scattered angular detrital quartz grains in the lower part.
Sylvan Shale 4423′ (SP log) -4490′ (sample depth)
Welling Formation 4490′ (sample depth)
4490′–4495′ (thin section) Organo-detrital crinoidal sparite with numerous well-rounded quartz grains to 0.5 mm.

ST. CLAIR LIME CO. DIAMOND CORE HOLE SCL 1—NE¼NE¼SE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; compl. 1953. This core starts in the Sylamore Sandstone Member of the Chattanooga Formation. It cuts the top of the Hunton Group at 4.8′ and extends down into the Hunton for a distance of 100′. It bottoms in the Barber Member, Quarry Mountain Formation, Chimneyhill Subgroup. A lithostratigraphic description and chemical analyses are given in Amsden and Rowland (1965, p. 113–115, 163, 166).

ST. CLAIR LIME CO. DIAMOND CORE HOLE SCL 2—NE¼NE¼SE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma; compl. 1960. This core starts in the Hunton Group (Barber Member, Quarry Mountain Formation, Chimneyhill Subgroup) and extends into the top of the Sylvan Shale (at 97.25′). A lithostratigraphic description and chemical analyses of this core are given in Amsden and Rowland (1965, p. 115–119, 163, 166).

MID-CONTINENT 1 SCOTT—NW¼SE¼NE¼ sec. 29, T. 10 N., R. 10 E., Okfuskee County, Oklahoma; elev. 904′ DF; TD 4150′; compl. 10/20/50, Hunton production reported. Tops: Misener 3800′ (−2896′) (sample depth), Hunton 3890′ (−2986′) (sample depth), Sylvan 3995′ (−3091′) (sample depth), Welling 4085′ (−3181′) (sample depth); Hunton thickness 115′. Samples examined from 3800′ to 4120′, good quality; 8 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 10′ to 15′ of the Hunton is a light-gray crinoidal-bryozoan sparite with no visible dolomite or quartz. On the basis of its stratigraphic position and lithology, it is provisionally referred to the Frisco Formation (cf. 1 Hall and 1 Boley). The remainder of the Hunton strata are strongly dolomitized pelmatozoan sparites ranging into porous crystalline dolomite and are here referred to the Chimneyhill Subgroup.

Woodford (Chattanooga) Shale
3800′-3890′ (sample depth) Misener Sandstone. Chert and carbonate with subangular to well-rounded quartz detritus.
Hunton Group 3890′-3995′ (sample depth)
3890′-3905′ (sample depths) ?Lower Devonian; ?Frisco Formation. Light-gray, organo-detrital crinoidal-bryozoan sparite. No quartz or dolomite observed.
3905′-3995′ (sample depths) Silurian; Chimneyhill Subgroup. Some moderately dolomitized pelmatozoan sparite, but mainly heavily dolomitized crinoidal limestone and porous crystalline dolomite. Very little detrital quartz.
Sylvan Shale 3995′-4085′ (sample depths)
Welling Formation 4085′ (sample depth)
4105′-4110′ (thin section) Organo-detrital sparite with a few rounded quartz grains. Little or no dolomite.

ARKLA 1 SHAW—SW¼NE¼SW¼ sec. 19, T. 9 N., R. 20 E., Haskell County, Oklahoma; elev. 568′ KB (558′ GL); TD 4968′ (Ordovician); compl. 6/9/71, D&A. Tops: Woodford 4790′ (−4222′) (GR log), Hunton 4838′ (−4270′) (GR log), Sylvan 4946′ (−4378′) (GR log), Welling 4960′ (−4392′) (GR log); Hunton thickness 108′. Samples examined from 4800′ to 4968′ (TD); 9 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Woodford-Hunton sequence is fairly well defined in the samples, although there is some shale contamination through the Hunton interval. A thin section from the deepest sample (4965′) is composed of pink crinoidal micrite with glauconite and appears to be typical Hunton-Blackgum-type lithology. The Sylvan Shale is reasonably well defined on the gamma-ray log from 4946′ to 4956′. Its absence from the samples is almost certainly due to sample lag. Hunton strata are represented by a dolomitic lithofacies with most samples ranging from strongly dolomitized into crystalline dolomite. This all appears to represent Chimneyhill strata, although the divisions of Quarry Mountain–Tenkiller–Blackgum are not well defined.

Woodford (Chattanooga) Shale 4790′-4838′ (GR log)
Trace of Misener Sandstone.
Hunton Group 4838′-4946′ (GR log)
4838′-4946′ (GR log) Silurian; Chimneyhill Subgroup. Mostly heavily dolomitized organo-detrital limestone ranging into crystalline dolomite; a few pieces of weakly dolomitized limestone. Fossils all appear to retain original microtexture; pelmatozoans common, along with bryozoans, etc. A few scattered grains of detrital quartz in lower part. Little or no chert. This interval assigned to the Chimneyhill on the basis of its lithologic character and stratigraphic position. No clearly defined Tenkiller or Blackgum lithology.
Sylvan Shale 4946′-4960′ (GR log)
Welling Formation 4960′-4968′ (GR log)

FLEET 1 SINCLAIR—C NE¼NE¼ sec. 14, T. 4 N., R. 8 E., Pontotoc County, Oklahoma; elev. 894′ KB (883′ GL); TD 6205′ (Ordovician, Arbuckle); compl. 11/23/57, production unknown. Tops: Woodford 4685′ (−3791′) (SP log), Hunton 4845′ (−3951′) (SP log), Sylvan 5058′ (−4164′) (SP log) 5095′ (sample depth), Welling 5170′ (−4276′) (sample depth), Bromide 5205′ (−4311′) (sample depth); Hunton thickness 213′. Samples examined from 4800′ to 5220′, good quality, although there is substantial sample lag in the Sylvan top; 19 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton sequence is fairly typical for the Arbuckle Mountain outcrops. It consists of marlstone (Henryhouse and/or Haragan) underlain by the Chimneyhill organo-detrital limestones including Clarita pink crinoidal limestone, Cochrane glauconitic limestone, and Keel oolite. The marlstone includes a substantial amount of silt-size quartz detritus with low to moderate dolomitization. Hunton strata are 213′ thick but include no organo-detrital sparite (Frisco) at the top (cf. 1 Hargrove-Hudson and 1-6 Johnson).

Woodford (Chattanooga) Shale 4685′-4845′ (SP log)
No Misener Sandstone observed.
Hunton Group 4845′-5058′ (SP log)
4845′ (SP log) -5000′ (sample depth) Silurian-?Devonian; Henryhouse Formation, probably including some Haragan Formation. Fossiliferous marlstone with scattered crinoids, ostracodes, trilobites, bryozoans, and other shelly debris; some beds with many bryozoans. Moderate to substantial subangular detrital quartz grains to 0.2 mm. Low to moderate dolomite in the form of euhedral crystals scattered through the mud matrix. A few pieces of chert in the upper 40′.
5000′ (sample depth) -5058′ (SP log) Chimneyhill Subgroup.
5000′-5055′ (sample depths) Clarita Formation. Pink crinoidal micrite with some subangular silt-size detrital quartz; mostly with very little dolomite. Shelly debris, including a number of ostracodes.
5055′-5090′ (sample depths) Cochrane Formation. Weakly dolomitized glauconitic crinoidal micrite and sparite. Very little detrital quartz, but some chert.

5090′-5095′ (sample depths) Keel Formation. Fossiliferous oolite with a micrite matrix. Oolites commonly with a fossil nucleus and with radial and concentric banding. Some silicified oolites. Little or no dolomite.

Sylvan Shale 5058′ (SP log) -5170′ (sample depth)
Light-green shale above, dark-gray below.
Welling Formation 5170′-5205′ (sample depths)
5174′-5180′ (thin section) Organo-detrital crinoidal sparite with some micrite; no detrital quartz or dolomite.
5195′-5200′ (thin section) Same as above but with a few scattered detrital quartz grains.
Bromide Formation (Pooleville Member-Corbin Ranch) 5205′ (sample depth)
5205′-5210′ (thin section) Pellet limestone and dense ?algal limestone with sparry calcite; ostracodes, also some organo-detrital micrite with numerous well-rounded quartz grains up to 0.5 mm (pl. 11, fig. 7).

WHEELER ET AL. 1 SNOW—C SE¼SW¼ sec. 36, T. 12 N., R. 22 E., Sequoyah County, Oklahoma; elev. 517.6′; compl. 1959. Tops: Hunton 965′ (−448′) (sample depth), Sylvan 1250′ (−733′) (sample depth); Hunton thickness 285′. Samples examined from 960′ to 1260′; 1 thin section. Described by T. L. Rowland (Amsden and Rowland, 1965, p. 138–141).

GLASS 1 STEWART—SE¼NW¼NW¼ sec. 32, T. 12 N., R. 6 E., Lincoln County, Oklahoma; elev. 977′ DF (971′ GL); TD 4739′ (Ordovician); compl. 12/20/61, production unknown. Tops: Hunton 4400′ (−3423′) (SP log), Sylvan 4526′ (−3542′) (SP log), Welling 4612′ (−3635′) (SP log); Hunton thickness 126′. Samples examined from 4350′ to 4739′, good quality; 12 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper 10′ of the Hunton is a crinoid-bryozoan sparite showing no detrital quartz or dolomite. On the basis of stratigraphic position and lithology it is here referred to the Frisco Formation (cf. Shell 1 Boley, described in this report and in Amsden, 1975b, p. 81). The underlying strata are dolomitized pink crinoidal limestones, grading downward into porous crystalline dolomite. These are provisionally referred to the Chimneyhill Subgroup.

