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STRATIGRAPHY AND PALEONTOLOGY OF THE HUNTON GROUP IN THE ARBUCKLE MOUNTAIN REGION

Part VI

Hunton Stratigraphy

By

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Hunton Stratigraphy

Thomas W. Amsden

ABSTRACT

The Hunton group comprises a sequence of carbonate strata which crop out in the Arbuckle Mountain region and Criner Hills of south-central Oklahoma. It is a thin group of strata, and within the outcrop area only locally attains a thickness of slightly more than 400 feet. The Hunton group is divided into the following formations and members:

		WOODFORD FORMATION
Devonian	HUNTON GROUP	Frisco formation
		unconformity
		Bois d'Arc formation
		Fittstown member
		Cravatt member
		Haragan formation
		unconformity
Silurian		Henryhouse formation
		unconformity
		Chimneyhill formation
		Clarita member
		unconformity
		Cochrane member
		unconformity
		Keel member
		Ideal Quarry member
Ordovician		SYLVAN FORMATION

These strata range in age from Early Silurian to Early Devonian, but the record is quite incomplete and there are several time breaks marked by unconformities.

The present report presents the results of a study based on a field investigation covering all of the major Hunton outcrop belts; a number of stratigraphic sections were measured and collected, and certain local areas were mapped in detail. This field work was supplemented by a laboratory study of the lithology by means of paralodion peels, thin sections, insoluble residues and chemical analyses. Numerous fossil collections were made, but this report does not include descriptive paleontology, and gives only summary data on the fossils and their age. The information which appears to have a bearing on environment of deposition is discussed and it is concluded that except for the Keel-Ideal Quarry beds, which appear to have formed in shallow water, the Hunton rocks are mostly the product of offshore deposition, mainly out of the zone of effective wave action; the text concludes with a short chapter on the depositional and erosional history of the group. The APPENDIX records all of the described stratigraphic sections, and tabulates the chemical analyses.

The cherty carbonates and siltstone which crop out near Oil Creek and in the Turkey Creek inlier are described and discussed in some detail. These strata have commonly been assigned to the Hunton, but evidence is presented pointing to a post-Hunton age.

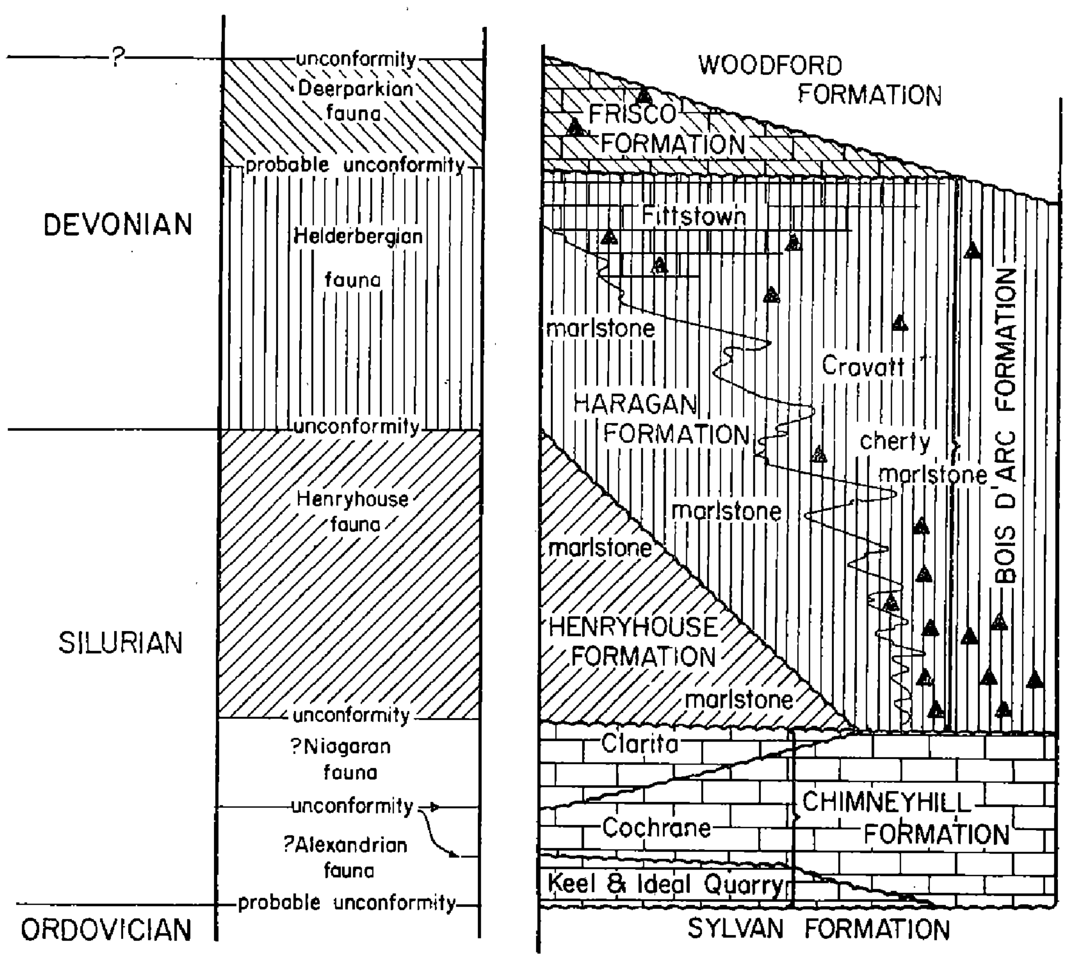

Figure 1. Diagrammatic section summarizing the stratigraphic and faunal relationships of the Hunton formations and members (from Amsden 1957).

INTRODUCTION

The Hunton group comprises a sequence of fossiliferous carbonate strata ranging from Early Silurian[1] to Early Devonian in age. These rocks crop out in the Arbuckle Mountain and Criner Hills region of south-central Oklahoma, in parts of Pontotoc, Coal, Atoka, Johnston, Murray, Carter and Love Counties (panel I). Although this group of rocks encompasses a long period of time they are thin, nowhere exceeding 450 feet in the outcrop area. The Hunton group has attracted interest among petroleum geologists as these rocks are known to carry oil in some areas. This group is also of interest to paleontologists as certain of its formations, notably the Haragan and Henryhouse, bear a prolific and well-preserved invertebrate fauna.

Acknowledgments: Two former University of Oklahoma students, Styron Douthit and William Ventress, furnished valuable information which has been incorporated into this report. Douthit made a detailed geologic map of the Hunton strata in the belt extending from just north of Bromide to Canyon Creek (sec. 16, T. 1 N, R. 7 E.); a part of this map appears as plate B, Panel II. Ventress made a biostratigraphic study of the Frisco formation, the results of this study being presented as a Master of Science thesis at the University of Oklahoma in 1958.

I wish to take this opportunity to thank personally William E. Ham, with whom I have consulted freely on various aspects of the Hunton study, and who has given generously of his time.

Previous Investigations: The strata covered in the present report were first described by Taff (1902; 1904, p. 29-31) as the Hunton limestone, the name being taken from the town of Hunton in Coal County (NW¼ sec. 8, T. 1 S., R. 8 E,; section C1 of the present report is near the old townsite; see panel I, and panel II, plate B; no trace of this town remains). In 1911 C. A. Reeds summarized the results of an extensive stratigraphic and faunal study of the Hunton, and in 1926 he made some revisions of his earlier classification. The next major study was by Ross Maxwell, who made the Hunton the subject of a Master of Science thesis at the University of Oklahoma (1931) and of a doctoral dissertation at Northwestern University (1936), but the results of this study have never been published except in abstract form (1936). In 1957 I published a paper outlining my ideas on the stratigraphic and faunal relationships within the Hunton group. This publication reviewed the stratigraphic classification of earlier workers, including terminology and type sections, and therefore no further discussion of these previous investigations will be given.

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[1] In this report Early Silurian, Middle Silurian and Late Silurian are used as time (epoch) terms corresponding to the time-rock terms (series) of Lower Silurian, Middle Silurian and Upper Silurian. I do not think such a dual terminology is necessary, but the Oklahoma Geological Survey is following the stratigraphic classification of the U.S. Geological Survey (*Suggestions to authors of the reports of the United States Geological Survey*, fifth edition, 1958, p. 90-91).

The Hunton strata are fossiliferous and some of the more prolific beds have been collected for well over 50 years. The first paper on Hunton paleontology was published by Girty in 1899, and this has been followed by a number of publications describing various biologic and stratigraphic assemblages. In 1956 I prepared a catalog listing all of the Hunton fossils that had been described and illustrated up to that time,[1] and in this publication the interested reader can find a reference to almost all of the papers published prior to 1956 on Hunton paleontology. The more recent works on Hunton fossils are Bulletin 78 of the Oklahoma Geological Survey, which describes the Haragan brachiopods with some supplementary information on Henryhouse brachiopods (Amsden 1958A, p. 1-157, 14 pls.), and Bulletin 82, which describes the Bois d'Arc brachiopods (Amsden 1958B, p. 1-95, 6 pls.).

Present Report: My study of the Hunton was started in September 1955 and has continued to the present with almost no interruption. This investigation has included both field and laboratory work. In the course of the field work most of the Hunton outcrop belts in the Arbuckle Mountain region and Criner Hills have been examined. The area investigated is shown on the map, panel I, which includes a location of all geographic features cited in the text. This part of the study has been greatly facilitated by the excellent geologic maps of the Arbuckle Mountain region by W. E. Ham (1954), and of the Criner Hills by E. A. Frederickson (1957). The field investigation involved measuring and describing stratigraphic sections, collecting fossils and lithologic specimens, along with some geologic mapping in certain selected areas (plates A, B, panel II). More than 60 detailed stratigraphic sections have been described and collected (see APPENDIX). All fossil collections and lithologic samples have been taken from these sections so that the stratigraphic position (as well as geographic location) is accurately known. This field procedure has made it possible to determine with considerable precision the stratigraphic distribution of the faunas, and to correlate these faunas with the lithologic subdivisions. The changes in interpretation from that given by previous investigators are believed to be due largely to this biostratigraphic study, although the laboratory work has also shown the need for revisions in the lithologic and fossil concepts. It should be emphasized that the present investigation deals only with the Hunton in its outcrop area. These rocks are known to have a wide distribution in the subsurface (Tarr 1955, fig. 1), but no attempt has been made to expand into the subsurface as I believe a clear understanding of surface relations is needed first.

The laboratory investigation has included a study of the fossil collections and of the lithologic specimens. Because the brachiopods are the dominant element of the megafauna, they have been most intensively investigated, but it is hoped that in the future other

[1] A few references not included in the 1959 catalog may be found in the Oklahoma Geology Notes, vol. 16, p. 138, and vol. 18, p. 14.

biologic groups can be studied in equal detail. Certain parts of the Hunton carry a prolific microfauna and a careful study of these fossils seems to offer the best opportunity for tracing Hunton stratigraphic units into the subsurface. The lithologic specimens have been studied by means of thin-sections, peels, insoluble residues, and chemical analyses.

The purpose of the present report is to summarize all of the stratigraphic and lithologic evidence which has been assembled in the course of this study. Results of the faunal studies are also discussed, although no fossil descriptions are included. My interpretation of the biostratigraphic relations is given and the report concludes with a chapter describing the inferred depositional and erosional history of the Hunton group.

Lithologic investigation: The lithologic character of the Hunton rocks has been determined in large part by laboratory examination of specimens collected from the stratigraphic sections. A number of HCl insoluble residues have been made by myself and in the Chemical Laboratory of the Oklahoma Geological Survey (see discussion in the APPENDIX—CHEMICAL ANALYSES). The data obtained from a study of these residues are of great value as they give a precise measure to the amount and character of the insoluble fraction, thus making it possible to apply a more exact terminology to the rock. Moreover, a knowledge of the insoluble clastic content, which represents material derived from outside of the basin of deposition, is of help in determining the depositional history of the rock. In addition a number of acetic acid residues were prepared, although the percentage was not calculated as these were used mainly to recover certain types of microfossils. The acetic residues from some parts of the Hunton (such as the Clarita member) yield a rich fauna of conodonts, arenaceous Foraminifera and inarticulate brachiopods.

About 260 rock specimens have been analyed for their $CaCO_3$ Geological Survey. The method used in preparing these samples is discussed in the APPENDIX, CHEMICAL ANALYSES, which also includes a complete tabulation of the results.

A great many peels (see discussion in the chapter on STRATIGRAPHIC SECTIONS—APPENDIX) and a number of thin sections have been prepared, and several of these are illustrated in the photomicrographs shown on plates X to XVI. These peels and thin sections have been used primarily to determine the texture (Pettijohn 1957, p. 13) of the Hunton limestones, with special reference to the size, shape and orientation of the clastic portion and the nature of the cementing material. This study, combined with the data from and $MgCO_3$ content in the Chemical Laboratory of the Oklahoma $CaCO_3$-$MgCO_3$ analyses and insoluble residues, makes it possible to define the rocks with some degree of precision. I have found this information to be of considerable value in the stratigraphic investigation as it permits a more accurate definition of the different Hunton units. It it also helpful in deciphering the depositional history of these strata.

Lithologic and stratigraphic terminology: The lithologic terminology used in this report generally follows that given by Pettijohn (1957). A discussion of this topic, including a description of those terms, such as marlstone, which have been used in a special manner, is given in the section on STRATIGRAPHIC SECTIONS in the APPENDIX.

The problem of facies terminology is a difficult and vexing one. Undoubtedly such terms as facies and lithofacies have been used by different authors in different ways, and in recent years a number of papers have been written attempting to clarify this nomenclature. Unfortunately much of this literature is based on hypothetical rather than actual examples, and whereas it may be useful in theory, in actual practice it is difficult to apply. Recently J. Marvin Weller (1958, p. 609-639) has commented on this, noting that "the development of an increasingly complex nomenclature designed to promote precision in thought and expression, has had the opposite effect." In fact, the entire problem has become so complicated that if it were possible I would avoid any mention of it, but unfortunately this cannot be done as there is clear evidence that certain of the Hunton stratigraphic units grade laterally into strata of quite different lithology. For example, the Haragan marlstones, Cravatt cherty calcilutites and Fittstown calcarenites represent, to a considerable extent, synchronous deposits. They thus exhibit what is commonly referred to as a facies relationship (Moore 1949, p. 32) and I have designated them as the Haragan lithofacies, Cravatt lithofacies and Fittstown lithofacies (Amsden 1958B, p. 8-9), thereby following Weller's definition of a lithofacies as a "lateral subdivision of a stratigraphic unit differentiated from other adjacent subdivisions by its lithologic characters." These correspond, I believe, to what Teichert (1958, p. 2739) has recently designated as a heteropic facies. The Haragan, Cravatt and Fittstown strata also contain slightly different fossil assemblages (Amsden 1958B, fig. 4) and I have indicated this relationship by the expression Haragan biofacies, Cravatt biofacies and Fittstown biofacies, again following Weller's definition. Teichert (1958, p. 2731-2734) has suggested that paleontologic facies would be a preferable term, pointing out, quite correctly, that there is a difference between the way in which biofacies is applied by neontologists and its usage by biostratigraphers. It would, however, appear to be perfectly clear in the present report that the concept of biofacies is based entirely upon paleontological (and stratigraphic) evidence.

Maps and stratigraphic sections: Several maps and graphic stratigraphic sections are given on the three panels in the pocket at the back of this report. Panel I is a geographic map showing the distribution of the Hunton outcrops in the Arbuckle Mountain region and Criner Hills; this gives the location of all described stratigraphic sections, and also shows the geographic features cited in the text.

Panel II consists of two geologic maps showing the distribution of Hunton units on the Lawrence Uplift and the area around old Hunton townsite. Panel III has two subcrop paleogeologic maps, one for the pre-Woodford surface and the other for the pre-Devonian (pre-Helderbergian) surface; this panel also has a series of four stratigraphic cross sections giving the distribution of the Hunton formations and members in the outcrop area.

HUNTON GROUP

The Hunton group (fig. 1) in its outcrop area consists of a sequence of marine carbonate strata which are dominantly limestone, the $MgCO_3$ content being only locally abundant enough to produce a dolomite (see below). Most of these rocks are detrital limestones (allochthonous or mechanical; Pettijohn 1957, p. 401) which range from calcilutites to calcarenites, rarely grading into calcirudites. The calcarenites are largely bioclastic limestones (discussed in the APPENDIX) which are mostly fossil debris, some beds having as much as 80 percent recognizable fossil material. Some of the calcilutites are also bioclastic rocks, although a considerable portion of the beds having this texture are marlstones (discussed in the APPENDIX) with a substantial silt-clay insoluble content. The Hunton faunas are large and varied, and belong primarily to the sessile and vagrant benthos; there is no tendency to develop reefs (Cloud 1952, p. 2126), and calcareous algae are known only from the earliest Hunton strata (Ideal Quarry member).