Woodford (Chattanooga) Shale
Misener Sandstone.
4350′-4400′ (SP log) Angular to subangular quartz sand mixed with black shale; much carbonate cement.
Hunton Group 4400′-4526′ (SP log)
4410′-4420′ (sample depths) Lower Devonian; Frisco Formation. Organo-detrital crinoid-bryozoan sparite with no visible dolomite or quartz.
4420′ (sample depth) -4526′ (SP log) Silurian; Chimneyhill Subgroup. Weakly to heavily dolomitized pink crinoidal micrite with some spar. Some beds have abundant bryozoans in addition to the other shelly debris, but mainly it is a crinoid-rich rock. Very little detrital quartz. The dolomite content increases downwards, from 4470′ to the base of the Hunton; it is mainly porous crystalline dolomite.
Sylvan Shale 4526′-4612′ (SP log)
The upper 10′ or so is apple-green shale; underlain by gray shale.
Welling Formation 4612′ (SP log)
4625′-4630′ and 4640′-4645′ (thin sections) (sample depths) Organo-detrital crinoid-bryozoan sparite with no visible dolomite or detrital quartz.

PAN AMERICAN 1 TACKETT UNIT—C SW¼NE¼ sec. 28, T. 8 N., R. 23 E., Le Flore County, Oklahoma; elev. 526′; TD 9272′ (Ordovician); compl. 7/11/63, Cromwell gas reported. Tops: Woodford 6147′ (−5621′) (CC), Misener 6280′ (−5754′) (sample depth), Sylvan 6290′ (−5764′) (sample depth), Welling 6330′ (−5804′) (sample depth), Fite 6350′ (−5824′) (sample depth). Samples examined from 6250′ to 7020′ and 7890′ to 7955′ (TD), samples missing from 7020′ to 7890′, samples good quality except for interval from 6330′ to 6450′, where they are very fine (air drilled?); 23 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

If Hunton strata are present in this well, they are very thin. The samples from 6280′ to 6290′ comprise chert and dolomite with sparse, scattered fine detrital quartz and are provisionally assigned to the Misener. The overlying Woodford Shale is distinctly darker than the underlying Sylvan Shale.

KING 1 TIGER—NW¼NW¼SW¼SE¼ sec. 3, T. 8 N., R. 5 E., Seminole County, Oklahoma; elev. 911′; TD 4292′ (Wilcox); compl. 5/16/69, no Hunton production reported. Tops: Woodford 3794′ (−2883′) (CC), Hunton 3917′ (−3006′) (CC), Sylvan 3954′ (−3043′) (core); Hunton thickness 37′. Cored; 3921′-3960′ (Hunton-Sylvan), 1 thin section; chemical analyses; OU Core Library. Described in Amsden (1975b, p. 102, 161).

Hunton strata in this well are referred to the Chimneyhill Subgroup on the basis of stratigraphic position, lithologic character, and fauna. The presence of a reserellid brachiopod (*Resserella* sp.), having similarities to a species present in the Wenlockian St. Clair Limestone (Arkansas), suggests Clarita equivalents within 9′ of the Sylvan Shale (Amsden, 1975b, p. 102). This faunal evidence is, however, not overwhelming, and no attempt is here made to recognize formation divisions.

This well is near the truncated margin of the Hunton Group. (See panel 2, also 1-6 Bean and 10A Rentie.)

Woodford (Chattanooga) Shale 3794′-3917′ (CC)
Hunton Group 3917′-3954′ (CC)
3917′-3921′ No core; samples not examined.
3921′-3954′ (core) 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 the $MgCO_3$ content averages only 8.82%, HCl-acid insolubles 2.25%. Fragmentary trilobites and brachiopods present; one specimen of *Resserella* sp. at 3945′ (cf. *Resserella* sp., Amsden, 1968, pl. 3, figs. 5a-5h). Referred to the Chimneyhill on the basis of its lithology and stratigraphic position.

Sylvan Shale 3954′ (core)
3954′–3960′ (core) Greenish-gray argillaceous dolomite with numerous small pyrite crystals. HCl-acid insolubles average 15.36%, $MgCO_3$ 30.87%.

SAMEDAN 1 TURNIPSEED—See HUMBLE 1 KERR

WISE 1 WALKER—SW¼SW¼NE¼ sec. 18, T. 13 N., R. 18 E., Muskogee County, Oklahoma; elev. 602′; compl. 1958, production unknown. Tops: Hunton 2038′ (−1436′) (sample depth), Sylvan 2061′ (−1459′) (sample depth); Hunton thickness 23′. Samples examined from 2025′ to 2075′. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 149).

LIGNON 1 J. WALKER—C NE¼SE¼SW¼ sec. 29, T. 8 N., R. 8 E., Seminole County, Oklahoma; elev. 843′ GL; TD 4091′ (Sylvan); compl. 4/17/67, Hunton oil production reported (perforations 3904′–3910′, 3962′–3982′, 4000′–4012′). Tops: Woodford 3850′ (−3007′) (GR log), Misener 3902′ (−3054′) (sample depth), Hunton 3912′ (−3064′) (sample depth), Sylvan 4054′ (−3206′) (GR log); Hunton thickness 142′. Samples examined from 3860′ to 4091′ (TD), excellent quality; 12 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The upper Hunton in this well is typical marlstone (all of which is provisionally referred to the Silurian Henryhouse Formation), and the lower part is pink crinoidal micrite with some spar, although some beds are heavily dolomitized. However, the boundary between the two is not sharply defined, possibly being obscured by dolomitization. There is no Frisco-type or Fittstown-type organo-detrital limestone in the upper part of the Hunton. The sandstone between the typical Woodford Shale and Hunton marlstone is here arbitrarily assigned to the Sylamore, although its lithologic character is not unlike some known Sallisaw beds.

Woodford (Chattanooga) Shale 3850′ (GR log) -3912′ (sample depth)
3902′–3912′ (sample depths) Misener Sandstone. Silty dolomite and dolomitic siltstone with subangular quartz grains to 0.2 mm. This could represent the Sallisaw Formation.
Hunton Group 3912′ (sample depth) -4054′ (GR log)
3912′–3970′ (sample depths) Silurian; Henryhouse Formation (upper part may include some Lower Devonian Haragan beds). Fossiliferous marlstone; fossils mostly crinoid plates along with some ostracodes, a few bryozoans, and other shelly fossils. Scattered subangular detrital quartz grains to 0.2 mm. Only minor dolomite.
3970′–4054′ Chimneyhill Subgroup (Clarita Formation in part?).
Weakly to heavily dolomitized pink crinodal micrite with some spar; some bryozoans along with a few ostracodes and other shelly fossils. In places the matrix is entirely crystalline dolomite, but no porous crystalline dolomite texture observed. Very little detrital quartz.
Sylvan Shale 4054′ (GR log) -4075′ (sample depth)
Greenish-gray shale at the top, dark-gray shale below.

SHELL 1 WESTERN COAL & MINING CO.—SE¼ sec. 36, T. 7 N., R. 32 W., Sebastian County, Arkansas; elev. 523′ DF (505′ GL); TD 10,921′ (Upper Cambrian; Haley, 1965, p. 17); compl. 2/23/62, Hunton gas production 7936′ (−7958′) Haley and Frezon, 1965, pl. 1. Tops: Woodford 7768′ (−7245′) (Haley and Frezon, 1965, p. 13), Hunton (Sallisaw Formation–Penters Chert) 7810′ (−7287′) (sample depth), Hunton (?Silurian) 7850′ (−7327′) (sample depth), Sylvan (=Cason Shale) 7959′ (−7436′) (core), Welling 7980′ (−7457′) (sample depth); Hunton thickness 149′. Samples examined from 7700′ to 8010′, good quality; 13 thin sections; this well cored lower Hunton and about 4′ of Sylvan Shale (7944′–7964′, recovering approximately 19′); 15 thin sections; 16 chemical analyses; samples, Arkansas Geological Commission, Little Rock, Arkansas; core, Shell Oil Co., Midland, Texas.

This well was described by Haley and Frezon (1965). In all essential respects I am in accord with their description and formation assignments. Minor discrepancies exist in some of the tops, but this may be due to the samples used. I have studied the samples as well as the core and have had 28 thin sections prepared. Also, 16 core specimens from the Hunton and upper Sylvan have been analyzed in the chemical laboratory of the Oklahoma Geological Survey (see table that follows). The thin sections and chemical analyses make it possible to characterize the Hunton in fairly precise lithologic terms and to compare it with the strata in eastern Oklahoma, especially with the well-known section exposed in the Marble City area.

Hunton rocks in this and the adjoining well studies in the Bonanza Field (text-fig. 11) are similar to those in easternmost Oklahoma. The correlation between the two areas appears to be reasonably straightforward. The uppermost strata make up a sequence that is largely chert, with varying amounts of subangular to subrounded detrital quartz. The grain size of the detritus ranges from well under 0.1 mm to over 1 mm, and the detritus also ranges widely in concentration but generally consists of well under 25% of the total volume. Minor dolomite is present, but this unit is largely chert. Haley and Frezon (1965, p. 3, 13) assigned these beds to the Penters Chert. In lithologic character and stratigraphic position they appear to be correlative with and an extension of the Sallisaw Formation of eastern Oklahoma (panel 4). This chert unit is underlain by crystalline dolomite and calcitic dolomite with little or no chert. The upper 20′ to 30′ includes minor quantities of fine subangular detrital quartz and a few quartz veins that may represent infiltration along solution cavities. The basal 15′ of the Hunton was cored. The thin sections plus the chemical analyses show this rock to be almost entirely low-insoluble crystalline dolomite (pl. 1, figs. 1, 2, 4–6); there is approximately 2′ of dolomitic crinoidal limestone from 7953′ to 7954′ (pl. 1, fig. 3). This interval ranges as high as 41.18% $MgCO_3$, averaging 34.44% $MgCO_3$. The HCl-acid insolubles are low throughout, with a maximum of 2.6% and an average of 0.80%. The crystalline dolomites show considerable visual porosity. Some of these pores are caused by the dissolution of crinoid plates. In fact, the low-magnesium bed at 7953′-7954′, as well as some of the dolomitic limestones above the cored portion, strongly suggests that the entire Hunton is largely heavily dolomitized crinoidal limestone (pl. 1). Some of the cavities have a linear form, suggesting solution along fractures (pl. 1, figs. 2, 4). All of the Hunton beds below the cherts are assigned to the Chimneyhill Subgroup. The lower, cored crystalline dolomites occupy the stratigraphic position of the Tenkiller-Blackgum, although they do not lithologically resemble these formations. This is possibly due to the intense dolomitization. The very low insolubles in these strata do suggest the Quarry Mountain Formation of the eastern outcrop area, which averages less than 1% insolubles, rather than the Tenkiller or Blackgum Formations, which averages 3% to 5% insolubles (Amsden and Rowland, 1965, p. 8). No glauconite or oolites were observed. For core sample analyses, see table that follows.

Woodford (Chattanooga) Shale 7768′-7810′ (Haley and Frezon, 1965, p. 13)

Hunton Group 7810′-7959′ (sample and core depths)

7810′-7850′ (sample depths) Lower Devonian; Sallisaw Formation (=Penters Chert). Light-gray chert with subangular to subrounded detrital quartz grains to 1 mm. Quartz grains variable in quantity, generally making up only a small part of the rock. Only minor carbonate.

7850′ (sample depth) -7959′ (core depth) Silurian; Chimneyhill Subgroup.

7850′-7910′ (sample depths) Almost all gray crystalline dolomite with some visible porosity. Minor widely scattered fine (less then 0.1 mm) subangular quartz, possible infiltration along solution cavities. This interval is here interpreted as heavily dolomitized Quarry Mountain strata, although it could include some younger strata.

7910′-7944′ (sample depths) Weakly to heavily dolomitized organo-detrital sparite with some micrite. Many pelmatozoans with some ostracodes and much bryozoan material. No detrital quartz observed.

7944′-7959′ (core) This is almost entirely crystalline dolomite with very little insoluble detritus. The 14 samples analyzed average 34.44% $MgCO_3$ (maximum 41.18% $MgCO_3$) and 0.80% HCl-acid insoluble residue (see table that follows). A 2′ interval (7953′-7954′) of dolomitic crinoidal limestone averages 13.64% $MgCO_3$. Much visual porosity in the crystalline dolomite.

Sylvan Shale (=Cason Shale) 7959′ (core) -7980′ (sample depth)

Upper 2′ to 3′ a light-greenish-gray argillaceous dolomite with rounded detrital quartz; 1 sample analyzed 27.34% $MgCO_3$ and 31.77% HCl-acid insolubles. Underlying shale is dark gray; 1 sample (7964′) analyzed 19.22% $MgCO_3$, 51.81% HCl-acid insolubles. The depth from 7959′ to 7964′ was studied from cores; 7964′-7980′ depth was studied from samples.

Welling Formation 7980′-8010′ (sample depths)

7980′-7985′, 7990′-7995′, 8005′-8010′ (thin sections) Weakly to moderately dolomitized organo-detrital sparite with minor micrite; no detrital quartz observed.

SHELL 1 WESTERN COAL & MINING CO.

CORE SAMPLES

Depth (ft)	$CaCO_3$	$MgCO_3$	Insoluble residue	Recovery	Mn (ppm)	Sr (ppm)
Chimneyhill Subgroup						
7944	59.32	39.02	0.82	99.16	198	100
7945	60.01	39.50	0.56	100.07	195	100
7948 B	62.32	35.57	0.50	98.39	208	100
7948 C	58.49	40.94	0.50	99.93	223	100
7950	61.30	36.41	0.52	98.23	228	100
7952 A	66.14	31.77	0.44	98.35	250	112
7952 B	56.65	41.18	1.16	98.99	238	75
7952 C	59.66	37.80	1.04	98.50	235	62
7954 A	86.81	11.28	0.48	98.57	120	88
7954 B	83.12	15.99	0.52	99.63	145	112
7955	60.72	37.91	0.92	99.55	215	112
7957	58.92	39.40	1.08	99.40	245	125
7958 B	58.27	38.97	2.60	99.84	358	162
7958	62.56	36.38	1.69	100.63	265	112
Average		34.44	0.92			
Sylvan Group						
7959	39.71	27.34	31.77	98.82	1100	125
7964	27.99	19.22	51.81	99.02	938	112

SERVICE 1-13 WHITEFIELD—NE¼NW¼SE¼ sec. 13, T. 9 N., R. 19 E., Haskell County, Oklahoma; elev. 553′; compl. unknown, Hunton gas production 4644′-4716′. Hunton top reported at 4638′. Samples and mechanical logs were not available at the time this report was written.

JONES-SHELBURNE 1 WHITWORTH—C SW¼ SE¼SW¼ sec. 2, T. 5 N., R. 5 E., Seminole County, Oklahoma; elev. 916′; TD 2814′ (Sylvan); compl. 7/15/52, Hunton production reported (perf. 2781′-2788′). Tops: Hunton 2600′ (−1684′) (sample depth), Sylvan 2790′ (−1875′) (SP log); Hunton thickness 191′. Samples examined from 2550′ to 2815′ (TD), good quality; 13 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

This appears to be a typical Arbuckle Mountain Hunton sequence consisting of marlstone (Henryhouse and/or Haragan Formation), underlain by the Chimneyhill Subgroup, including the Clarita, Cochrane, and Keel Formations. Low in dolomite throughout.

Woodford (Chattanooga) Shale
No Misener Sandstone observed.
Hunton Group 2600′ (sample depth) -2591′ (SP log)
2600′-2730′ (sample depths) Silurian (may include some Devonian at top); Henryhouse Formation, possibly including some Haragan beds in the upper part. Fossiliferous marlstone, mostly with a low fossil content but including pelmatozoans, ostracodes, triobites, bryozoans, and other shelly debris; no corals observed. Moderate scattered subangular detrital quartz grains to 0.2 mm. Low to moderate scattered dolomite crystals.
2730′-2790′ (sample depths) Chimneyhill Subgroup.
2730′-2780′ (sample depths) Clarita Formation. Pink crinoidal micrite with ostracodes, bryozoans, etc. Moderate detrital quartz to 0.2 mm or so. Moderate scattered dolomite crystals.
2780′-2790′ (sample depths) Cochrane Formation. Glauconitic crinoidal micrite with many bryozoans. Minor detrital quartz and dolomite. Chert.
2790′-2800′ (sample depths) Keel Formation. Mixture of rock like 2780′-2790′ interval above plus oolites set in spar. Latter with many fossils and resembling the Ideal Quarry beds of the Arbuckle Mountain exposures. Discussed in Amsden (1960, pl. 10, figs. 1-3).
Sylvan Shale 2790′ (SP log)

BRIDGEVIEW COAL 1 WILLIAMSON—SE¼NW¼ SE¼ sec. 2, T. 12 N., R. 18 E., McIntosh County, Oklahoma; elev. 518′; compl. 1958, production unknown. Tops: Hunton 2210′ (−1693′) (sample depth), Sylvan 2290′ (−1772′) (sample depth); Hunton thickness 80′. Samples examined from 2200′ to 2300′; 2 thin sections. Well examined by T. L. Rowland (Amsden and Rowland, 1965, p. 147-148).

VISE 2-A WRIGHT—SE¼SW¼SE¼ sec. 3, T. 8 N., R. 4 E., Pottawatomie County, Oklahoma; elev. 994′; TD 4365′ (Ordovician; Viola); compl. 1/29/59, Hunton production reported. Tops: Woodford 3970′ (−2976′) (CC), Hunton 4134′ (−3140′) (CC), Sylvan 4200′ (−3206′) (CC), Welling 4288′ (−3294′) (CC); Hunton thickness 66′; samples examined from 4000′ to 4330′, good quality; 8 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

The Hunton strata are assigned to the Chimneyhill Subgroup on the basis of stratigraphic position, thickness, and lithology. For the most part, these strata are only weakly dolomitized.

Woodford Shale 3970′-4134′ (CC)
No Misener Sandstone observed.
Hunton Group 4134′-4200′ (CC)
4134′-4200′ (CC) Silurian; Chimneyhill Subgroup. Weakly to heavily dolomitized pink crinoidal micrite and sparite; ostracodes, bryozoans, trilobites, and brachiopods are also common. The upper 10′ or so is heavily dolomitized, the underlying beds having only scattered dolomite crystals. Very little quartz observed. Minor glauconite in the lower few feet.
Sylvan Shale 4200′-4288′ (CC)
Pale-green shale at the top, becoming gray or grayish-green below.
Welling Formation 4288′ (CC)
4305′-4310′, 4325′-4330′ (thin sections) (sample depths) Organo-detrital sparite with no visible quartz or dolomite.

U.S.S.R.A.M. 1 YOUNG—NE¼SW¼SW¼ sec. 13, T. 13 N., R. 5 E., Lincoln County, Oklahoma; elev. 801′ DF (795′ GL); TD 4559′ (Ordovician; Arbuckle); compl. unknown, Hunton and Simpson ("Wilcox") production reported. Tops: Hunton 4170′ (−3369′) (SP log), Sylvan 4260′ (−3459′) (SP log), Welling 4345′ (−3544′) (sample depth); Hunton thickness 90′. Samples examined 4100′-4172′, core chips 4172′-4188′, samples 4188′-4440′, core chips 4440′-4515′, samples 4515′-4959′ (TD), good quality; 37 thin sections; samples, Oklahoma Well Sample Service, Shawnee, Oklahoma.

Hunton strata in the 1 Young are almost entirely in a crystalline dolomite lithofacies showing considerable visual porosity. This appears to be a part of a northwest-southeast elongate area of rather intensely dolomitized rock (see panel 4).

Woodford (Chattanooga) Shale
Misener Sandstone present in the basal part.
Hunton Group 4170′-4260′ (SP log)
4170′-4260′ (SP log) Silurian; Chimneyhill Subgroup. Almost entirely crystalline dolomite showing visual porosity.
4189′-4190′ (sample depths) Heavily dolomitized pink crinoidal limestone with some bryozoan, brachiopod, and other shelly debris.
4200′-4201′ (sample depths) Pink crinoidal limestone with little or no dolomitization. Entire Hunton shows very little detrital quartz.
Sylvan Shale 4260′ (SP log) -4345′ (sample depth)
Greenish-gray to gray shale.
Welling Formation 4345′-4390′ (sample depths)
Organo-detrital sparite; mostly pelmatozoan plates, but including bryozoan, brachiopod, and other shelly debris. Minor dolomite. No detrital quartz observed except in basal 10′ which has scattered rounded quartz grains to 0.4 mm.