Hunton HCl insoluble residue: The Hunton is basically a limestone sequence, although some beds do have a relatively high insoluble content, few ranging as high as 50 percent. Figure 2 shows the average insoluble residue for each formation and member (all residues calculated on a chert-free basis). It should be emphasized that these are averages, in some cases of rather widely varying analyses; the extent to which individual analyses can vary is well illustrated in figures 4 and 5. All the data used in compiling these graphs are given in the APPENDIX (CHEMICAL ANALYSES), and are discussed at some length in the sections on *Lithology* under each formation and member.

The Chimneyhill members are bioclastic limestones having a low insoluble content; almost all of the individual analyses show less than 10 percent acid insolubles, and most of the members average 5 percent or less. The Henryhouse, Haragan and Cravatt, which are predominantly marlstones, show the highest residues and the greatest individual variation of any Hunton units; the Henryhouse has the highest average (20 percent), followed by the Haragan (16 percent) and the Cravatt (11½ percent). The upper part of the Bois d'Arc (Fittstown member) is predominantly a bioclastic calcarenite with low acid insolubles (4½ percent). The Frisco calcarenites average slightly less than 2 percent, making it one of the lowest in the Hunton group.

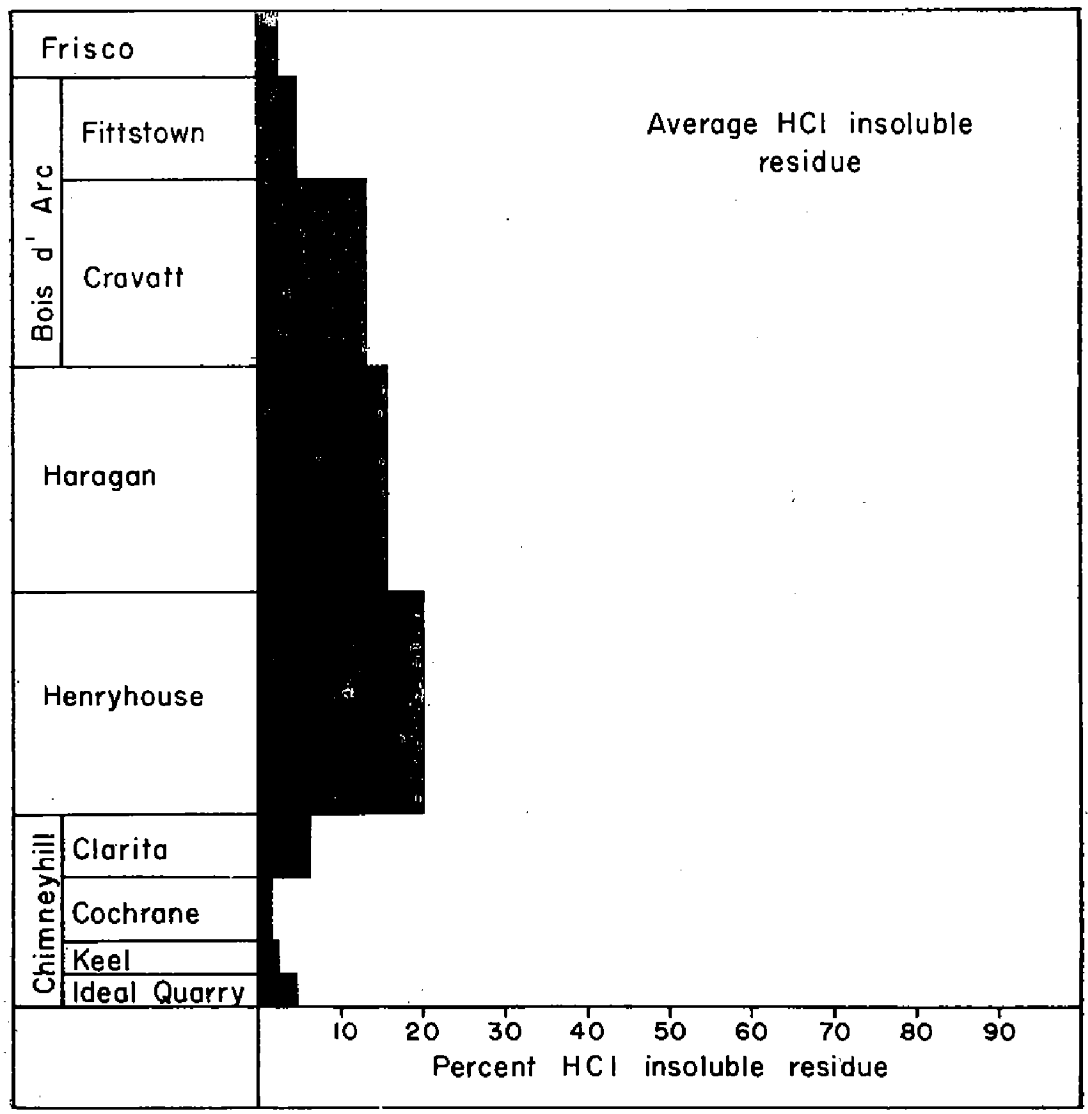


Figure 2. Diagram showing the distribution of HCl insoluble residues in the Hunton group. The percentage shown for each of the stratigraphic units is an average of the data given in the APPENDIX. A discussion of the HCl insoluble residues is given in the section on *Lithology* for each formation and member.

A considerable part of most Hunton residues is silt and clay size detritus which is clearly a primary constituent of the rock, introduced at the time of deposition. The coarser fraction of this debris is commonly clear, subangular, silt size quartz; sand size detritus is uncommon, and rounded and frosted grains are rare. In addition many residues include fragments of silicified fossils, and locally these may make up most of the sample. Traces of glauconite are found in most residues, and in certain members this is the dominant part (see below). Other minerals such as pyrite and

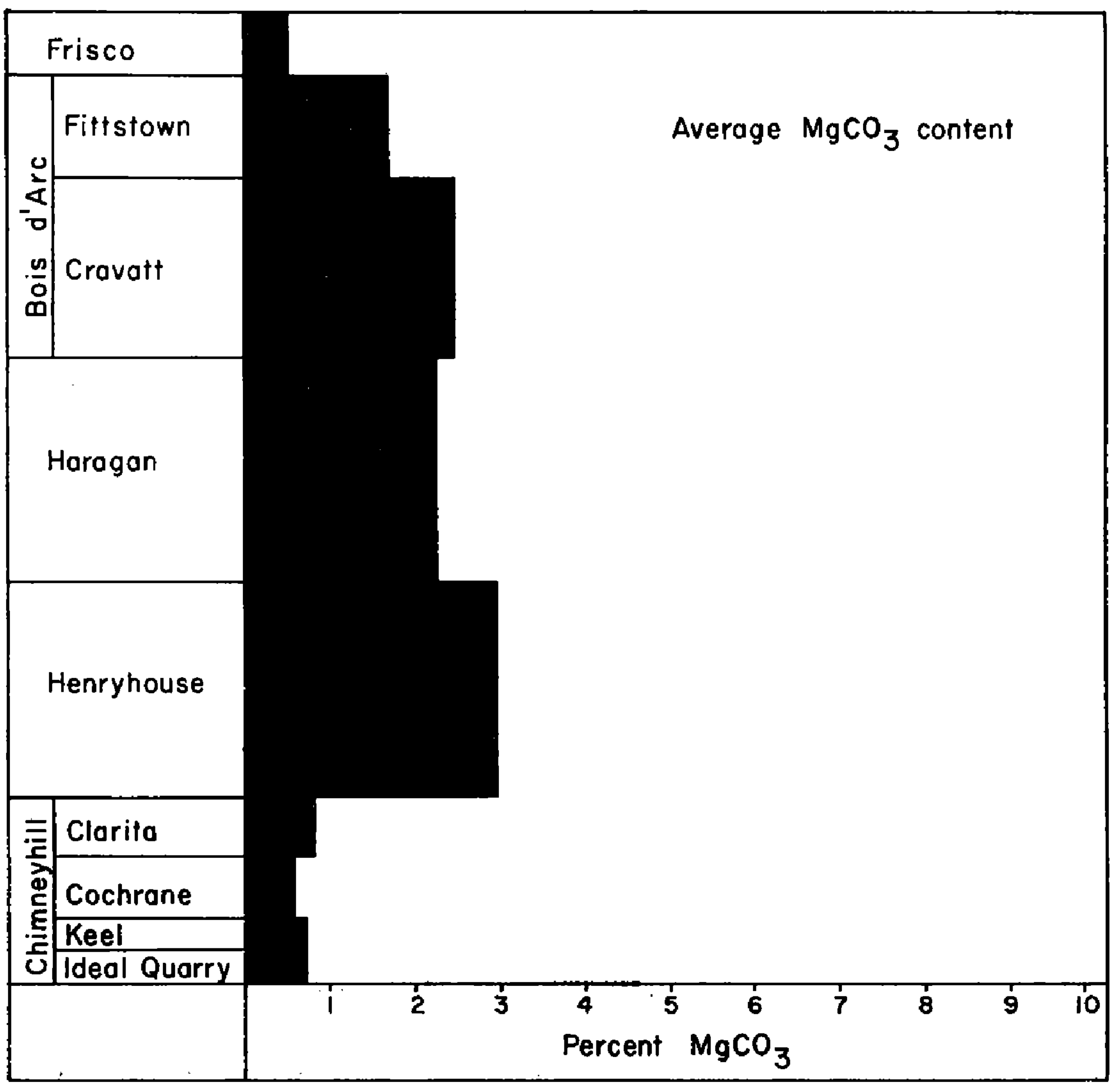


Figure 3. Diagram showing the distribution of $MgCO_3$ in the Hunton group. The percentage shown for each stratigraphic unit is an average of the da'a given in the APPENDIX. Two analyses were omitted because they differ so greatly from the others: J6-A, Ideal Quarry (15.1%) and J4-A, Keel member (36.4%). A discussion of the $MgCO_3$ content is given in the section on *Lithology* for each formation and member.

limonite may be present but generally in minor quantities (no investigation has been made of the heavy mineral suite). The character of the HCl residues is discussed further in the sections on *Lithology* which accompany each formation and member.

There is an interesting relationship between the *average* insoluble residue content and the *average* $MgCO_3$ content. A comparison of figures 2 and 3 shows that, in general, those Hunton formations with the highest acid insolubles also have the highest $MgCO_3$ content. This is discussed below in the section on *Hunton $MgCO_3$*.

Hunton $MgCO_3$: The Hunton strata have, for the most part, a low $MgCO_3$ content and only rarely do they exceed the zone of "magnesium enriched limestones" recognized by Fairbridge (1957, p. 128-129). The analyses given in the APPENDIX range from a fraction of a percent up to 36 percent, but few exceed 2 or 3 percent and most of the relatively high magnesium strata are confined to localized "hot spots"; most of the Hunton thus falls within the category of "limestone" as defined by Pettijohn (1957, p. 417). The average $MgCO_3$ content for each of the Hunton stratigraphic units is shown in figure 3; the Henryhouse had the highest average (3.2 percent) with the others falling around 2 percent or less. Frequency diagrams showing the range of $MgCO_3$ are given in the sections on *Lithology* under each formation and member.

Several authors have noted a relationship between insoluble residues and $MgCO_3$ content (Bisque and Lemish 1959, p. 73-76), and the present study shows an apparent correlation between the average $MgCO_3$ content and the average HCl insoluble residue (compare figures 2 and 3). It should, however, be emphasized that in so far as the Hunton rocks are concerned this applies only to the average content, whereas the analyses of individual rock specimens may depart considerably from this pattern. This is well illustrated in figure 4 where the individual analyses from section P8 are plotted separately. The $CaCO_3$ analyses from this section show an inverse relationship to the acid insolubles, but this is to be expected as the $CaCO_3$ is calculated from, and is the dominant part of, the acid soluble portion of the rock; the $MgCO_3$ on the other hand, does not exhibit much in common with either the $CaCO_3$ content or the HCl residues. A similar graph for section Cal (2) is shown in figure 5; this shows a closer relationship in that there is a general tendency for those rocks with a relatively high insoluble content to have a relatively high $MgCO_3$ content, but some of the analyses show a marked departure from this. This relationship is also brought out by a study of the analyses listed in the APPENDIX. The $MgCO_3$ "hot-spots" are not confined to rocks with either high or low insolubles; for example the Keel member at section J4 with

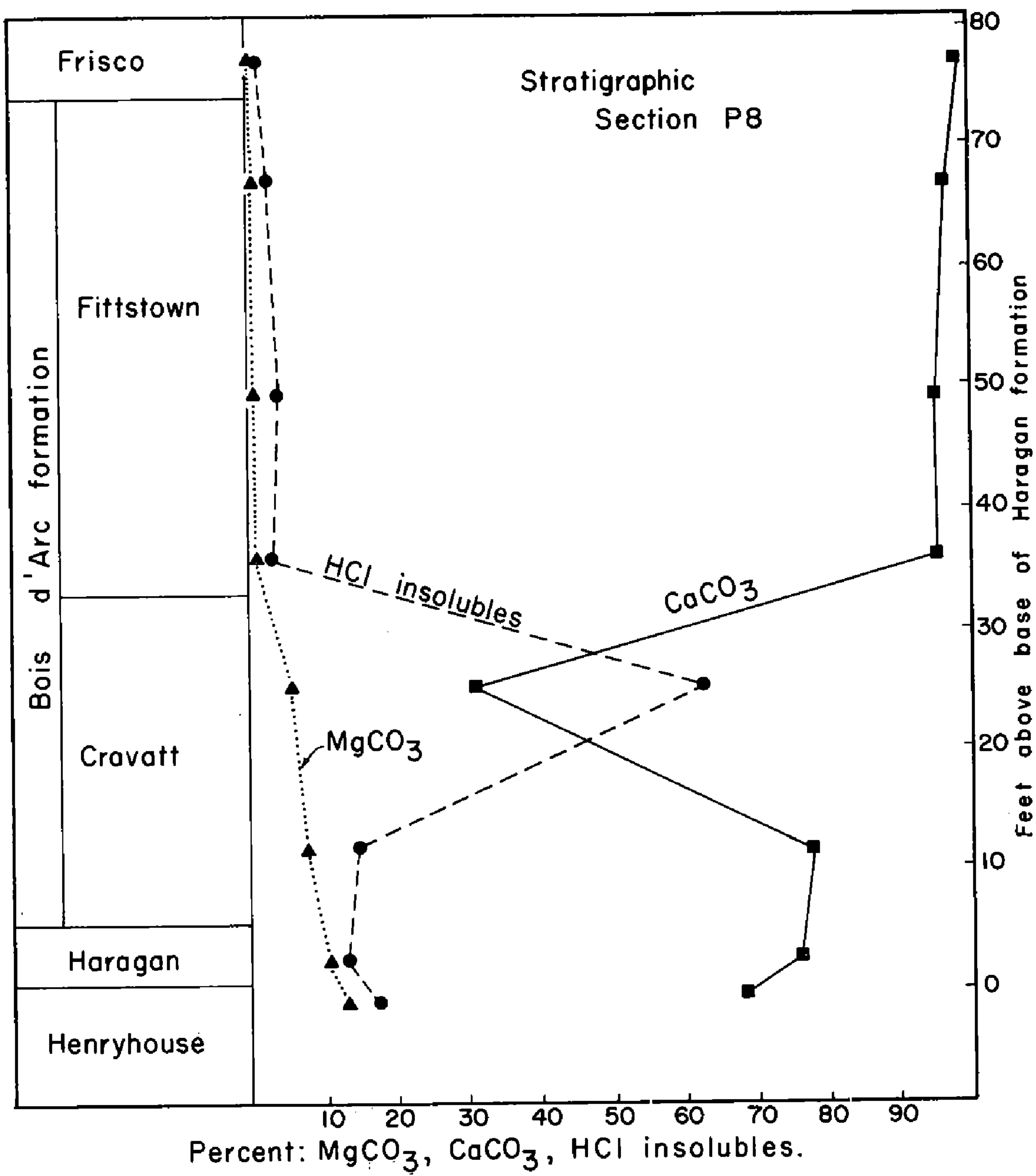


Figure 4. Diagram showing the range of HCl insoluble residues, $MgCO_3$ and $CaCO_3$ in the rock samples collected from stratigraphic section P8. Each point represents the analysis of a single rock specimen. The data used in compiling this chart are given in the APPENDIX.

only 2.3 percent insoluble residues has 36 percent $MgCO_3$, whereas the Henryhouse at Ca4 has 36 percent insolubles accompanied by 24 percent $MgCO_3$. There does, however, appear to be some similarity between the distribution of the average insolubles and the average $MgCO_3$ content in the different Hunton formations and members. This similarity may be entirely fortuitous although there is enough correlation to suggest a genetic relationship (see below).