PLATES

Plate 1

Hunton Group, Chimneyhill Subgroup

(Bar scale = 1 mm)

Fig. 1.—Photomicrograph showing crystalline dolomite matrix with fossils (mostly crinoid plates) preserved in spar. Clear areas are voids in thin section. Chemical analysis: $MgCO_3$, 40.94 percent; HCl-acid insolubles, 0.50 percent. Shell 1 Western Coal & Mining Co., Sebastian County, Arkansas, SE¼ sec. 36, T. 7 N., R. 32 W., depth 7,948 feet. Thin section from core. Described in Appendix.

Fig. 2.—Photomicrograph showing crystalline dolomite matrix with irregular vein of spar, probably fracture filling. Clear areas are voids in thin section. Chemical analysis: $MgCO_3$, 41.18 percent; HCl-acid insolubles, 1.16 percent. Shell 1 Western Coal & Mining Co., depth 7,952 feet. Thin section from core. Described in Appendix.

Fig. 3.—Photomicrograph of moderately dolomitized pelmatozoan limestone lying in a 2-foot bed of moderately dolomitized organo-detrital limestone interbedded with crystalline dolomites that make up most of lower Hunton in this well. Chemical analysis: $MgCO_3$, 11.28 percent; HCl-acid insolubles, 0.48 percent. Shell 1 Western Coal & Mining Co., depth 7,954 feet. Thin section from core. Described in Appendix.

Fig. 4.—Photomicrograph showing crystalline dolomite matrix with irregular vein of spar, probably fracture filling. Note shell preserved faintly in spar just left of vein. Chemical analysis: $MgCO_3$, 38.97 percent; HCl-acid insolubles, 2.60 percent. Shell 1 Western Coal & Mining Co., depth 7,958 feet. Thin section from core. Described in Appendix.

Fig. 5.—Photomicrograph showing crystalline dolomite matrix with fossils preserved in spar. Staining with Alizarin Red-S shows mainly calcspar. Predominant fossils are pelmatozoan plates; some shelly debris also present. Chemical analysis: $MgCO_3$, 36.38 percent; HCl-acid insolubles, 1.69 percent. Shell 1 Western Coal & Mining Co., depth 7,958 feet. Thin section from core. Described in Appendix.

Fig. 6.—Photomicrograph showing crystalline dolomite with fossils preserved partly in spar, partly as molds. Clear areas are voids in thin section. Chemical analysis: $MgCO_3$, 36.38 percent; HCl-acid insolubles, 1.69 percent. Shell 1 Western Coal & Mining Co., depth 7,155 feet. Thin section from core. Described in Appendix.

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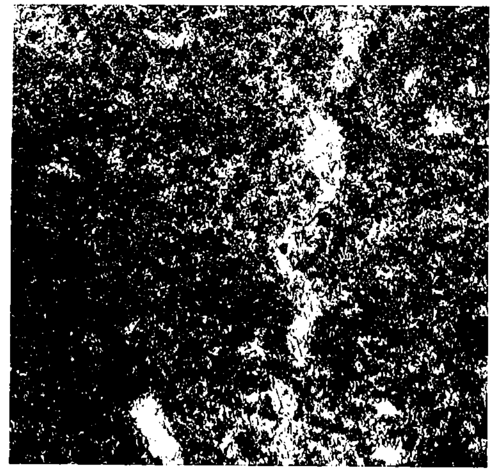

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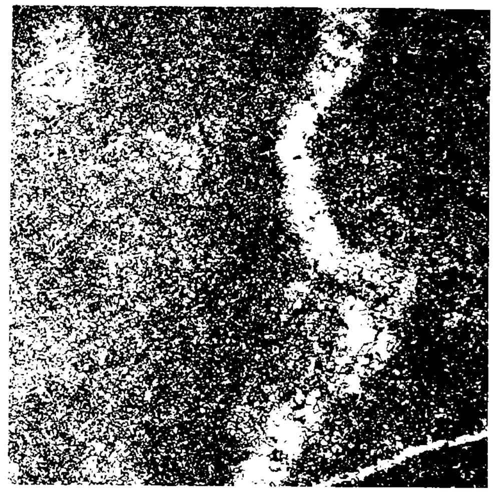

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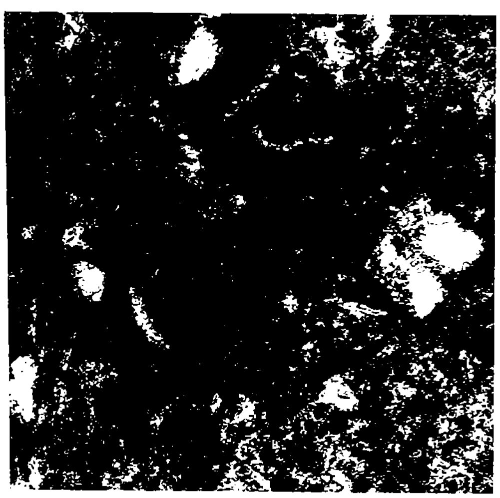

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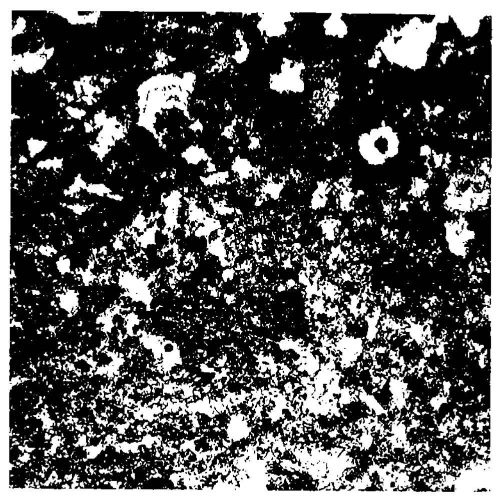

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Plate 2

Silurian Porosity; Marble City Area

Figs. 1–3.—*1, 2,* broken surface, ×3, showing articulated meristellid brachiopod shells unfilled except for thin coating of crystalline spar; note broken remnants of internal spire, also coated with thin layer of spar crystals. *3,* broken surface, slightly enlarged, showing cavities (arrows), some of which are partly filled with spar; most cavities appear to represent incomplete cementation. Marble City Member, Quarry Mountain Formation, 15 feet stratigraphically below Marble City–"Boone" contact, Malloy Hollow, SW¼SW¼SW¼ sec. 4, T. 14 N., R. 24 E., Adair County, Oklahoma (stratigraphic section Ad1, Amsden and Rowland, 1965, p. 101).

Fig. 4.—Photomicrograph, ×5, of Tenkiller Formation, showing sediment-filled cavity with open cavity (arrow) and spar. From bed 11 feet below top of formation, Oklahoma Geological Survey diamond core hole OGS 1, SW¼SE¼SW¼ sec. 4, T. 14 N., R. 24 E., Adair County, Oklahoma (Amsden and Rowland, 1965, p. 102–105). Thin section.

Fig. 5.—Cephalopod shell, ×1.3, showing cavity (arrow) partly filled with calcspar in one of the chambers. It appears to represent incomplete filling of original chamber. From upper Barber Member, Quarry Mountain Formation, St. Clair Lime Co. quarry, SE¼NE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma (stratigraphic section S18, Amsden and Rowland, 1965, p. 99).

Fig. 6.—Photomicrograph, ×6, showing solution cavities (arrows) along stylolite seam. From Barber Member, Quarry Mountain Formation, St. Clair Lime Co. diamond core hole SCL 2, St. Clair Lime Co. quarry, NE¼NE¼SE¼ sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma (see Amsden and Rowland, 1965, p. 115). Thin section.

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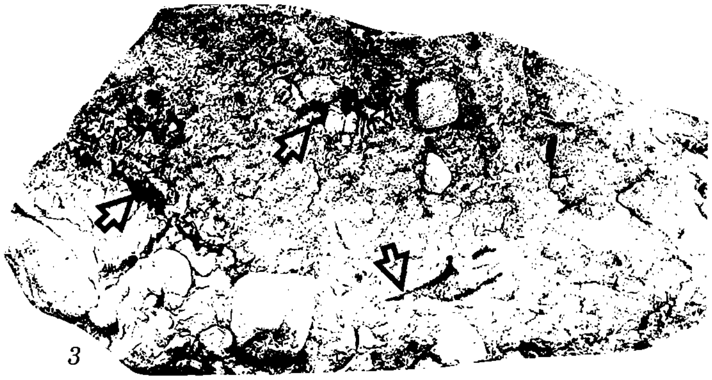

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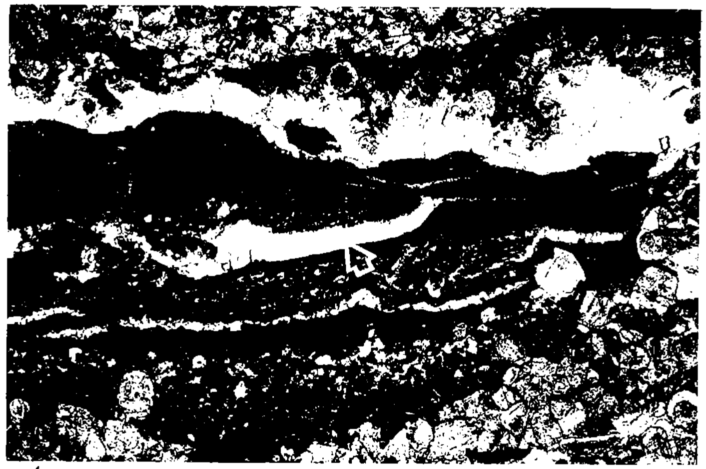

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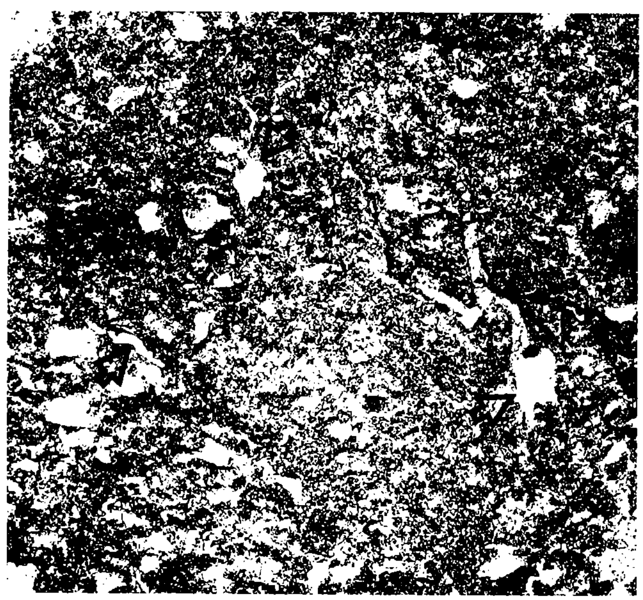

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Plate 3

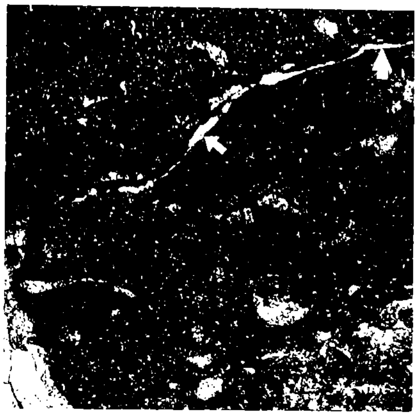
Silurian Porosity, Marble City Area

Fig. 1.—Photomicrograph, ×8, of lower part of Barber Member, Quarry Mountain Formation, showing solution cavity (arrows) along trilobite carapace. Diamond core hole 29Z, about 1/3 mile southwest of St. Clair Lime Co. quarry, SE1/4NW1/4SW1/4 sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma. Thin section.

Fig. 2.—Articulated shell of brachiopod *Eospirifer* sp., slightly enlarged, from Quarry Mountain Formation, Marble City Member. It is unfilled with matrix except for lining of crystalline spar (reverse side of specimen, illustrated in fig. 4). North end, St. Clair Lime Co. quarry, NE1/4 sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma.

Fig. 3.—Cut surface, ×3, showing sediment-filled cavity with unfilled portion (arrow) lined with spar. From upper 20 feet of Barber Member, Quarry Mountain Formation, St. Clair Lime Co. quarry, SE1/4NE1/4 sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma. Locality S18 (see Amsden and Rowland, 1965, p. 99).

Fig. 4.—Cut surface of specimen, approximately ×1. Arrows point to cavities, some associated with fossils (*c*) and some with sediment fillings. Brachiopod from reverse side of this specimen illustrated in fig. 2. From Marble City Member, Quarry Mountain Formation, north end of St. Clair Lime Co. quarry, NE1/4 sec. 14, T. 13 N., R. 23 E., Sequoyah County, Oklahoma.



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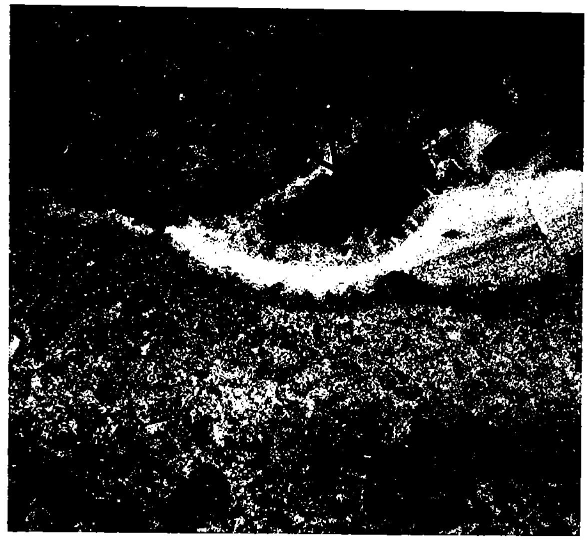

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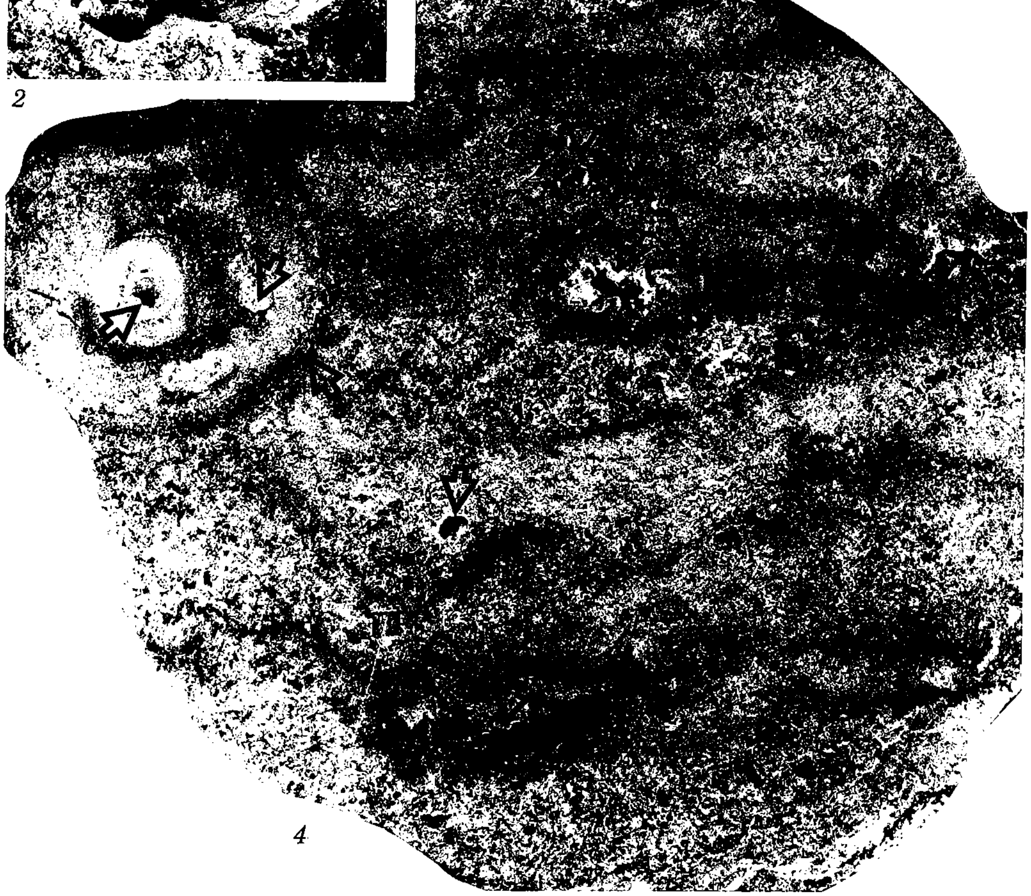

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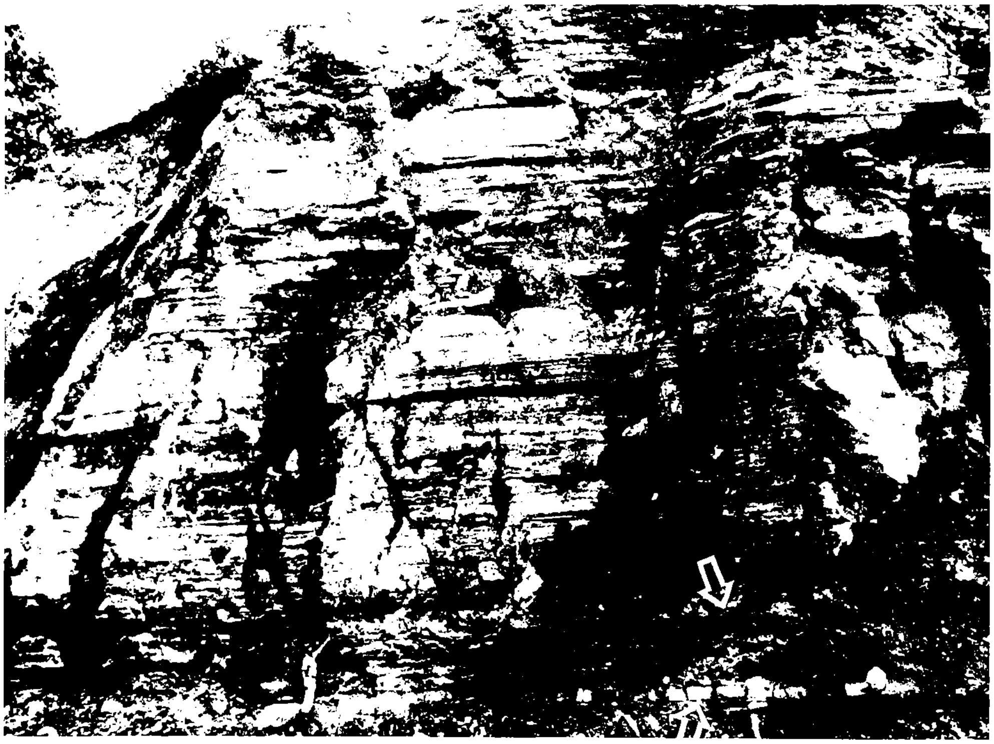
Plate 4

Limestone Lens in Cason Shale, near Batesville, Arkansas

Fig. 1.—St. Clair Limestone (above) and Cason Shale (below); upper arrow and hammer head mark contact, and lower arrow marks *Triplesia alata*-bearing limestone lens within Cason Shale. Upper part of exposed section may include some Lafferty Limestone. Love Hollow quarry, SW¼ sec. 4, T. 14 N., R. 8 W., Izard County, Arkansas.