The genesis of $MgCO_3$ generally presents a problem and the Hunton dolomite is certainly no exception. The question most commonly raised concerns the time at which the magnesium reached its present position (Pettijohn 1957, p. 424); that is, is it "primary" in the sense that it was introduced into the sediment at the

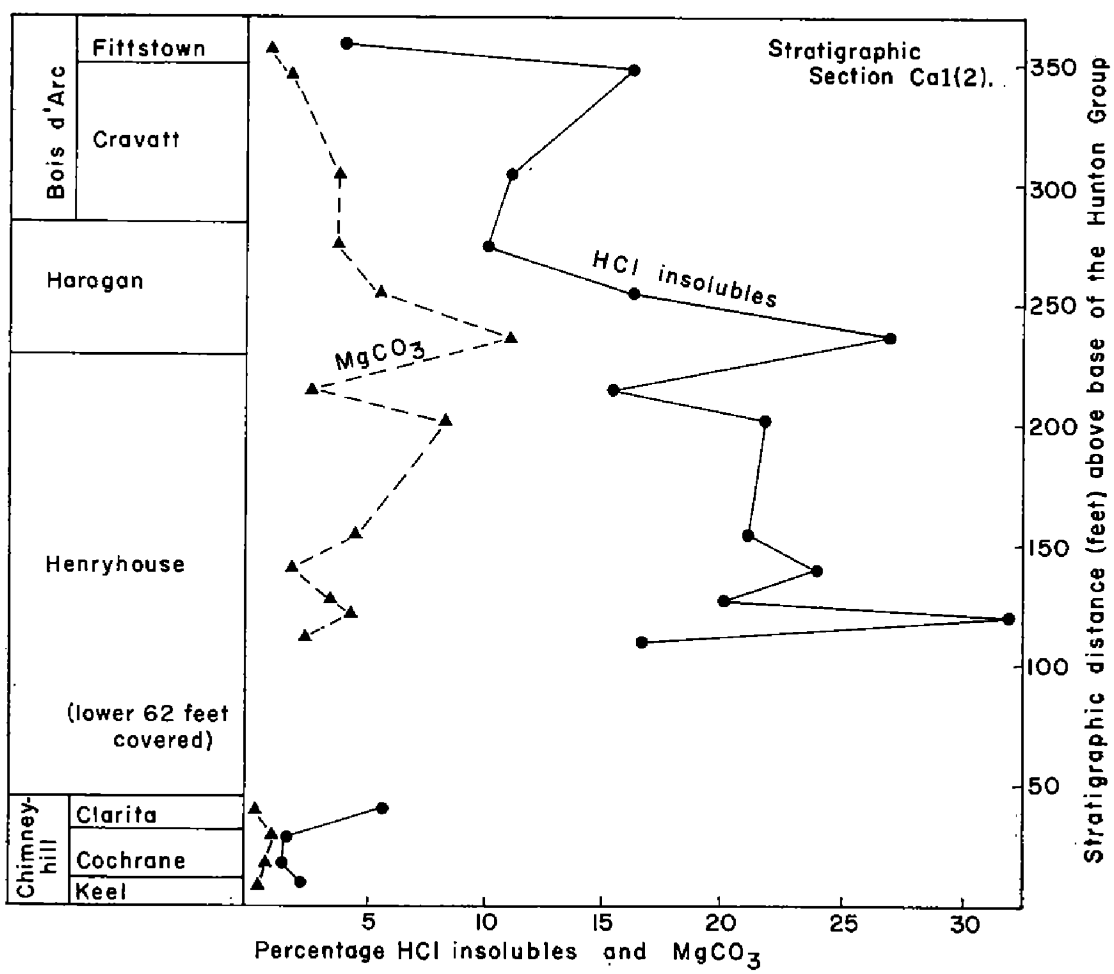


Figure 5. Diagram showing the range of HCl insoluble residues and $MgCO_3$ in the rock samples collected from stratigraphic section Cal (2). Each point represents the analysis of a single rock specimen. The data used in compiling this chart are given in the APPENDIX.

time of deposition (including a penecontemporaneous replacement), or is it "secondary" in the sense that it was introduced at some later date following withdrawal of the sea ("continental" of Fairbridge 1957, p. 131). I do not have any conclusive data on this time factor in the Hunton, but a study of the stratigraphic distribution of those beds showing a relatively high concentration of $MgCO_3$ furnishes some suggestive evidence. Figure 6 shows

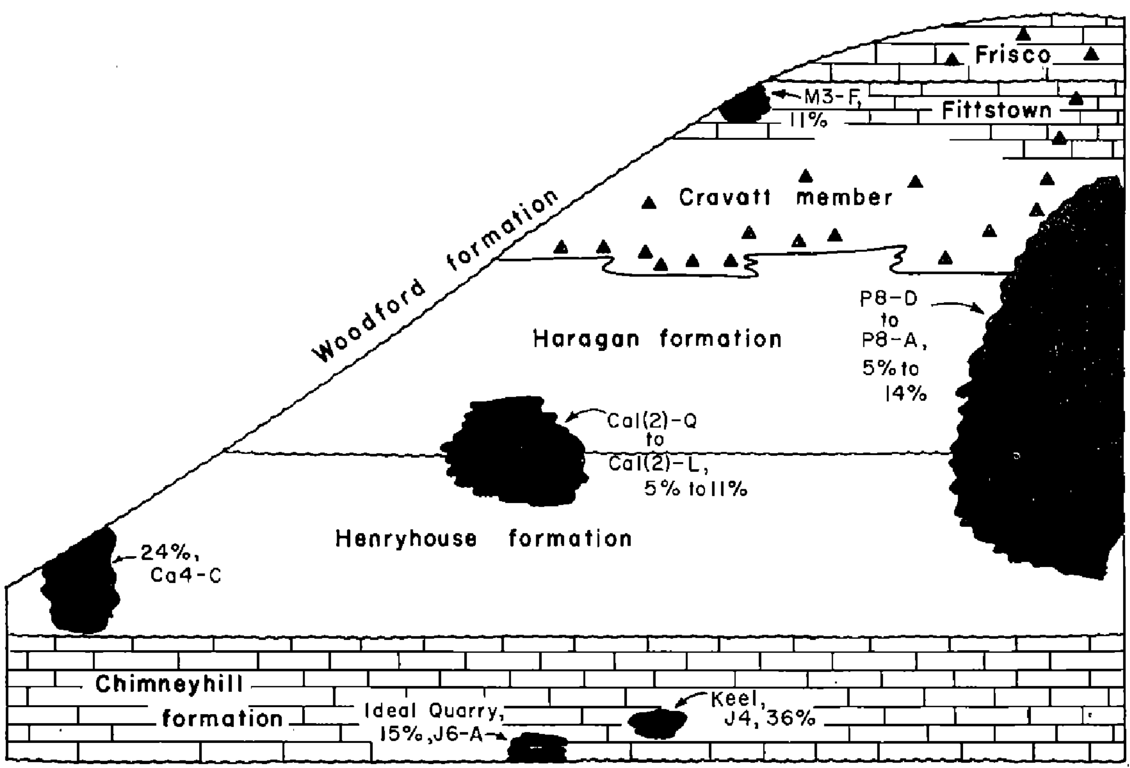


Figure 6. Diagrammatic section showing the stratigraphic distribution of the Hunton rocks having a relatively high $MgCO_3$ content (rocks with 5 percent or more $MgCO_3$ shown in black). This drawing is schematic and the size of the do'omite bodies is not to scale, but it is based on chemical anaylses of rock specimens collected from described stratigraphic sections (see APPENDIX).

the stratigraphic position of most of the Hunton rocks having 5 percent or more $MgCO_3$; this drawing is schematic in that the size and geographic position are not to scale, but it is based on chemical analyses of rock specimens whose stratigraphic position was carefully determined in the field (APPENDIX). The strong concentration of $MgCO_3$ in very localized areas (for example, 36 percent in the Keel at J4), plus its transgressive character (for example, the relatively high dolomite content of the Henryhouse, Haragan and lower part of the Cravatt at P8) points to a "secondary" dolomite introduced at some time after the end of Hunton deposition. The apparent correlation between the Hunton HCl and $MgCO_3$ content (averages only; see figs. 2 and 3) might be explained under an hypothesis of "secondary" origin by assuming that the argillaceous and silty calcilutites of the Hunton were more susceptible to dolomitization. Even if one assumes that the position of the dolomite-rich rocks is "secondary", it does not necessarily follow that all of the Hunton magnesium had such an origin. It seems reasonable to suppose that small quantities were laid down with the sediments and possibly this represents the source for the concentration which took place later. This question is discussed further under the HENRYHOUSE FORMATION.

Hunton chert: Chert is present in parts of the Hunton group and is locally abundant in certain formations and members. Most of this chert is a vitreous type in the form of small lenses and irregular nodules, but some porous-weathering, spongy chert is found in the Bois d'Arc formation (see discussion under STRATIGRAPHIC SECTIONS, APPENDIX). There is a marked stratigraphic control to the distribution of Hunton cherts; it is present in the Ideal Quarry, Keel and Cochrane members; absent in the Clarita member and Henryhouse formation; again present in the Bois d'Arc formation (rarely in the Haragan, which is a facies of the Bois d'Arc), and the Frisco formation. This distribution suggests that the Hunton chert is a primary part of the rock introduced at the time of deposition, either deposited with the sediments or as a penecontemporaneous replacement. This interpretation does not, of course, preclude the possibility that some reorganization and redistribution took place after deposition (see FRISCO FORMATION, *Lithology*).

Hunton glauconite: Traces of glauconite are present in many parts of the Hunton group. It is abundant in most beds of the Cochrane member and locally it is fairly common in parts of the Bois d'Arc and Frisco formations; in the other Hunton units it is generally present only in small amounts. For a further discussion of glauconite see the section on *Lithology* for the COCHRANE MEMBER, and the section on STRATIGRAPHIC SECTIONS in the APPENDIX.

In those areas where the Hunton stratigraphic sequence is reasonably complete, the typical sequence consists of a basal series of calcilutites and calcarenites (Chimneyhill formation), overlain by marlstones (Henryhouse and Haragan formations), followed by cherty marlstones (lower part of the Bois d'Arc formation) and calcarenites (upper part of the Bois d'Arc formation and, locally, the Frisco formation). This lithologic sequence commonly produces a distinctive profile; the Chimneyhill limestones and Bois d'Arc cherty marlstones and limestones from two ridges separated by a saddle cut in the marlstones. As a rule the Bois d'Arc ridge is more prominent than is that of the Chimneyhill (Amsden 1957, p. 5-6).

The Hunton group includes a quite incomplete representation of Silurian and early Devonian strata which unconformably underlie the Woodford shale and unconformably overlie the Sylvan shale. Five formations have been recognized, some of these being further subdivided into members as follows:

Frisco formation	Devonian
unconformity	
Bois d'Arc formation	
Fittstown member	
Cravatt member	
Haragan formation	
unconformity	
Henryhouse formation	Silurian
unconformity	
Chimneyhill formation	
Clarita member	
unconformity	
Cochrane member	
unconformity	
Keel member	
Ideal Quarry member	

The general stratigraphic relationships of the Hunton formations and members are shown in figure 1.

Thickness and distribution: The Hunton group has an extensive surface distribution in the Arbuckle Mountain region and in the Criner Hills (panel I). It is present throughout this region except for the area extending from around Oil Creek southeast to Turkey Creek (T. 3-4 S., R. 3-4 E.) where the Woodford rests on pre-Hunton strata (see discussion in the chapters on the WOODFORD? BROWN CARBONATE and the TURKEY CREEK INLIER).

The thickness of the Hunton varies widely in the outcrop area, as is shown on the isopach map, figure 7. The Hunton

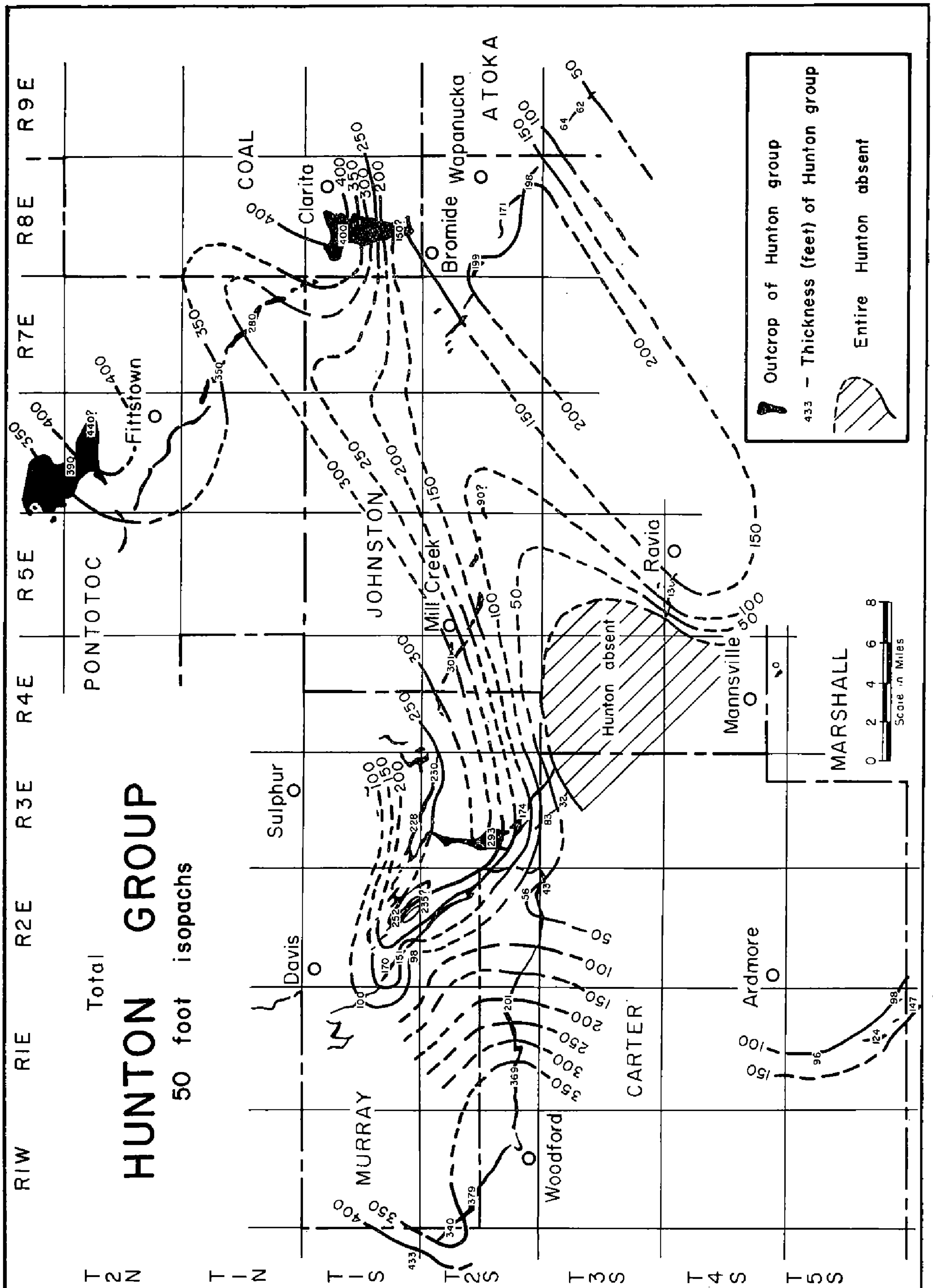


Figure 7. Isopach map of the Hunton group

probably attains its maximum on the Lawrence uplift (T. 2 N., R. 6 E.) where it has a thickness of approximately 440 feet (this is a composite section based on the thickness obtained from sections P1, P3, P11). There is a complete Hunton section in this area with all of the formations and members present including 60 feet of Frisco limestone at the top. The Hunton maintains a thickness of 300 to 400 feet in the belt extending northeast to old Hunton townsite (T. 1 S., R. 8 E.), but south of the type area it thins rapidly. The group is about 300 feet thick in the vicinity of Mill Creek town, thinning to the south and west. In the western areas of outcrop the Hunton is again thick, and in the westernmost section which I measured (sections Ca9, Ca10; T. 1 S., R. 2 W.) it is 435 feet. This thickening of the Hunton to the north and west apparently marks a well-developed regional trend, because Tarr (1955, fig. 1) and Huffman (1959, fig. 6) show the Hunton continuing to thicken in the subsurface, finally reaching a maximum of about 1500 feet in Washita and Caddo Counties. The Hunton in the Criner Hills ranges from about 100 to 150 feet thick.