Fig. 2.—Closer view of limestone lens illustrated above. Upper and lower arrows mark upper and lower contacts of lens within Cason Shale. Lower bed (*o*) is oolite, and upper bed (*t*) is pink glauconitic crinoidal limestone yielding *Triplesia alata*; closer view of pink-crinoidal-limestone–oolite contact is shown on pl. 5.



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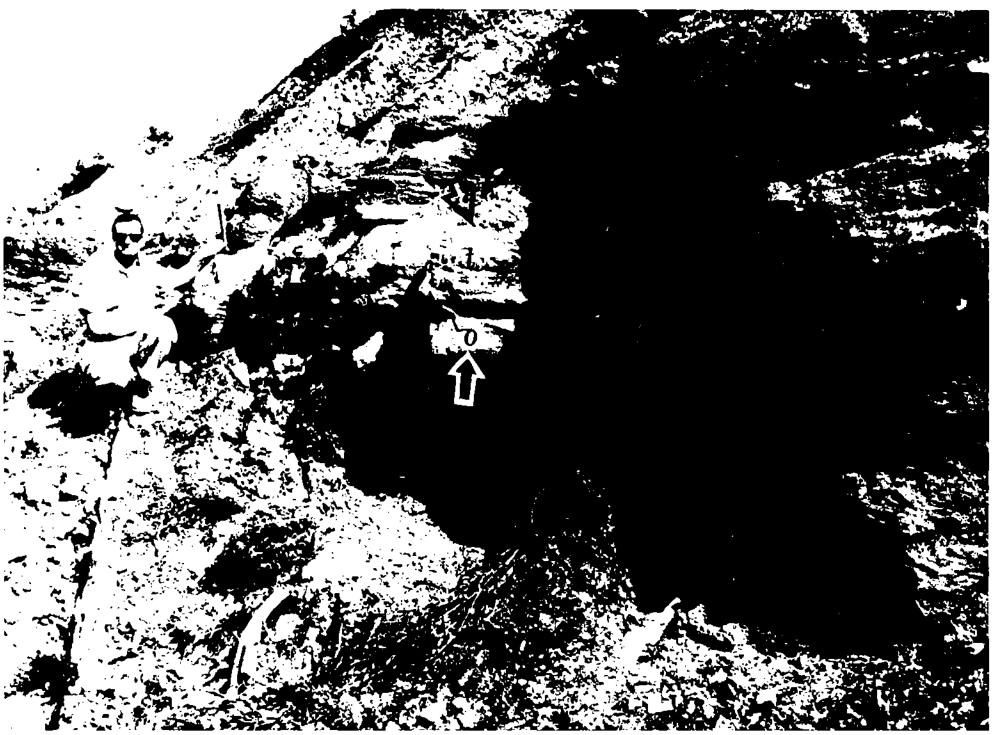

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Plate 5

LIMESTONE LENS IN CASON SHALE, NEAR BATESVILLE, ARKANSAS

Figs. 1, 2.—Rock specimens from upper part of pink glauconitic crinoidal limestone illustrated in fig. 3, below (*t*), and in pl. 4, figs. 1, 2. Love Hollow quarry, SW1/4 sec. 4, T. 14 N., R. 8 W., Izard County, Arkansas.

Fig. 3.—Closeup, approximately ×1, of contact (arrow; stylolite seam) between oolite (*o*, below) and pink glauconitic crinoidal limestone (*t*, above) that furnishes specimens of *Triplesia alata*. Specimen cut from block collected at Love Hollow quarry, illustrated on pl. 4. Described in Amsden (1971).

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Plate 6

Limestone Lens in Cason Shale, near Batesville, Arkansas

Fig. 1.—Enlarged view, ×11, of rock specimen illustrated in fig. 2, showing relation of oolite bed (*o*) to *Triplesia alata*-bearing pelmatozoan limestone (*t*). Contact at top (*sd*, arrow) appears to be an unaltered sedimentary boundary, whereas lateral contacts (*st*, arrows) are solution boundaries (stylolite seams). Love Hollow quarry, SW¼ sec. 4, T. 14 N., R. 8 W., Izard County, Arkansas.

Fig. 2.—Contact, approximately ×2, of oolite bed (*o*) with *Triplesia alata*-bearing pelmatozoan limestone (*t*). Arrows marked *st* denote solution contacts (stylolite seams), whereas arrow marked *sd* appears to mark normal depositional contact. Cut from rock specimen illustrated in pl. 5. Love Hollow quarry, same locality as fig. 1.

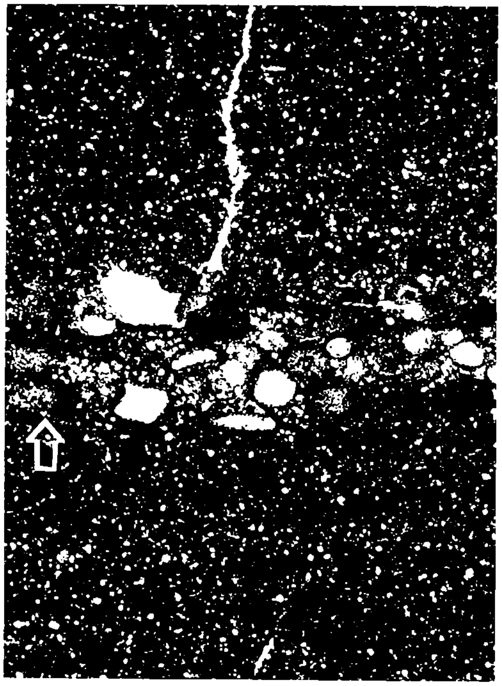
1

2

Plate 7

Keel Formation

Figs. 1.–3.—Photomicrographs showing interval assigned to Keel Formation, consisting of oolites scattered through about 3 inches (80 mm) of argillaceous, dolomitic micrite. Chemical analysis: $CaCO_3$, 77.25 percent; $MgCO_3$, 11.42 percent; HCl-acid insolubles, 10.16 percent. Figs. 1 and 2 are enlarged views, ×12, of upper and lower parts of fig. 3; arrows point to oolites. Fig. 3, enlarged ×5, covers much of oolite bed. Kirkpatrick 1 Blevins Unit core, C NE¼SW¼ sec. 7, T. 17 N., R. 4 W., Logan County, Oklahoma. See pl. 8 and text-fig. 14.



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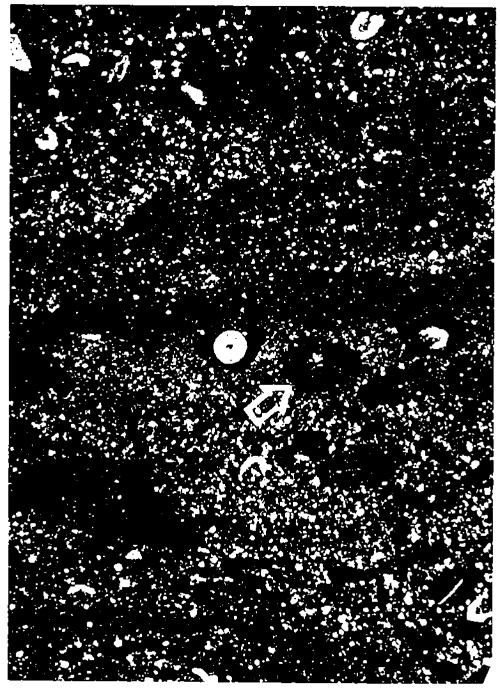

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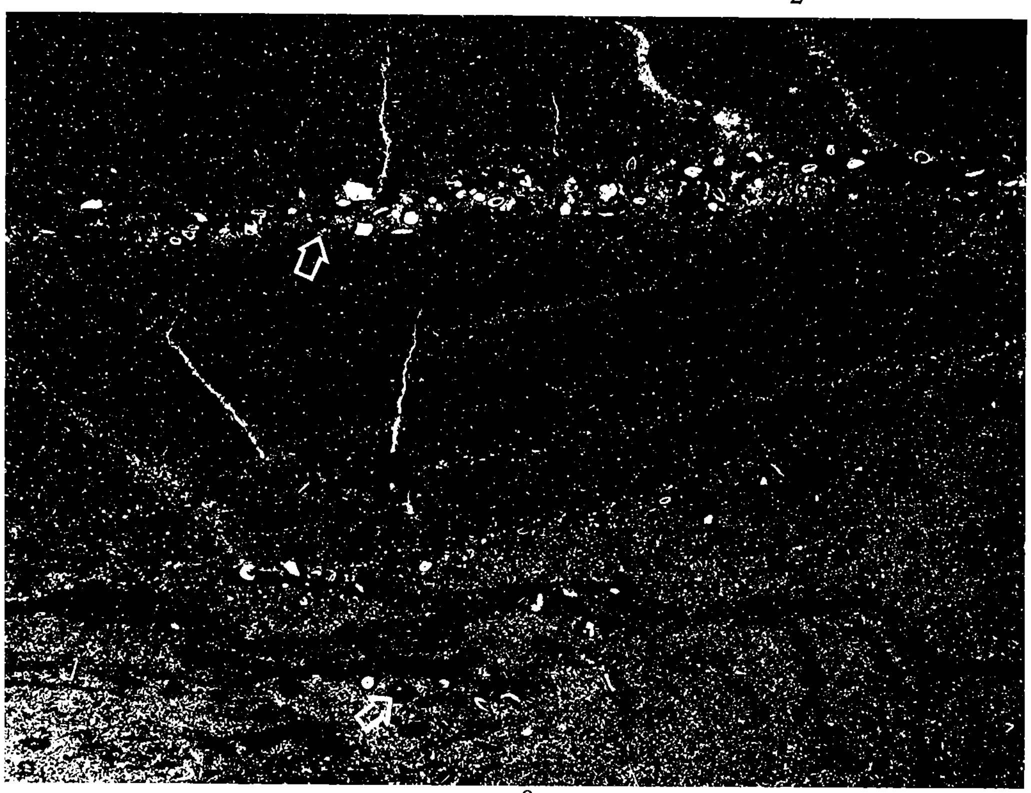

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Plate 8

COCHRANE(?)-KEEL(?)-SYLVAN(?) INTERVAL

Fig. 1.—Cut surface of core, slightly reduced; depth 7,039 feet (top). Kirkpatrick 1 Blevins Unit core, C NE¼SW¼ sec. 7, T. 17 N., R. 4 W., Logan County, Oklahoma. Thin section cut from this core illustrated on pl. 7; see text-fig. 14.

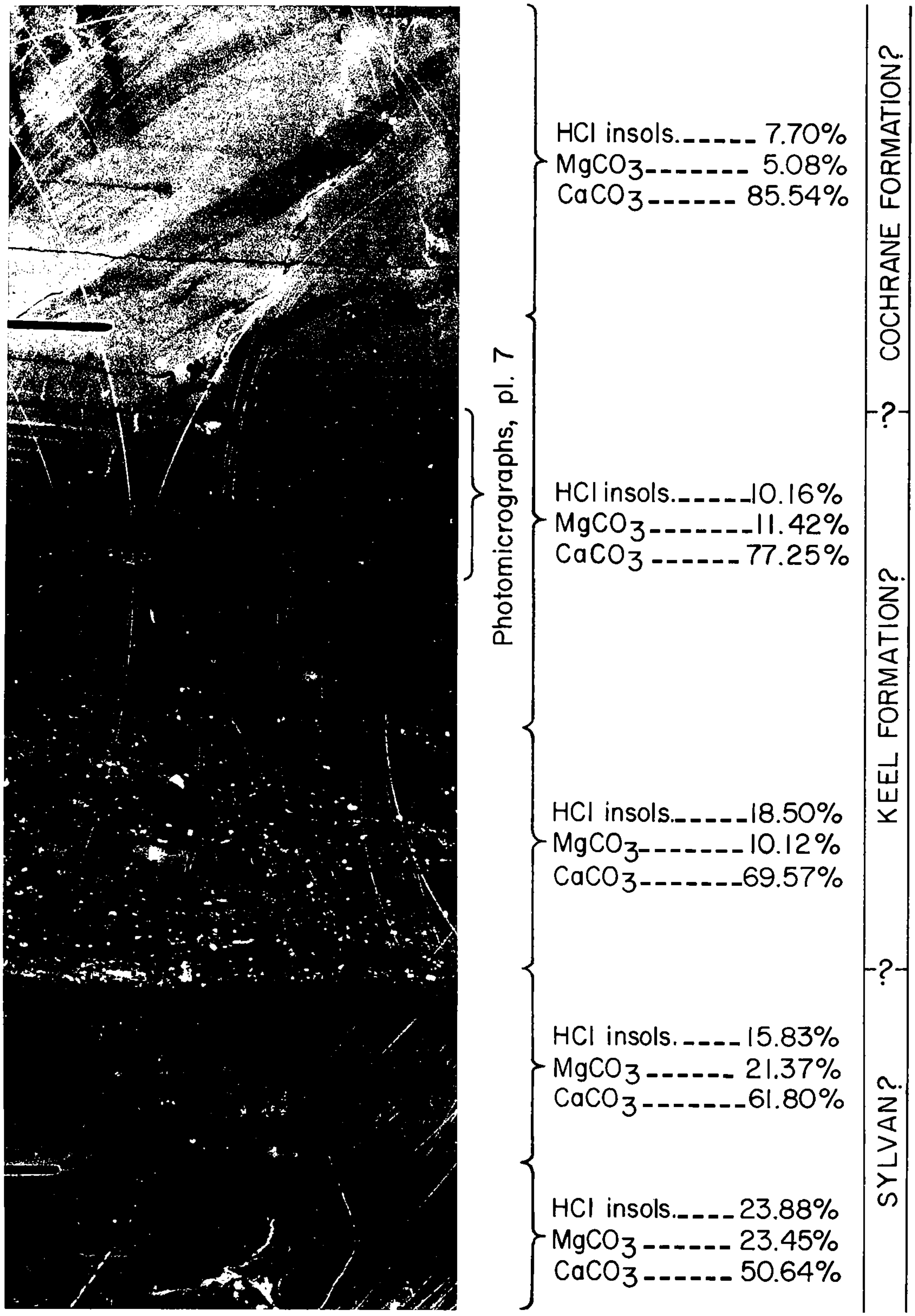
HCl insols.------ 7.70%
MgCO3-------- 5.08%
CaCO3------- 85.54%
Photomicrographs, pl. 7
HCl insols.------10.16%
MgCO3--------11.42%
CaCO3------- 77.25%
HCl insols.------18.50%
MgCO3--------10.12%
CaCO3--------69.57%
HCl insols.-----15.83%
MgCO3------- 21.37%
CaCO3--------61.80%
HCl insols.-----23.88%
MgCO3------- 23.45%
CaCO3------- 50.64%
COCHRANE FORMATION?
?
KEEL FORMATION?
?
SYLVAN?

Plate 9

FRISCO-SILURIAN CONTACT

Fig. 1.—Cut core surface, ×2.5, showing contact of light-gray organo-detrital Frisco limestone (above) with dark organo-detrital limestone of *Kirkidium* biofacies (Henryhouse Formation). Phillips 1 Brooks, depth 8,770 feet, E½SW¼SE¼ sec. 30, T. 14 N., R. 6 W., Canadian County, Oklahoma. Described in Appendix.

Fig. 2.—Photomicrograph, ×10, of upper 2 inches of *Kirkidium* biofacies, showing shells that are fragments of *Kirkidium* sp. Phillips 1 Brooks, depth 8,770 feet. See fig. 1 and Appendix.

Figs. 3, 4.—Cut core surface, ×4.5, ×2.5, showing light-gray organo-detrital Frisco limestone (above) and dark dolomitic limestones of *Kirkidium* biofacies (Henryhouse Formation). Tenneco 1-5 Biller, depth 8,612 feet, E½W½SE¼ sec. 5, T. 13 N., R. 6 W., Canadian County, Oklahoma (see Appendix). Thin section. Illustrated on pl. 10, figs. 1-5.

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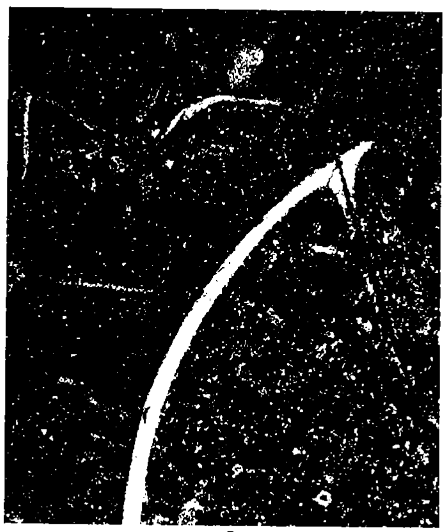

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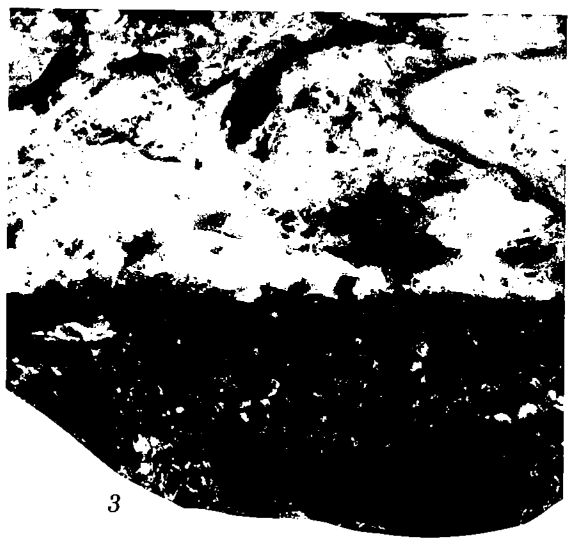

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Plate 10

Frisco Formation and *Kirkidium* Biofacies (Henryhouse Formation)

Fig. 1.—Cut core surface, ×1, of Frisco Formation, showing fracture partly filled with calcite and partly with solid hydrocarbons. Tenneco 1-5 Biller, depth 8,603 feet, E½W½SE¼ sec. 5, T. 13 N., R. 6 W., Canadian County, Oklahoma (see Appendix).

Fig. 2.—Thin section, ×6, from basal 1 foot of Frisco Formation, showing typical organo-detrital sparite texture. Chemical analysis: $MgCO_3$, 0.55 percent; HCl-acid insolubles, 0.27 percent. Tenneco 1-5 Biller, depth 8,611 feet.

Fig. 3.—Thin section, ×6, of Frisco Formation, showing brachiopod shell with finer organic debris. Tenneco 1-5 Biller, depth 8,600 feet.

Fig. 4.—Thin section, ×5, from upper 2 feet of *Kirkidium* biofacies (Henryhouse Formation), showing organic debris set in matrix of finely divided carbonate with considerable dolomite and quartz detritus. Chemical analysis: $MgCO_3$, 7.94 percent; HCl-acid insolubles, 16.17 percent. Tenneco 1-5 Biller, depth 8,614 feet.

Fig. 5.—Thin section, ×5, of *Kirkidium* biofacies (Henryhouse Formation), showing halysitid coral (above) and transverse section of pedicle valve of *Kirkidium* (below). Tenneco 1-5 Biller, depth 8,621 feet. Other illustrations from Tenneco 1-5 Biller on plate 9, figs. 3, 4.