The variation in thickness of the Hunton group shown on figure 7 is not a simple relation produced by one or two factors. In any particular area the thickness of the Hunton group depends upon the amount of original deposition acted on by subsequent periods of erosion. The unconformity at the base of the Woodford is the best known, but at five other periods during Hunton time erosion occurred. These are: pre-Frisco; pre-Helderbergian (Haragan and Bois d'Arc); pre-Henryhouse; pre-Clarita; pre-Cochrane. Little is known about the pre-Frisco unconformity as these strata have a limited outcrop area, thus making it difficult to separate the effects of this unconformity from that of the Hunton-Woodford. All of the other erosional intervals can, however, be demonstrated to have removed appreciable quantities of rock. These will be discussed in detail later, but the sections in panel III, plate C will show at a glance the major effects of these different periods of erosion. The pre-Woodford and pre-Lower Devonian subcrop maps on Panel III will also give some idea of the amount of strata removed during these two periods of erosion. The Hunton isopachous map will be more understandable if viewed in connection with these subcrop maps and sections.

The thickness and distribution of the Hunton group within the outcrop area does not appear to have any relation to the major structural trends found in the Arbuckle Mountain region. These structures are well shown on the Arbuckle Geologic Map by Ham (1954), and are summarized in the small inset map near the top of the sheet. I have plotted these structural trends on a Hunton isopachous map and can find no clear relationship. Furthermore, none of the other isopachous maps given in the present report shows any major axes of thinning or thickening which correspond with the major axes of folding or faulting. The pre-Woodford and pre-Lower Devonian paleogeologic maps do not show much in common with the present day geologic map; nor do they show much resemblance with one another (see discussion under *Unconformities,* SILURIAN STRATA; DEVONIAN STRATA).

HUNTON SILURIAN STRATA

The Silurian part of the Hunton is referred to two formations, Henryhouse and Chimneyhill, the latter further subdivided into four members, which are, in descending order: Clarita, Cochrane, Keel, and Ideal Quarry (fig. 1). The Henryhouse is early Late Silurian (early Ludlovian) (Amsden 1958, p. 15, 147), the Clarita member of the Chimneyhill formation is believed to be Middle Silurian and the Cochrane, Keel and Ideal Quarry members Early Silurian.

Thickness and distribution of Hunton Silurian strata: Silurian strata are widely distributed in the Hunton outcrop area as is shown in plate C of panel III, and in the isopach map, figure 8. On the isopach map those areas in which the Silurian beds are directly overlain by Woodford shale are stippled, whereas in all other places these rocks are overlain by Lower Devonian (Helderbergian); only in the regions indicated by stippling has the Silurian been partially truncated by pre-Woodford erosion whereas in all other areas this unconformity does not affect the

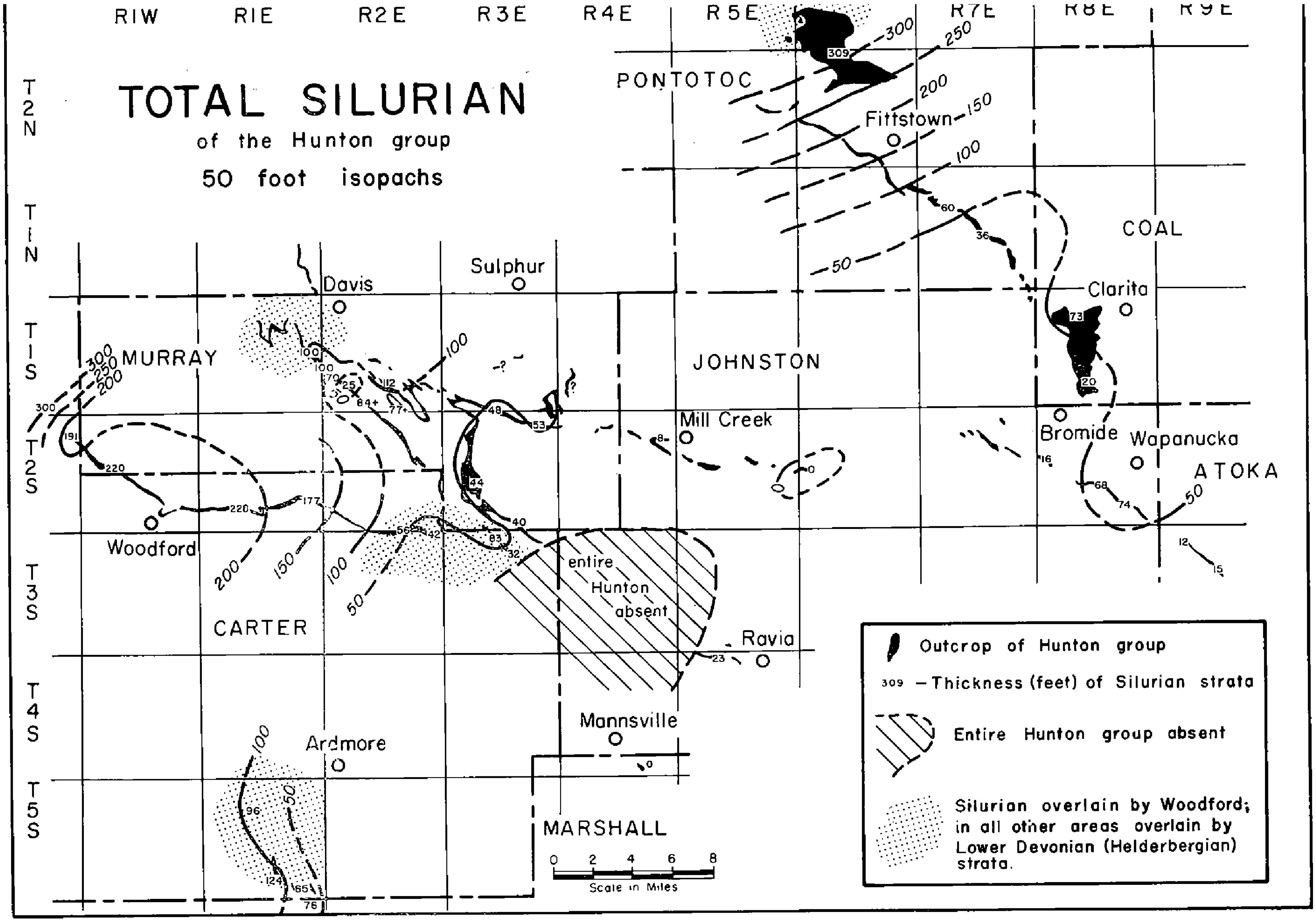


Figure 8. Isopach map of the Silurian strata in the Hunton group.

thickness. Silurian rocks are absent in the Oil Creek area (T. 3 S., R. 4 E.), where all of the Hunton is missing, and also appear to be missing in a small area east of Mill Creek town (T. 2 S., R. 5-6 E.). In this outcrop belt, which is a little over a mile long, I could find no trace of Chimneyhill or Henryhouse (panel III, plate C), and the Cravatt member of the Bois d'Arc must rest directly upon Sylvan shale (see description of section J9, APPENDIX). The maximum Silurian thickness is on the Lawrence unlift (Tps. 2-3 N., R. 6 E.) and in the outcrop belt northwest of Woodford (T. 1 S., R. 2 W.). In both places the Henryhouse strata make up most of the Hunton group (fig. 27), but the Chimneyhill formation in these areas is also near its maximum thickness (fig. 9). The Silurian strata are at least partially truncated by pre-Woodford erosion in the northern part of the Lawrence uplift, but the thickness in the western areas is unaffected by this unconformity. Tarr (1955, fig. 1) and Huffman (1959, fig. 6) show the Hunton in the subsurface reaching its maximum thickness in Washita and Caddo Counties, north and west of the Murray County outcrops, and it is interesting to speculate on the possibility that a considerable part of this is due to a thickening of the Silurian part of the Hunton.

Unconformities: Silurian rocks are separated from the Helderbergian strata by an unconformity of such magnitude that the Haragan-Bois d'Arc beds may rest on the Henryhouse, or on any of the different Chimneyhill members, locally coming to rest on the Sylvan shale. This unconformity is readily seen on the stratigraphic sections given in plate C of panel III as the Silurian-Devonian boundary was used as the datum plane. A pre-Helderbergian paleogeologic map appears on plate A of panel III, the area of maximum truncation as shown being in the region between Mill Creek and Bromide where the Devonian generally rests on Cochrane. This map indicates a considerable lapse of time between the deposition of the youngest Silurian (Henryhouse formation) and the deposition of the oldest Devonian (Haragan formation), an interval of sufficient duration to allow for the rather widespread removal of Silurian rocks. The evidence from this map and the sections, plate C, panel III) serves to further reinforce the faunal evidence of a considerable time interval between the end of Henryhouse deposition and the beginning of Haragan deposition (Amsden 1957, p. 30-31; 1958A, p. 15-17). The effect of this post-Silurian unconformity is considerable when viewed in terms of its effect on the distribution of stratigraphic units (plate C, panel III; also discussion under DEVONIAN), but it should be kept in mind that the amount of rock removed is not so impressive if the geographic size of the area is taken into consideration. Almost 300 feet of Silurian strata are removed between the Lawrence uplift and Coal Creek, but the distance is about 10 miles so that the "rate" of truncation is about 30 feet per mile. Undoubtedly some crustal movement occurred between the deposition of the Henryhouse and the Haragan, but this must have been largely confined to a slight warping rather than any folding. A somewhat different outcrop pattern is shown on the pre-Woodford subcrop map, which indicates that the deepest post-Hunton erosion was in the area of eastern Carter and southwestern Johnston Counties, extending in a more or less northwest-southeast direction (panel III, plate A).

There are three unconformities within the Silurian sequence: between the Henryhouse and the Clarita, between the Clarita and the Cochrane, and between the Cochrane and the Keel. The effect of these unconformities is to produce a complicated stratigraphic relationship (plate C, panel III), and the variation in thickness shown on the isopach map is the result not only of post-Silurian erosion, but also of truncation on the unconformities within the Silurian sequence. This is discussed in more detail under the different formations and members.

CHIMNEYHILL FORMATION

The Chimneyhill formation was named by Reeds for exposures on Chimneyhill Creek, which appears on most maps as the South Fork of Jackfork Creek (see Amsden 1957, p. 7 for a discussion of the type locality). This formation comprises a thin sequence of strata ranging from Early to Middle Silurian in age. It is underlain by the Sylvan shale (Late Ordovician) and generally overlain by the Henryhouse (Late Silurian), although in some areas the post-Silurian unconformity brings it into contact with the

Devonian (panel III pl. C). The Chimneyhill consists of a rather complicated sequence of oolitic and bioclastic limestones which are divided into several members separated from one another by unconformities as follows:

Clarita member
unconformity
Cochrane member
unconformity
Keel member
Ideal Quarry member

Although these members represent a considerable period of time, including two periods of uplift and erosion, they have certain lithologic characters in common which make it convenient to combine them in a common formation (Amsden 1957, p. 8). They are mostly detrital limestones with a relatively low silt-clay content. In rare instances the HCl insoluble residues may be as high as 10 or 11 percent, but the great majority range from around 5 percent to less than 1 percent. The fossil content is high and much of the rock is bioclastic calcilutite or calcarenite. Even the oolitic limestones may locally include a considerable percentage of fossil debris. These rocks generally have a low dolomite content, the $MgCO_3$ content being almost everywhere less than 2 percent.

Chimneyhill strata generally make good outcrops. They are more resistant to erosion than either the Sylvan shale or the Henryhouse marlstone and in many areas form a low topographic ridge. Chimneyhill rocks are easily distinguished lithologically from the Sylvan shale (pl. I, figs. 1, 2). In some areas the upper few feet of the Clarita member carries a substantial amount of silt and clay so that it resembles the Henryhouse marlstone (see discussion under CLARITA MEMBER), but in all such areas where I have studied this contact the thickness of strata in question is small, and, excluding the few feet of questionable strata, the Chimneyhill and Henryhouse are easily separated on the basis of lithology.

The Chimneyhill limestone is known to carry bodies of manganiferous carbonates in two areas. One such deposit is present in a small area north of Bromide (T. 1 S., R. 8 E.), and the other in an area to the west of Viola (T. 2 S., R. 7 E.). These manganese deposits are described at some length in a paper by Ham and Oakes (1944, p. 412-443).

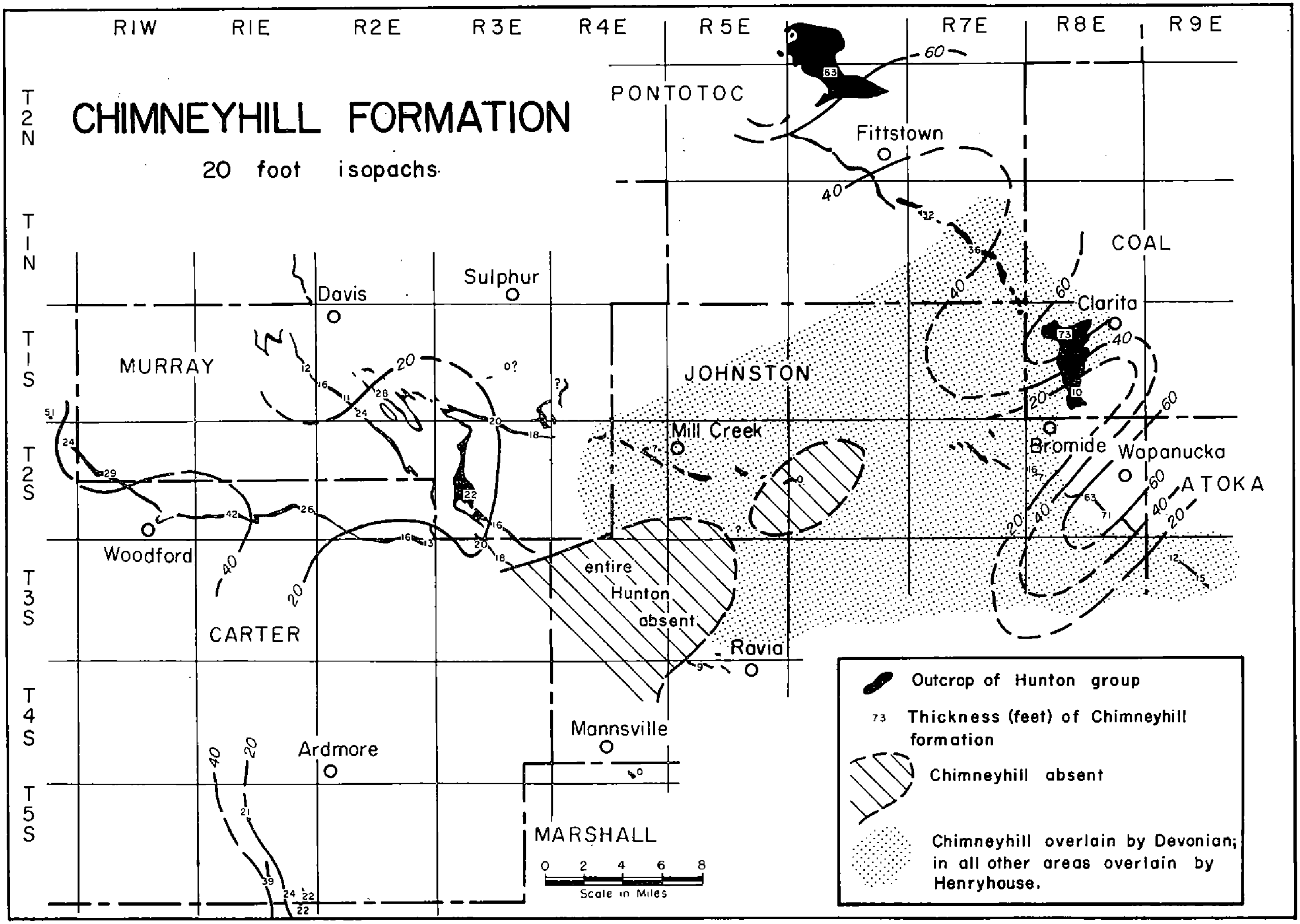


Figure 9. Isopach map of the Chimneyhill formation.