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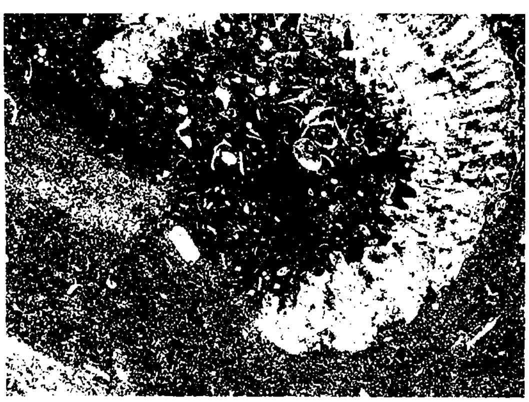

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Plate 11

Fite, Welling ("Fernvale"), and Keel Formations

Fig. 1.—Photomicrograph, ×15, showing Fite Limestone. Dark background in dense algal(?) limestone with scattered isolated dolomite crystals and solid areas of crystalline dolomite. Thin section from sample chip. Gibraltar 1 Franks, depth 3,630-3,640 feet; described in Appendix.

Fig. 2.—Photomicrograph, ×15, showing Welling Formation organo-detrital pelmatozoan sparite. Dominant skeletal material is crinoidal but includes other shelly debris. Thin section from well sample. Allied et al. 1-D Keegan, depth 4,790-4,795 feet; described in Appendix.

Fig. 3.—Photomicrograph, ×15, showing Welling Formation organo-detrital sparite with pelmatozoan plates, brachiopods, and other shelly debris. Thin section from well sample. Oklahoma Natural Gas 1 Hale, depth 4,280-4,290 feet; described in Appendix.

Fig. 4.—Photomicrograph, ×15, showing Welling Formation organo-detrital sparite with rounded detrital quartz grains (arrow). Thin section from well sample. Ambassador 1 Chapman, depth 4,225-4,230 feet; described in Appendix.

Fig. 5.—Photomicrograph, ×15, showing Fite Limestone. This is a dense pellet limestone with irregular areas of spar. Thin section from well sample. Horwitz 1 Rose, depth 4,550-4,560 feet; described in Appendix.

Fig. 6.—Photomicrograph, ×15, of Fite Limestone, showing characteristic dense pellet limestone with some irregular areas of spar. Gibraltar 1 Franks, depth 3,630-3,640 feet.

Fig. 7.—Photomicrograph, ×15, showing dense algal(?) limestone of Fite Limestone with scattered fossils, mainly ostracodes; fossil at top probably coral *Tetradium*. Fleet 1 Sinclair, depth 5,205-5,210 feet; described in Appendix.

Fig. 8.—Photomicrograph, ×15, of Keel Formation, basal 1 inch showing heavily dolomitized oolites. Thin section from core. Shell 1 Boley, depth 4,508 feet; described in Appendix.

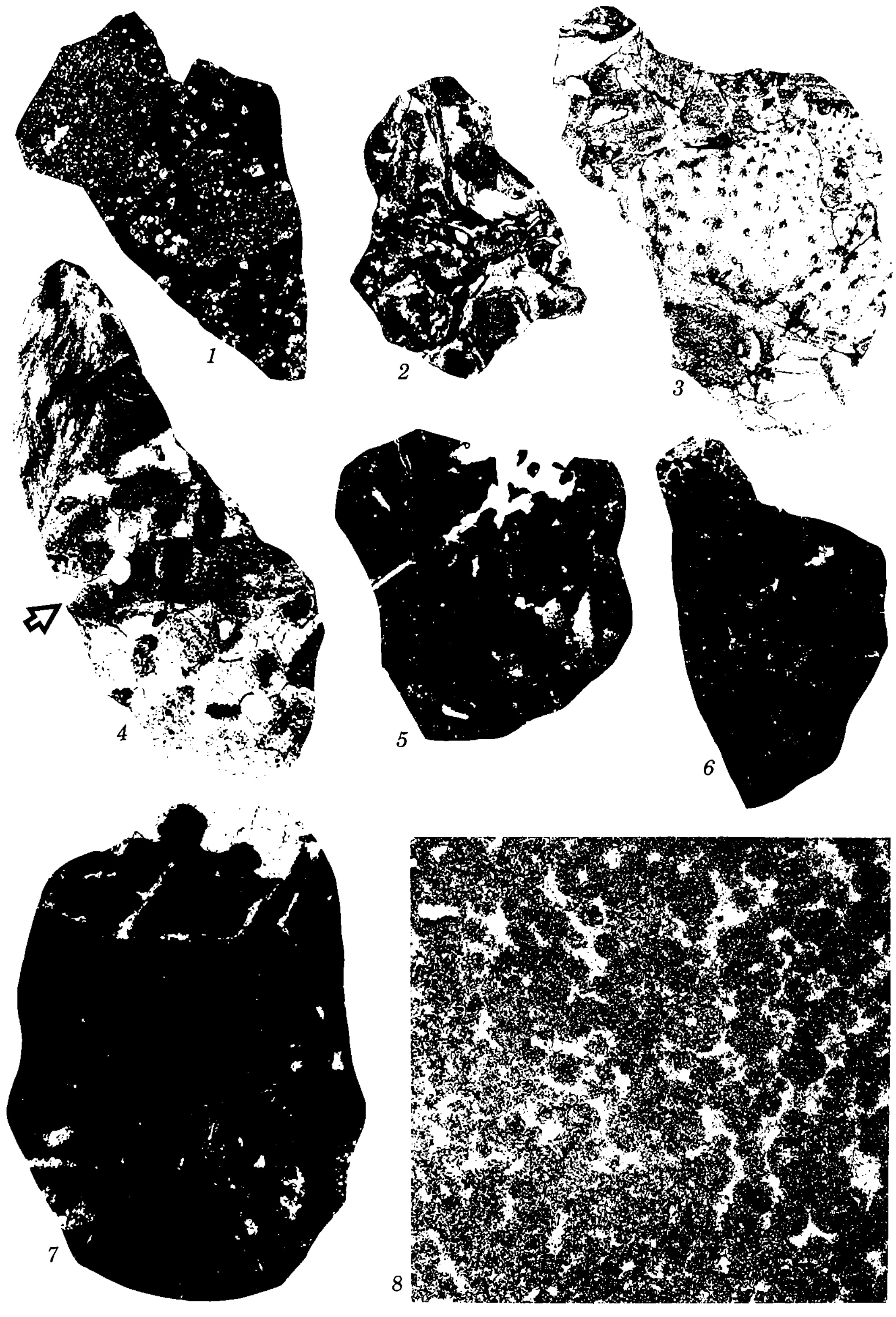
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Plate 12

WELLING ("FERNVALE") FORMATION AND FITE LIMESTONE

Fig. 1.—Photomicrograph, ×5, of Welling limestone, showing organo-detrital sparite. Chemical analysis: $CaCO_3$, 93.45 percent; $MgCO_3$, 0.57 percent; HCl-acid insolubles, 5.37 percent. Oklahoma Geological Survey diamond core hole OGS 3, depth 193 feet; described in Appendix.

Fig. 2.—Photomicrograph, ×10, of Fite Limestone, showing pellet limestone with scattered trilobites and irregular areas of spar. Oklahoma Geological Survey diamond core hole OGS 3, depth 207 feet; described in Appendix. Compare to pl. 11, figs. 1, 5, 6, 7.

Fig. 3.—Photomicrograph, ×15, of Fite Limestone, showing dense limestone with scattered fossils, mainly pelmatozoan plates and ostracodes, and irregular areas of dolomite. Chemical analysis: $CaCO_3$, 75.72 percent; $MgCO_3$, 21.22 percent; HCl-acid insolubles, 3.10 percent (Amsden and Rowland, 1965, p. 162). Oklahoma Geological Survey diamond core hole OGS 3, depth 212 feet; described in Appendix. Compare to pl. 11, figs. 1, 5, 6, 7.

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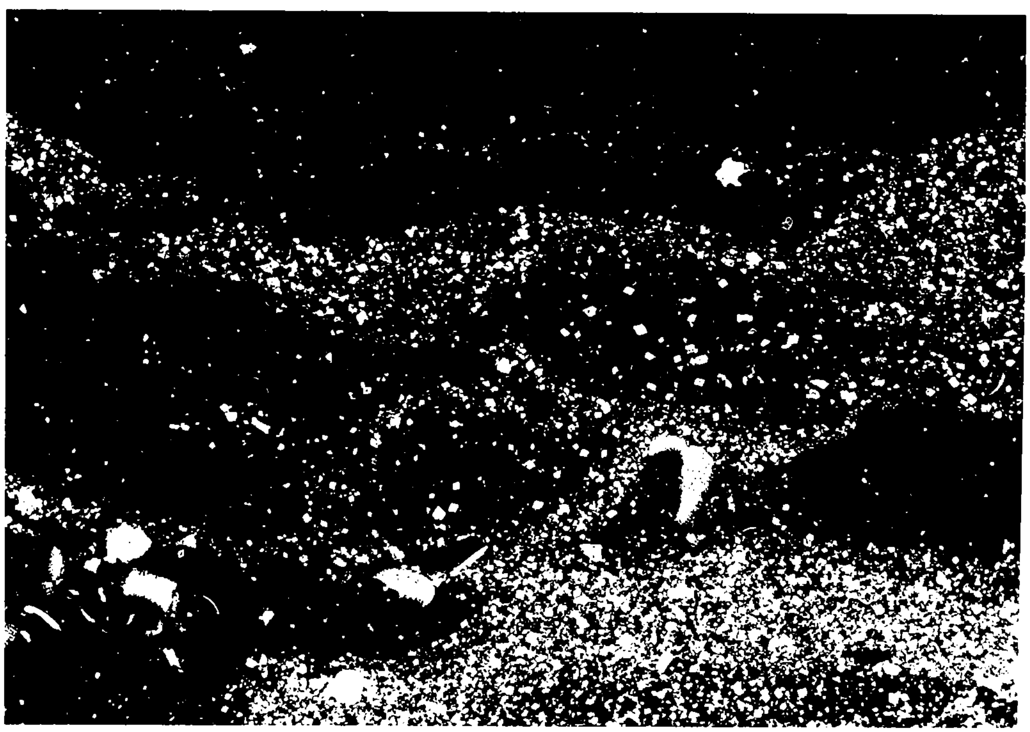

3

INDEX

(**Boldface** numbers indicate main references; parentheses indicate page numbers of text-figures; brackets indicate plate numbers)