Chimneyhill strata are exposed over a wide area in the Arbuckle Mountain and Criner Hills regions (fig. 9). These rocks are present in all areas where the Hunton crops out with the exception of a small area east of Mill Creek town (T. 2 S., R. 5-6 E.) where the Bois d'Arc appears to rest directly upon the Sylvan (see section J9, APPENDIX.) Throughout much of its outcrop area the Chimneyhill formation is less than 40 feet thick, and not uncommonly less than 20 feet thick. The maximum thickness which I have measured is 73 feet in the vicinity of old Hunton townsite (section C1). It is 63 feet on the Lawrence uplift (section P1) and 51 feet in the westermost outcrop near Pooleville (section Ca 10). A part of this thickness variation is the result of the post-Chimneyhill unconformities, but some is due to truncation on the unconformities within the formation.

IDEAL QUARRY MEMBER

The Ideal Quarry member was named for exposures in the Lawrence quarry of the Ideal Cement Company, sec. 36, T. 3 N., R. 5 E. For a discussion of the nomenclatorial history of this member see Amsden 1957 (p. 9, fig. 2).

Lithology: The Ideal Quarry member is a brown-weathering, fossiliferous calcarenite which locally carries small nodules of chert. It is almost invariably a light-brown to yellowish-brown, but in a few places it grades into an olive-gray (Amsden 1957, p 9.) . This rock is difficult to study in an outcrop or a hand specimen due to its dark color and dense texture; moreover, it does not yield satisfactory paralodion peels so the details of its lithology can only be determined by means of thin sections. I had seven thin sections prepared of specimens from localities C1, Ca2, Ca3, Ca11, M12A, P1, and these give a fairly good idea of its lithologic character.

This rock is highly fossiliferous limestone with most thin sections showing over 50 percent fossil material. Various organisms such as brachiopods and snails are represented, but the most common fossils are the plates of pelmatozoans. The fossils are generally set in matrix of clay to silt size carbonate and insoluble debris having a brown color, but in places they are largely or entirely embedded in clear, crystalline calcite (pl. X, fig. 2, 3; see discussion under KEEL MEMBER, *Lithology*). One of the interesting and significant (from the point of view of its genesis) features of this rock is the fact that many of the fossils are coated with thin, concentric layers of calcareous material. These layers, commonly crinkled, produce bodies that are irregular in shape, although the larger ones tend to be subspherical. These structures, several of which are illustrated on plate X, figures 1-3, resemble the algal oolites and pisolites described by Pettijohn (1957, p. 22, pl. 26), and would seem to be reasonably interpreted as the result of algal action. In a hand specimen they resemble the Keel oolites, but their structure (and probably their origin) is quite different (see discussion under KEEL MEMBER).

The HCl insoluble residue content is commonly low, ranging from 1 to 4 percent, as is shown in figure 10. One specimen from section Ca2-A yielded a residue of 10.1 percent, which is almost twice as high as that of any other sample tested. The

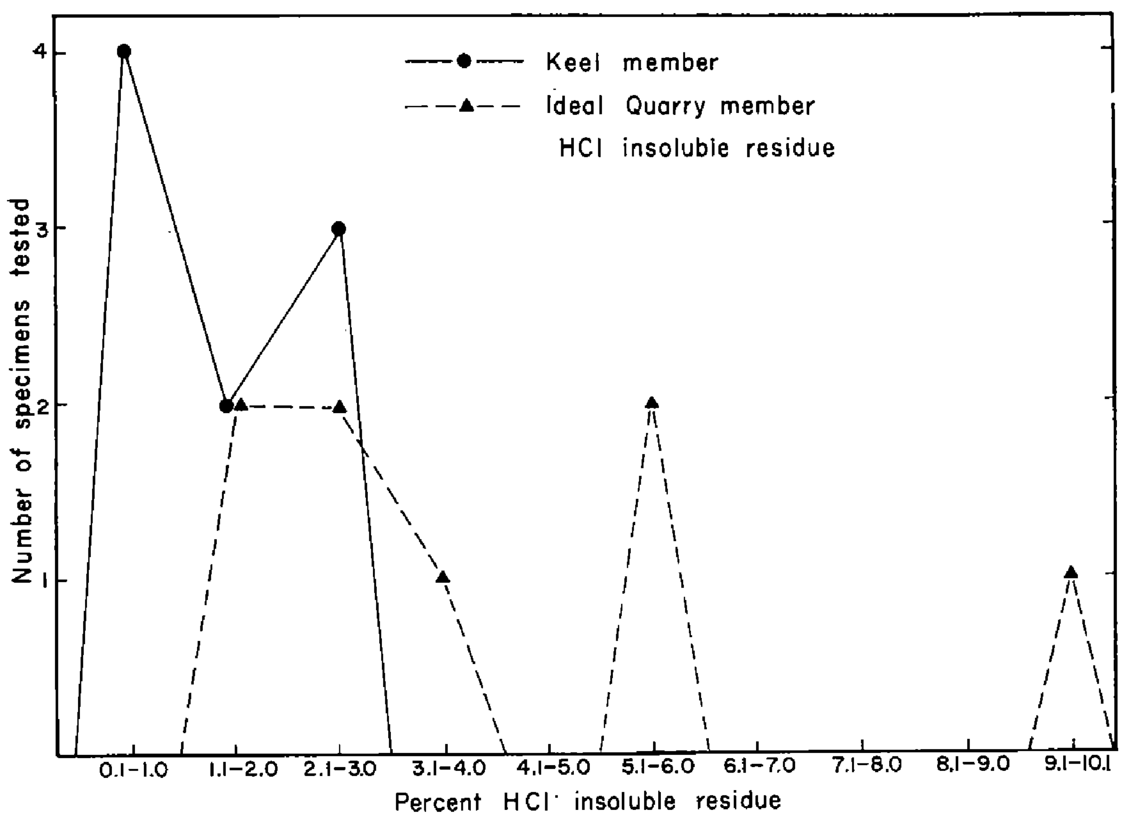


Figure 10. Frequency diagram showing the distribution of HCl insoluble residues in the Keel and Ideal Quarry members. The data for this are given in the APPENDIX.

residues generally show much brown material, presumably limonite, and also some glauconite. Fragments of silicified macrofossils are common, but no arenaceous Foraminifera have been observed. Detrital grains are uncommon.

The Ideal Quarry member has, for the most part, a low $MgCO_3$ content, as shown in figure 11; of six specimens tested, five had less than 2 percent. For further information see the APPENDIX.

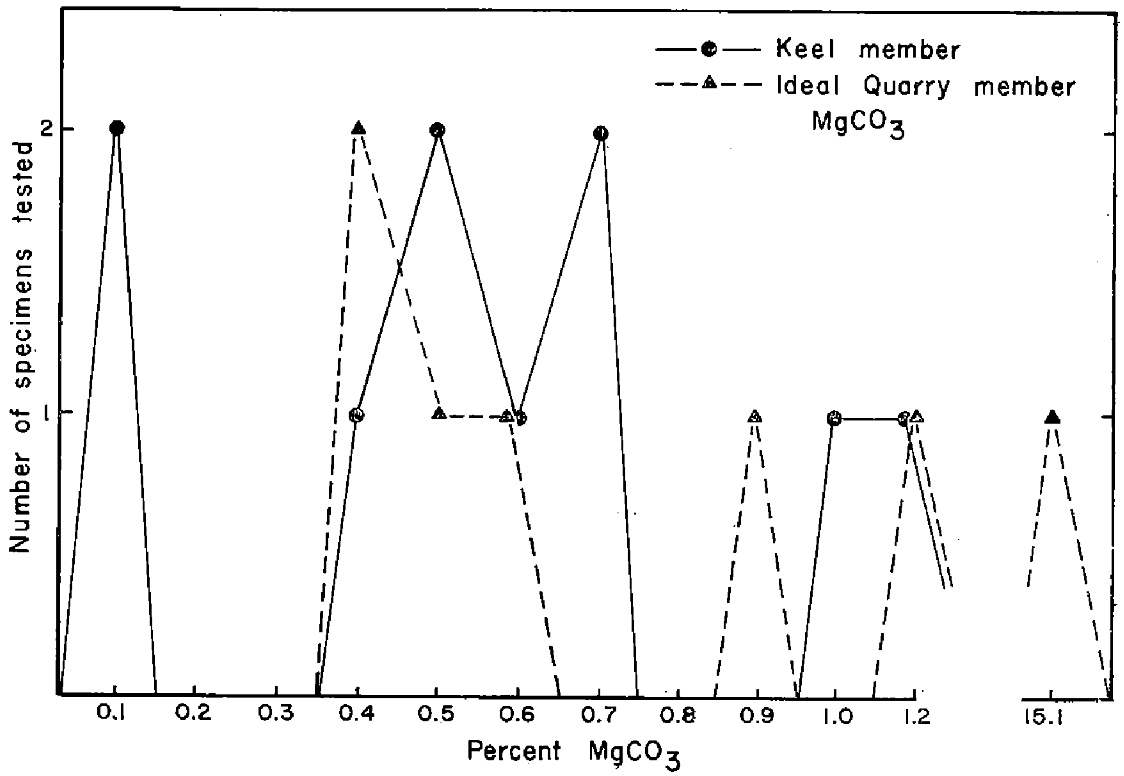


Figure 11. Frequency diagram showing the distribution of $MgCO_3$ in the Keel and Ideal Quarry members of the Chimneyhill formation. One Keel analysis of 36.3 percent is omitted. The data for this are given in the APPENDIX.

Environment of deposition: See under KEEL MEMBER, *Keel-Ideal Quarry contact;* also chapter on GEOLOGIC HISTORY.

Sylvan-Ideal Quarry contact: I have little evidence pertaining to the relationship of the Ideal Quarry to the underlying Ordovician strata. The Sylvan shale disintegrates easily, and as it rarely crops out the base of the Chimneyhill is generally covered. The only good exposure of the Ideal Quarry-Sylvan boundary which I have seen is at Lawrence where the Sylvan is being quar-

Figure 1. Chimneyhill limestone resting on Sylvan shale; Lawrence Quarry of the Ideal Portland Cement Company, SE¼ sec. 36, T. 3 N., R. 5 E. Arrow points to Chimneyhill-Sylvan contact.

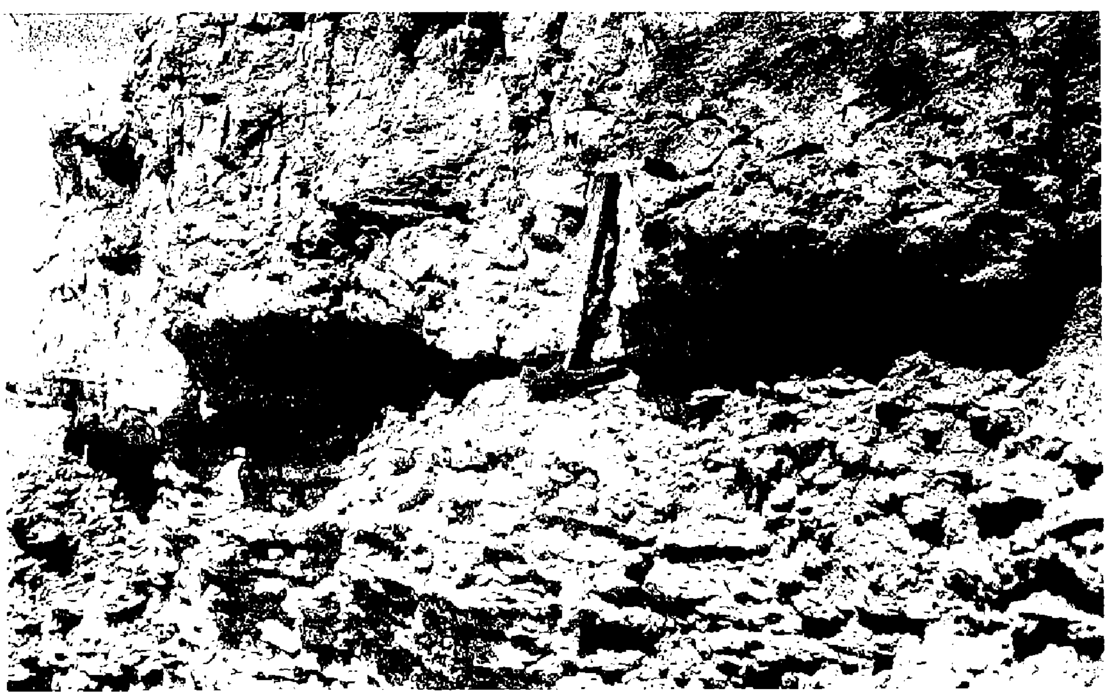


Figure 2. Hammer head rests on the Chimneyhill-Sylvan contact. The basal foot of the Chimneyhill represents the Ideal Quarry member, overlain by the Keel oolite. This picture is a close-up view taken near the arrow in figure 1.

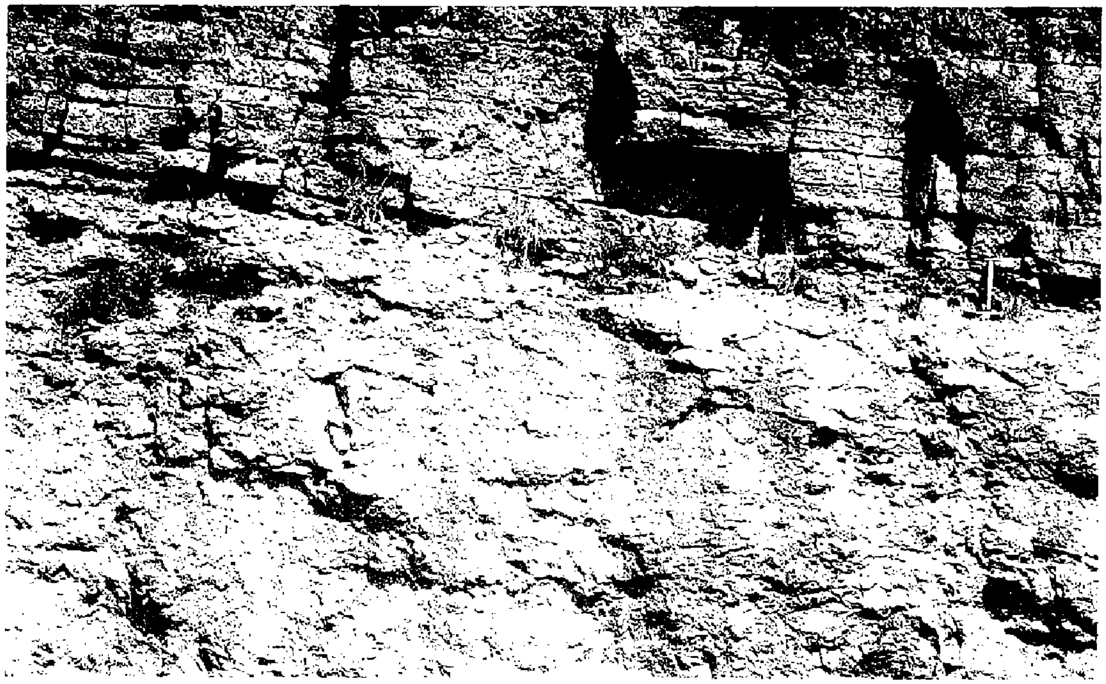


Figure 1. Clarita and Cochrane members of the Chimneyhill formation. Hammer head rests on the contact. Small quarry, NE¼ SE¼ sec. 30, T. 3 N., R. 6 E., Pontotoc County.

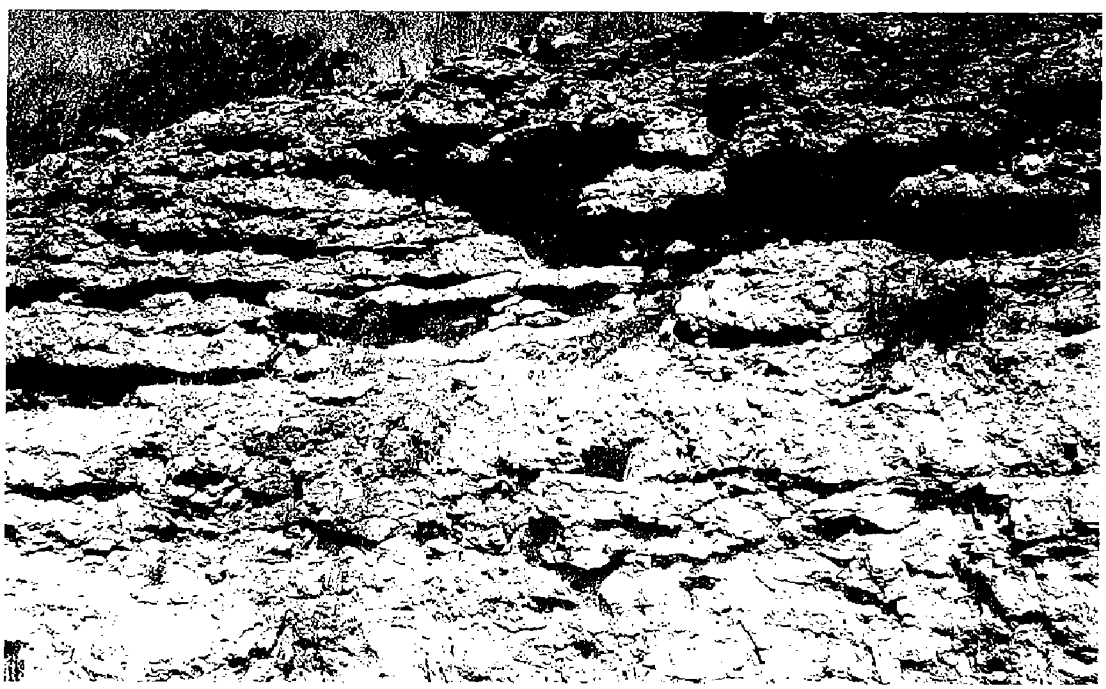


Figure 2. Cochrane member of the Chimneyhill formation; the note book shown in the center of the picture is 7½ inches long. This view was taken in the same quarry as figure 1.

ried so that the contact is exposed for some distance; a distant and close-up view of this contact is shown in plate I, figures 1, 2. The exposures at Lawrence suggest an erosional unconformity, but the degree of Sylvan truncation, if any, has not been investigated by me.

Ideal Quarry-Keel contact: The Ideal Quarry appears to be closely related to the Keel member and has generally been treated as the basal part of the Keel with a more or less distinct lithology (Reeds 1911, p. 259; Maxwell 1936; Amsden 1957, p. 10). Lithologically, the typical Ideal Quarry can be distinguished from the Keel at most outcrops by its earthy-brown color, coarse texture and absence (or scarcity) of oolites. The boundary between these two members nowhere appears to be sharply defined, and in the field the Ideal Quarry gives every evidence of grading into the Keel through transitional beds. Moreover, in a few places it is difficult to distinguish the two members in the field and the basal part of the Chimneyhill has been referred to the Ideal Quarry-Keel undifferentiated (see Ca3). It should be noted, however, that a study of the typical Ideal Quarry lithology by means of thin sections shows some marked differences from the Keel lithology. The Ideal Quarry contains a significant amount of fossil material, generally well over 50 percent, in contrast to the rather low fossil content of the Keel. Futhermore, none of the highly symmetrical Keel-type oolites appears in any of the sections examined by me, all of the Ideal Quarry oolites being the irregular, concentrically banded, crinkly bodies which strongly suggest algal structures. A more detailed comparison of these two lithologies is given below (KEEL MEMBER) and I only wish to note here that the characteristic Ideal Quarry is sufficiently different to suggest a different environment of deposition. That part of the Ideal Quarry-Keel sequence which appears to be transitional from one lithologic type to the other has not been investigated by means of thin sections.

Thickness and distribution: The Ideal Quarry member has been combined with the Keel member in the stratigraphic sections of panel III, and the isopach map of figure 12. In most areas where one member is present the other member is also present so the isopach map gives a reasonably accurate picture of the distri-

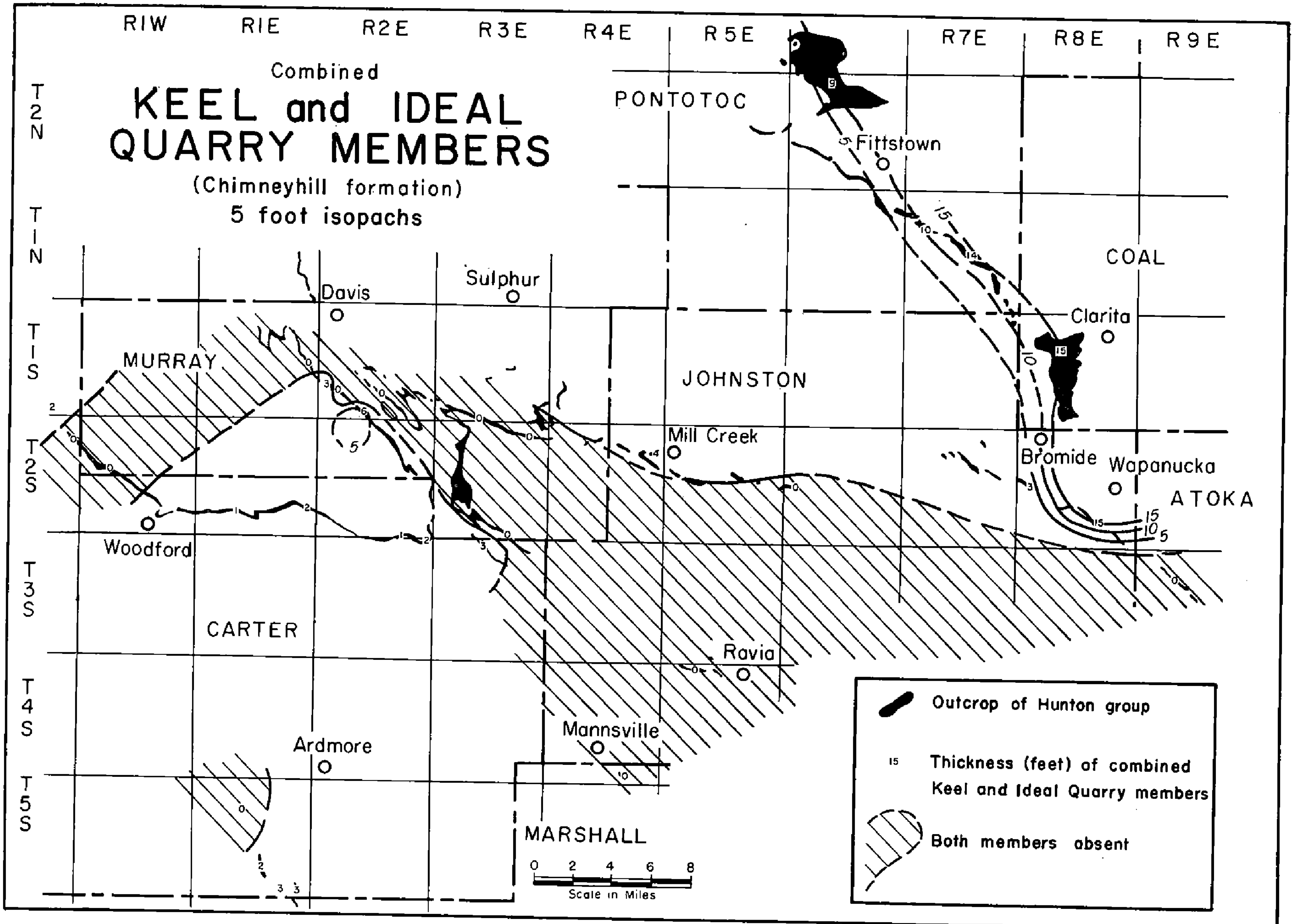


Figure 12. Isopach map of the combined Keel and Ideal Quarry members of the Chimneyhill formati...

bution of the Ideal Quarry. Good exposures of typical Ideal Quarry lithology are present on the Lawrence uplift (P1); Coal Creek (P9); old Hunton townsite (C1); south of Wapanucka (J1); near Mill Creek town (J11); Price's Falls (M12A); Tulip Creek (Ca2); Criner Hills (Ca11). Its thickness is generally around two feet; the greatest thickness I have observed is five feet on Chimneyhill Creek.

Fossils and age: The Ideal Quarry member is abundantly fossiliferous, although it is difficult to collect satisfactory specimens. Reeds included the strata here referred to this member under the Keel (oolitic member) and gave a combined faunal list. Maxwell (1936, p. 49) recognized it as a separate member (Hawkins member; see Amsden 1957, p. 9) and listed nine species including three corals, one bryozoan, two brachiopods, two pelecypods, and one gastropod. I have obtained a few fossils from section P1, partly by breaking them out of the rock and partly by etching. This fauna has not been studied in detail, but a preliminary examination indicates the presence of *Clorinda* cf. *C. thebesensis* Savage, *Dictyonella* sp., *Modiolopsis?* sp., and a few gastropods.

The Ideal Quarry member has commonly been correlated with the Alexandrian (Reeds 1911, p. 258; Maxwell 1936, p. 48; Amsden, p. 11), although the detailed faunal evidence for such an age assignment has never been published. Its stratigraphic position, however, makes such such a correlation appear reasonable, and the fossils I have observed appear to fit with this interpretation. The Ideal Quarry member is believed to be closely related in age to the Keel member.

KEEL MEMBER

The type locality for the Keel member is at the site of the Lawrence quarry of the Ideal Cement Company, NE¼ sec. 36, T. 3 N., R. 5 E., Pontotoc County, Oklahoma (pl. I, figs. 1, 2). This member is well exposed at the type locality, as well as a number of other places in the Arbuckle Mountain and Criner Hills regions; excellent exposures may be seen along Chimneyhill Creek (P1), near old Hunton townsite (C1), at Price's Falls (M12A) and at several places in the Criner Hills (Call, Ca12). For additional information on the type locality and nomenclatorial history see Amsden 1957 (p. 11).

Lithology: The Keel is a medium- to light-gray (commonly N6 to N7) oolitic limestone. Commonly the oolites are less than 2 mm in diameter, but pisolites are present with some ranging up to almost 5 mm. In some outcrops the bedding is clearly defined by differences in the size of the oolites; this is well displayed at Lawrence quarry where the oolites and pisolites are concentrated into distinct beds, some of which show a subdued type of cross-bedding. In most areas, however, the oolites are small, a millimeter or less in diameter, and the bedding is obscure.

Silicification is moderately common in the Keel member. This may affect the oolites and not the matrix, in which case the HCl insoluble residues will be composed in large part of free, silicified oolites and pisolites. In other places the silicification is more intense and produces nodules and small lenses of oolitic chert (see HUNTON GROUP, Hunton chert).

The Keel is a rather high-calcium stone which is generally composed of 96 percent or more $CaCO_3$. The HCl insoluble residues (excluding chert) are low, all of those tested falling below 4 percent, and most being 1 percent or less (fig. 10). In most samples the residues are composed in large part of knots or centers of silicification, with some aggregates of quartz crystals. Locally, as in the area around old Hunton townsite (C1), the residues contain much brown, finely divided material (limonite?), some of which is in the form of oolites. Most residues contain minor amounts of glauconite. I have observed very little material that is clearly detrital, although undoubtedly there is some present in the clay size.

The $MgCO_3$ content is low on all specimens tested with a single exception; on section J4, located on the outcrop belt southwest of Wapanucka, the Keel is strongly dolomitic, a rock specimen from here (J4-C) testing 36 percent $MgCO_3$. This is especially surprising because, as shown in figure 11, all of the other Keel specimens yielded less than 1½ percent $MgCO_3$. There is, however, no doubt that the Keel in the vicinity of J4 has been heavily dolomitized as this analysis was run twice; this appears to be quite localized, and at J1 about a half mile to the southeast, the

$MgCO_3$ content is only a percent or so. For further data on the chemical composition see the APPENDIX.

A number of paralodion peels and thin sections have been prepared of Keel rock specimens and several of these are illustrated on plates X and XI. These show that the Keel is largely made up of oolites which locally grade into pisolites. The fossil content is variable, but almost everywhere low, and makes up only a small part of the rock. This reduced fossil concentration contrasts sharply with the other merbers of the Chimneyhill formation, all of which are bioclastic limestones (including the Ideal Quarry member). The Keel oolites are generally packed closely together, either in contact or else separated by only a small amount of matrix (pl. X, figs. 4, 5; pl. XI, fig. 1).

Most oolites show a well-marked concentric and radial internal structure (pl. X, figs. 4-6; pl. XI, fig. 1), although on some the radial structure is obscure (pl. XI, fig. 6). It has been suggested that the radial structure is a secondary feature, developed when the original aragonite (Monaghan and Lytle 1956, p. 113; Illings 1954, p. 35) is altered to calcite (Williams, Turner and Gilbert 1954, p. 344). I have no information pertinent to the origin of this structure, but it is a fact that whereas most Keel oolites show a concentric banding, the radial structure is variable in its development. Another interesting feature of these oolites is their microscopic texture. An examination at magnifications ranging up to x110 shows that most, if not all, are composed of tiny granules ranging up to 0.01 mm in diameter (pl. XI, fig. 6). These granules are believed to be more or less subspherical rather than rod-like bodies, because on all sections they appear somewhat subcircular with no tendency towards an elongate shape.

One of the remarkable features of some of the larger oolites and pisolites is their symmetry, Many develop a degree of sphericity (or, viewed in section, a degree of roundness) that is unusual. On specimens like the one illustrated in figure 5 of plate X the difference between the maximum and minimum diameters is quite small.

Many of the oolites have a core and this is commonly a fossil (pl. X, figs. 4-6; pl. XI, fig. 1). Reeds (1914, p. 76) noted that "a few oolites posses a primary nuclei, many none at all . . . . .", but this is difficult to determine by means of sections. If the nucleus is small in relation to the diameter of the oolites, and most of the Keel oolites are of this kind, the chances are against exposing the core in a randomly oriented section. Therefore nuclei may be more universally present in the Keel oolites than the peels and thin sections show. One of the conspicuous features of this rock is that practically all of the fossil material, in fact almost all of the fragments, are coated with a layer of granular material that appears to be identical in texture to that which makes up the oolites (pl. XI, figs. 2, 3). On many fossils this layer is thin so that the outline is similar to that of the fossil core (pl. XI, figs. 2, 3). With an increase in the thickness of the coating the shape of the fossil tends to become obliterated, and the larger oolites and pisolites develop the subspherical shape mentioned above. This change may be recorded in the concentric bands; the inner bands of the oolite shown in plate XI, figure 1, are elliptical and conform to the elongate shape of the core, but with increased size this is lost and the outer rings are nearly circular.

There are at least two kinds of matrix enclosing the oolites. The first, and perhaps the most common, is a clear, crystalline calcite (sparry calcite of Folk, 1959) like that shown in figures 4 to 6 of plate X. The second type is a finely granular matrix (microcrystalline calcite of Folk, 1959) having a texture like that of the oolites and material coating the fossils (pl. XI, figs. 2, 6). The latter may be present with the clear calcite (pl. XI, fig. 1), but commonly they are separated into distinct beds (see below). Clear, crystalline calcite of this type is rather common in limestones and its origin has been the subject of considerable discussion; some authors have interpreted the sparry calcite as a primary feature of the rock while others have regarded it as the product of recrystallization from a finer textured rock. The term recrystallization is a broad one and, as noted by Bathurst (1959, p. 13) probably covers several rather different processes, but in the present report my principal concern is whether this is a primary texture of the rock developed at the time of deposition, or whether it is secondary, developed by "recrystallization" at some later date and thereby obscuring the original texture. In a recent paper on limestone classification Folk (1959, p. 29-36) considers most clear sparry calcite to have originated as a primary part of the rock, although he does recognize some as the product of recrystallization. Bathurst (1959, p. 13), in an interesting paper on limestone diagenesis, recognizes at least six different processes of which two, granular cementation and rim cementation, are developed by chemical precipitation at the time of deposition. This is a difficult problem to settle conclusively, but I strongly suspect that much of the clear, crystalline calcite in the Keel member is a primary feature, probably corresponding in origin to the granular cementation of Bathurst (with some, minor, rim cementation). There are two principal lines of evidence pointing to this conclusion: (1) In some parts of the Keel the oolites cemented by clear calcite are concentrated into clearly defined beds which alternate with beds of oolites that are cemented by the finely granular calcite; these correspond with beds defined by different size oolites. (2) There is very little evidence in the Keel pointing to recrystallization; most of the oolites have well-defined, even boundaries which do not exhibit any "corrosion". This does not, of course, rule out recrystallization, but it does seem probable that this process has had a minor effect on the Keel and that the present texture is essentially the same as that formed at the time of deposition. It might be added that clear calcite is also found as a cementing material in other Hunton strata (e. g. Fittstown) where it also gives evidence of being a primary texture. For a further discussion of this topic see BOIS D'ARC FORMATION, and FITTSTOWN MEMBER, *Environment of deposition.*

The same evidence cited above for the sparry calcite, suggests that the finely divided, granular calcite which makes up the oolites, coats the fossils and locally serves as a matrix, is also a primary feature of the rock. This, of course, raises the question as to why there are two types of material cementing the oolites. Folk (1959, p. 20) suggests that sparry calcite cement occurs where the currents were strong enough to sweep away the finely divided, microcrystalline ooze. This is a possible explanation, although the intimate interbedding within the Keel of these two types of matrix make this mechanism a little difficult to understand. Some additional remarks are made on the origin of the Keel oolites in the section on environment of deposition, although this particular question is left unanswered.

Subdivisions of the Keel member. In the eastern part of the Arbuckle region the Keel member can be locally subdivided into three submembers. On those sections (P9, P10, J1) where this has been observed, the upper and lower parts retain their typical, gray, oolitic character, but the middle part is a brown, thinly laminated limestone (plate IV, figure 1). I discussed this three-fold division at some length in 1957 (p. 12-14, fig. 5) and the present remarks will be confined to some additional observations on the lithologic character of the middle laminated unit. This middle unit was first observed by Reeds (1911, p. 259) in the Coal Creek area (my section P9) and was called a "yellowish shale bed". Actually it is a thinly laminated, grayish orange (10YR 7/4) calcilutite. The insoluble residues are not high, one specimen from P9 yielded 7.8 percent, and a paralodion peel shows it is composed largely of finely divided carbonate with very little fossil material; the only fossils collected are a few fragments of a colonial tetracoral. The strata above and below have a characteristic Keel oolite lithology, but no oolites have been observed in the laminated part. A similar Keel lithologic sequence has been observed at P10, four or five miles to the northwest. The three-fold division is also present at J1, southwest of Wapanucka, but the lithology of the middle part is somewhat different. This unit retains its laminated appearance, but the rock is composed in large part of irregular fragments of limestone ranging up to one half inch in length. Some of these pebbles are clearly fragmentary oolites which still retain their concentric and radial structure. Other fragments do not show this structure and are much too large to be derived from oolites, but even these have a granular texture like that of the oolites (pl. XI, fig. 4). In fact all of the fragments in this rock have a texture exactly like that found in the typical Keel oolites ,and this suggests that all had a similar origin. The matrix is partly clear crystalline calcite and partly finely divided carbonate and insoluble debris (see above). This type of lithology has been observed at one other locality; Call in the Criner Hills. At this place, however, there is no three-fold division and all of the Keel member consists of oolites mixed with irregular fragments having the same granular texture. The oolites and fragments are set in a matrix of clear calcite (plate XI, figure 5). The fossils in this rock, like those in the more typical Keel oolite, are coated with a layer of material having the same granular texture as the oolites and fragments.

Environment of deposition: The origin of oolites is a complex problem and even a summary of the literature is beyond the scope of this report. Undoubtedly there are different kinds of oolites originating in different ways. Even within the Chimneyhill formation there appear to be two different types of oolites: (1) the Keel type, and (2) the Ideal Quarry type, which is quite different in structure and believed to have a different origin (see under *Keel-Ideal Quarry contact*). It has, however, been possible by a study of thin sections and peels to assemble enough detailed information on the Keel lithology to permit some observations on this topic. Perhaps the most conspicuous feature of this rock is the similarity between the granular texture of the oolites, the texture of the material coating the fossils, and the texture of parts of the matrix, a similarity that can hardly be fortuitous and which seems to suggest that all originated in the same manner. This granular texture could be secondary, possibly the result of recrystallization from aragonite to calcite, but if this is the case it appears to have uniformly affected all parts of the Keel member throughout its area of outcrop. Moreover, if recrystallization did occur it had little effect on such primarily rock parts as the fossils, because their boundaries remain sharp and uncorroded (see discussion above). It is difficult to avoid the conclusion that a rock of this fabric and texture was deposited in warm, shallow water which was sufficiently saturated with calcium to coat all debris with a layer of this material. The degree of saturation at times must have been great enough to cause precipitation of the calcium as layers which actually engulfed the oolites. Such an environment would presumably be unfavorable for most forms of life, an interpretation supported by the general paucity of fossil material. Possibly the fossils that are present were washed in from other areas having a more favorable environment.

The exact method by which the Keel oolites developed is unknown. Their structure and symmetry suggest a mechanical and/or chemical rather than organic origin as the high degree of sphericity would seem to rule out algal action. It is generally stated that oolites form in saturated waters that are actively agitated by wave or current action (Illings 1954, p. 41-44; Beales 1958, p. 1874-1875; Folk 195, p. 22). The Keel furnishes some evidence of current or wave action as it is locally cross-bedded and in at least two places (J1, Call) there is evidence of breakage, but considered as a whole this member does not appear to represent a sediment deposited in strongly turbulent water.

There is a possible comparison between the fragmental facies developed at J1 and Call (see *Subdivisions of the Keel member*) and some of the deposits forming on the Bahama Banks today. Illings (1954, p. 26; Beales 1958, p. 1869) indicates that many of the carbonate pellets found on the banks today are not the result of mechanical disruption of a previously formed sediment, but are produced by aggregation of precipitated calcium carbonate particles. It is possible that some of the Keel carbonate fragments, such as those illustrated on plate XI, figure 5, could have formed in this manner. Supporting such an hypothesis is their texture, these fragments having exactly the same granular texture as do the oolites and pisolites. It should, however, be kept in mind that there is evidence at Jl of mechanical disruption, because broken pieces of oolites are present.

Keel-Ideal Quarry contact. This contact appears to be gradational and in most outcrops exposing both members it is difficult to determine where one ends and the other begins (see IDEAL QUARRY MEMBER, *Ideal Quarry-Keel contact*). The typical Keel lithology is, however, quite distinct from that of the Ideal Quarry. The latter is a bioclastic calcarenite composed in large part of fossil material. Some of the fossil debris is coated with concentric layers of calcite (pl. X, figs. 1-2), but this coating is irregular and crinkly, nowhere developing the sphericity attained by some Keel oolites. Moreover, the Ideal Quarry oolites are only scattered through the rock and are in no case closely packed as are the Keel oolites. The Ideal Quarry appears to represent a deposit laid down in a normal Paleozoic marine environment which was favorable for life. If the oolites are properly interpreted as algal, and this seems reasonable, then they must have been deposited in fairly shallow water (i.e. within the zone of effective light penetration). In the Keel member, however, the fossil content drops sharply and the dominant rock constituent becomes the oolites. Most of these oolites show a radial as well as concentric internal structure and their outlines, at least of the larger ones, are nearly circular. Such a marked lithologic change must indicate a change in the environment of deposition. Quite possibly this involved a shoaling of the water accompanied by an increase in the concentration of calcium (see above). The change from Ideal Quarry to Keel deposition does not seem to have been accompanied by withdrawal of the sea and emergence as all the evidence points to continuous deposition from one to the other. The age of these two members has not been precisely determined, but the available faunal evidence suggests they are closely related.

Keel-Cochrane contact: The Cochrane is a glauconitic, bioclastic calcarenite which is sharply and abruptly marked off from the Keel. The actual Keel-Cochrane contact has been observed at a number of places and in every case it can be precisely and easily located. At section M12A a rock specimen bridging this contact was collected; a peel made from this specimen brings out the marked lithologic change and even shows the truncation of oolites along the contact.

There is substantial regional stratigraphic evidence for an unconformity between the Keel and the Cochrane members. In no place have I observed the Cochrane in direct contact with the Sylvan, but this shale is so rarely exposed that the chance of finding such an exposure is slight. There are, however, many areas where no Keel or Ideal Quarry have been observed and since the limestones of the Chimneyhill are resistant and make excellent outcrops it seems reasonable to assume that in these areas the Cochrane rests directly on the Sylvan. The inferred relation of the Cochrane to the Keel-Ideal Quarry is shown in the stratigraphic sections of panel III, plate C; the geographic distribution of the Keel-Ideal Quarry is given in figure 12.

Thickness and distribution: The Keel member has been combined with the Ideal Quarry member on the isopach map, figure 12. In most areas where one member is present the other is also present, so this map gives a reasonably accurate picture of the distribution of the Keel. The Keel commonly ranges from one to three feet in thickness, but on the Lawrence uplift it is four to five feet thick (P1) and near old Hunton townsite (C1) it reaches 11 feet. In those places where the middle laminated member is developed (P9, P10,, J1) the total Keel (including all three submembers) is 10 to 14 feet thick.

Fossils and age: The Keel member is sparingly fossiliferous and it is difficult to extract satisfactory specimens from the rock. Reeds (1911, p. 261) listed four species from his Oolitic member (which included the Ideal Quarry) and Maxwell (1936, p. 54) listed a total of nine species from the Keel member. I have collected a small fauna from the Keel at the Lawrence Quarry of the Ideal Cement Company. These fossils have not been carefully studied, but a preliminary check indicates the following species: *Cyclonema?* sp., *Modiolopsis?* sp., *Pterinea?* sp., *Dictyonella* sp., *Clorinda* cf. *C. thebesensis* Savage, *Leptaena* sp., *Resserella* sp. (see Amsden 1958, p. 14), *Rhynchotreta?* cf. *R.? thebesensis multistriata* Savage, *Halysites* sp. This fauna appears to be distinct from that of the Cochrane member.

The Keel member has commonly been correlated with the Alexandrian (Reeds 1911, p. 258; Maxwell 1936, p. 53). In 1957 (p. 16) I tentatively accepted this correlation, and at this time have no further information on the age of the Keel member.

COCHRANE MEMBER

The type locality of the Cochrane member is near Chimneyhill Creek in the SE¼ of section 5, T. 2 N., R. 6 E., Pontotoc County (panel I; plate A, panel II). This is the Chimneyhill unit which Reeds (1911, p. 260) called the glauconitic member. It is well exposed along the banks of a small stream which enters Chimneyhill Creek from the south; see my stratigraphic section P1, in the APPENDIX. For a further discussion of the nomenclatorial history see Amsden 1957 (p. 16, fig. 2).

Lithology: The Cochrane is a bioclastic limestone, typically a calcarenite, with scattered grains of glauconite. On a fresh surface it is generally a light-gray (N8), in places with some shade of orange (10YR 8/2) or green (10Y 6/2), and weathering to a medium-gray (N6 to N7). The bedding is commonly irregular, ranging from six inches to two feet in thickness (pl. II, fig. 2). but in many areas it is obscure (pl. II, fig. 1). This irregular to obscure bedding is one of the most distinctive features of the Cochrane and stands in marked contrast to the evenly and conspicuously bedded character of the overlying Clarita member (compare the Cochrane illustrated on plate II to the Clarita illustrated on plate III).

In many parts of the Arbuckle Mountain region the Cochrane strata carry chert in the form of irregular nodules and slightly elongate lenses. This is generally light in color, but in a few places is almost black. Cochrane chert is common on the Lawrence uplift, and in the outcrop belt extending south to old Hunton townsite. Chert is also present in the exposures to the south of Wapanucka, from sections J5 to A2, but is rare or absent throughout much of the central Arbuckles. It is again common in the western areas, being present in much of the Cochrane from eastern Carter County west to section Ca10 (it is also present in M15 and M17, south and west of Davis). I have not observed any Cochrane chert in the Criner Hills region. Locally the chert has a brecciated texture; see discussion under FRISCO FORMATION, *Lithology*.

The HCl acid insolubles of the Cochrane member are low. of 23 specimens tested only two are over 5 percent, with the remaining samples falling between 0.5 percent and 3.5 percent. The frequency distribution of these residues is shown in figure 13; this graph is based on the analyses given in the chapter on CHEMICAL ANALYSES, APPENDIX.

Glauconite commonly makes up most of the insoluble residues, although some samples include a substantial amount of spongy silica, much of this being clearly a secondary silica representing the incomplete silicification of fossils. In addition the residues carry some silt size, clear, subangular (rarely subrounded) quartz, but in all cases this detrital material makes up less than one percent of the total rock. Some of these grains have a roughened appearance which may be the result of secondary growth of quartz on the silt particles. I have not observed any detrital material which is well rounded or frosted, nor have I seen any ranging into a sand size, and if such is present is must be rare. Arenaceous Foraminifera are rare in the HCl residues. Acetic acid residues carry a small microfauna composed largely of conodonts (see *Cochrane-Clarita contact*).

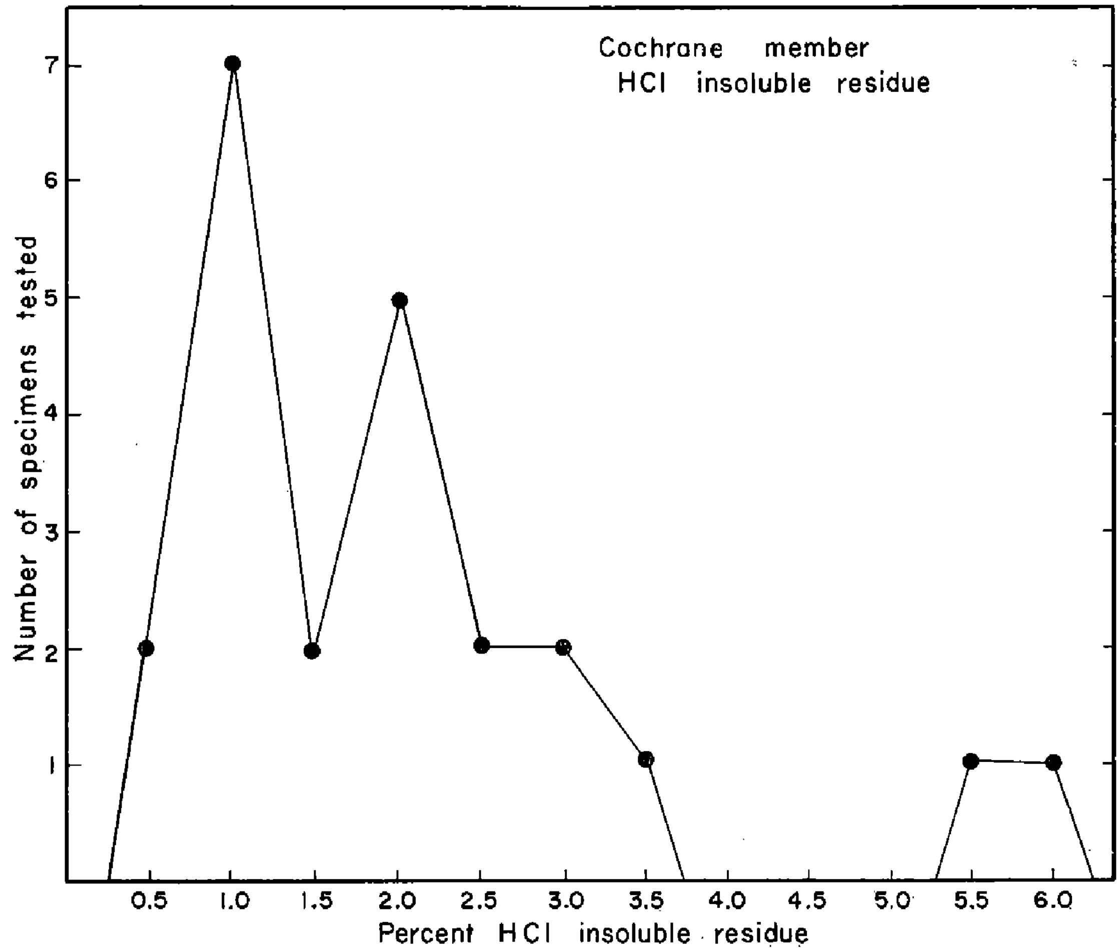


Figure 13. Frequency diagram showing the distribution of HCl insoluble residues in the Cochrane member of the Chimneyhill formation. The data for this are given in the APPENDIX.

The glauconite content of the Cochrane is variable (see STRATIGRAPHIC SECTIONS, APPENDIX). In some beds the grains are relatively large and numerous enough to be conspicuous in a hand specimen, whereas in others the glauconite content is so reduced that it is not readily seen. The exact percentage of glauconite has not been determined for any specimen, but as it makes up a significant part of most HCl residues (fig. 13) it probably ranges between ½ and 2 percent. It is present in the form of small grains few of which exceed a millimeter or so in diameter. The color is some shade of medium to dark green, commonly a grayish green (10GY 5/2) to olive green 5GY 3/2). Most of the grains are in the form of rounded nodules with a polylobate outline. Irregular cracks may be present and these sometimes produce an external shape not unlike that a miniature septarian concretion (pl. XVII, fig. 6). Much of the glauconite represents the filling of hollow fossils such as ostracods and gastropods, and others have the unmistakable shape of sponge spicules, although whether this last type represents the filling of the hollow core (or a fossil mold), or is an actual replacement is not known (pl. XVII, fig. 5).

The Cochrane is a high-calcium limestone. The $CaCO_3$ content from 23 analyses ranges from 93 percent to 99 percent with most specimens falling between 96 and 98 percent. The $MgCO_3$ content is low on all specimens tested; the maximum is 1.6 percent and most are 1 percent or less as shown in figure 14.

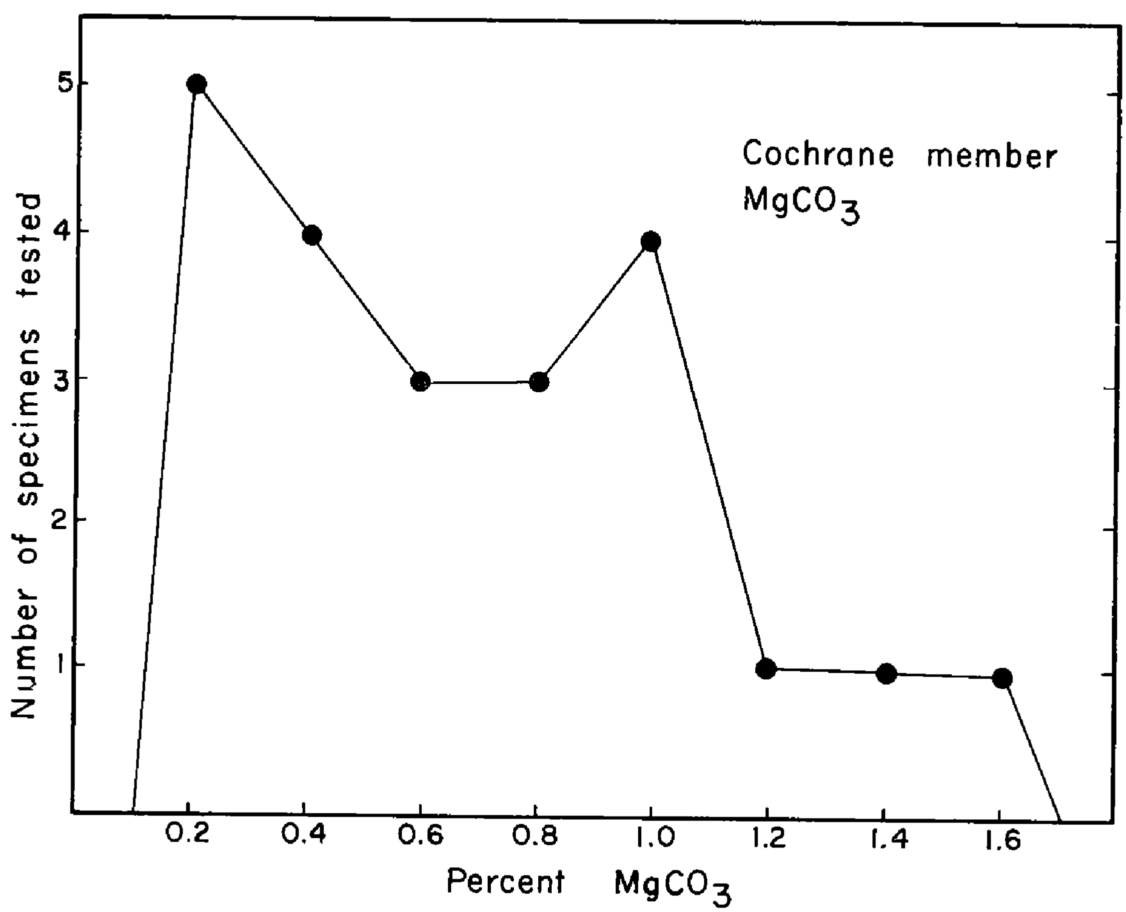


Figure 14. Frequency diagram showing the distribution of $MgCO_3$ in the Cochrane member of the Chimneyhill formation. The data for this are given in the APPENDIX.

The Cochrane is composed in large part of fossil material, and most paralodion peels and thin sections show well over 50 percent recognizable fossil debris. The texture is dominantly a calcarenite although some of the coarser parts range into a calcirudite. Many of the fossils are pelmatozoan plates as shown in the thin section illustrated on plate XII, figure 5; however, other fossils do contribute and in some beds to a substantial degree (pl. XII, fig. 6). The matrix enclosing the fossils is in part a finely divided carbonate and in part clear crystalline calcite (pl. XII, fig. 6; see discussion under KEEL MEMBER, *Lithology*). In places this clear calcite matrix appears to "corrode" the fossil outlines, suggesting some recrystallization. A number of peels and sections show what appears to be fragmentation of the fossils, although it is sometimes difficult to separate this from the effect of recrystallization; several specimens do indicate breakage, possibly quite extensive, and the Cochrane is probably in part a thanatocoenose.

Environment of deposition: It is not possible on the basis of the evidence now available to determine the precise environment of deposition for the Cochrane member, but certain lithologic and stratigraphic features do give some clues. This member is essentially a lime sand, composed in large part of fossil debris, with a low insoluble detrital content. This points to an offshore, shelf type of deposit (outer neritic or outer sublittoral; Hedgpeth 1957, figs. 1, 3) well removed from any land-derived clastics. Not much can be said about the temperature, although a rich shelly marine deposit of this type suggests warm water. At least a part of the Cochrane is believed to be a thanatocoenose (see above) which would necessitate some movement of the organisms after death, but this movement was probably not extensive and certainly there is no evidence in the bedding or other rock features pointing to deposition in a turbulent environment.

The significance of glauconite in respect to the problem of environment is difficult to ascertain. Recently Cloud (1955, p. 490-491; see also Burst 1958) has tried to outline the physical limits of glauconite formation. He notes that most present day glauconite deposits develop in marine waters of normal salinity, mainly on the continental shelves away from large streams. They are generally neritic and mostly in the upper part of the 10 to 400 fathom range, although not confined to this zone. An environment of this general character seems to fit in with, and perhaps even reinforce, the inferred environment of deposition as deduced from other evidence (see above). Cloud goes on to note that the sedimentary influx (presumably land-derived insoluble debris) is probably slight in glauconitic limestones and most such deposits are associated with detrital calcareous sediments in which algae, corals and Bryozoa are rare. No algae have been observed in the Cochrane limestone and although some corals and Bryozoa appear to be represented they are not a conspicuous part of the fauna.

Cochrane-Keel contact. The Cochrane is lithologically quite unlike the underlying Keel member from which it is separated by an unconformity. This unconformity does not represent a great time span, but it does involve uplift and sufficient erosion to remove the Keel-Ideal Quarry members locally, allowing the Cochrane to rest directly on the Sylvan (see KEEL MEMBER, Keel-Cochrane contact).

Strata overlying the Cochrane members The Cochrane is overlain in most areas by the Clarita member from which it is separated by an unconformity; for a discussion of this contact and a comparison of these two members see under the CLARITA MEMBER. In several places the Clarita member is absent and the Cochrane is directly overlain by post-Chimneyhill beds (panel III, plate C). It is overlain by the Henryhouse in a few places: this is the relationship in parts of the eastern Arbuckles, on the belt extending from Lawrence uplift south to Atoka County (stratigraphic section A-A, panel III, plate C); it is also the relationship at section Ca7, in the eastern part of Carter County, and at section L1 in the southern part of the Criner Hills. The Cochrane is directly overlain by the Devonian (either Haragan or Bois d'Arc formations) over quite a large area in Johnston and Atoka Counties (stratigraphic sections A-A and B-B, panel III, pl. C). The Henryhouse, Haragan and Bois d'Arc formations can be easily distinguished from the Cochrane by their more argillaceous character.

Thickness and distribution: The Cochrane is the most widely distributed member in the Chimneyhill formation. It is present in all of the Hunton outcrops which I have examined except for the belt north and west of Ravia, where all of the Hunton is absent, and a small area south of Davis (it is entirely absent at M6, and is only two or three inches thick at M12A). In most outcrops the Cochrane is the thickest member of the Chimneyhill and in the area south of Wapanucka attains its maximum of 57 feet (J1). The thickness and distribution are shown on the isopach map, figure 15. It should be kept in mind that the thickness shown on this map is the result of several factors in addition to any variation which may have existed in the primary deposit. The Cochrane has been affected in one place or another by three unconformities: (1) post-Cochrane pre-Clarita, (2) post-Clarita pre-Henryhouse, and (3) post-Henryhouse pre-Devonian. In those areas where the Cochrane is directly overlain by the Devonian some removal of strata may have taken place on each of these unconformities (i. e. at three different times). See panel III, plate C, and discussion under *Strata overlying the Cochrane contact.*

Fossils and age: The Cochrane limestone is richly fossiliferous although it is difficult to break out satisfactory specimens. Reeds (1911, p. 261) listed about a dozen species, and Maxwell (1936, p. 60) recorded two dozen species distributed as follows: six corals, four bryozoans, four brachiopods, two gastropods, two cephalopods, and six trilobites. I have also collected a small fauna from the Cochrane although most specimens are fragmentary. At Henryhouse Creek (Cal-B) I found a number of well preserved specimens of *Triplesia* which are similar to *T. alata* Ulrich and Cooper from the Brassfield near Batesville, Arkansas.

Arenaceous Foraminifera are present in some HCl acid residues, and both arenaceous Foraminifera and conodonts can generally be found in acetic acid residues. The Cochrane microfauna is not nearly as abundant as is that of the Clarita member.

Reeds (1911, p. 258) and Maxwell (1936, p. 57) assigned the Cochrane to the Lower Silurian and correlated it with a part of the Alexandrian strata. I do not have any detailed paleontological evidence at this time to fully substantiate this age assignment, but the general character of the fauna together with its stratigraphic position indicates an early Silurian age.

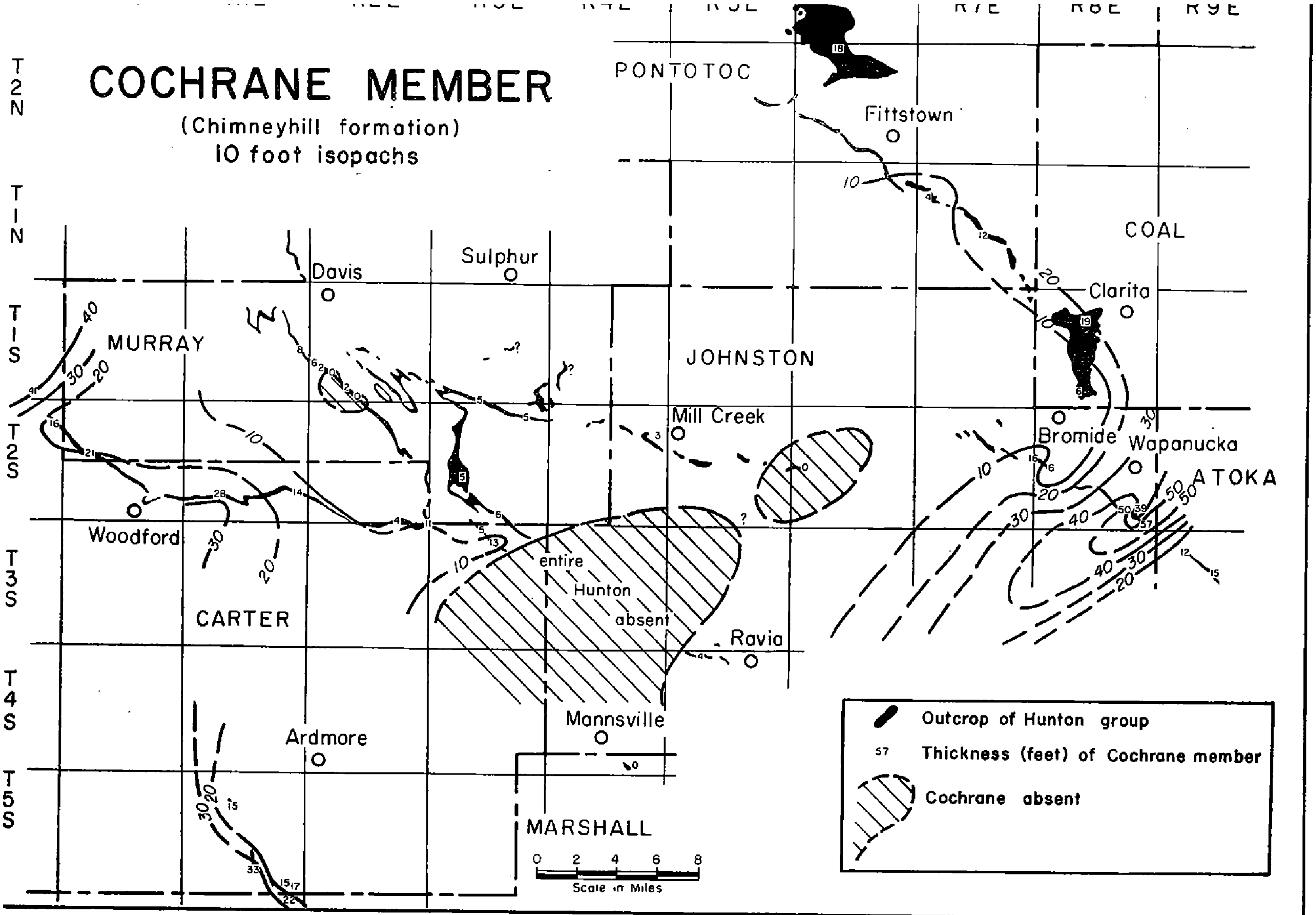


Figure 15. Isopach map of the Cochrane member of the Chimneyhill formation.

CLARITA MEMBER

The type locality for the Clarita member (Pink-crinoidal member of Reeds) is near old Hunton townsite, in the NW¼ sec. 8, T. 1 S., R. 8 E., Coal County, Oklahoma (panel I). A relatively thick sequence is also well exposed along Chimneyhill Creek (C1), and thinner sections of this member may be seen at many other places in the Arbuckle Mountain and Criner Hills regions. For additional information on the nomenclatorial history see Amsden 1957 (p. 19).

Lithology: The Clarita is a bioclastic limestone which commonly has scattered pink pelmatozoan plates. This rock exhibits wide textural variations, although throughout much of its outcrop area it is predominantly a calcilutite (some megafossils are present even in the finest parts). In some areas, notably the northeastern part of the Arbuckle region, it develops a coarse facies and ranges into a calcarenite or even locally to a calcirudite. The Clarita section on Chimneyhill Creek (P1) can be divided into two parts, an upper sequence which is dominantly a calcarenite, and a lower part which is dominantly calcilutite. Farther south, in the arear around old Hunton townsite (C1) the calcarenite and calcilutite textures are interbedded. Locally the Clarita becomes quite coarse, as at section P9 near Coal Creek, where beds of calcirudite result from a strong concentration of trilobites.

The Clarita generally weathers to a medium-gray (N6 to N7), but on a fresh surface the color is affected by textural changes and thus shows more variation. The calcilutite lithology is commonly a yellowish-gray (5Y 7/2) to pale-olive (10Y 6/2) with scattered pelmatozoan plates which are orange-pink (10R 7/4 to 10R 6/6). The coarser textured parts generally have a much higher concentration of pelmatozoan debris and this gives the rock an overall orange-pink color.

The Clarita is evenly bedded, the individual beds being uniform and ranging up to six or eight inches in thckness (plate III). Throughout its outcrop area this evenly and conspicuously bedded character is one of the most distinctive features of the Clarita and generally serves to distinguish this member from the underlying

Figure 1. Clarita member of the Chimneyhill formation. Note the evenly bedded character of this member. This picture was taken in the NW¼ sec. 9, T. 2 N., R. 6 E., Pontotoc County (unit C of stratigraphic section P3; see APPENDIX).

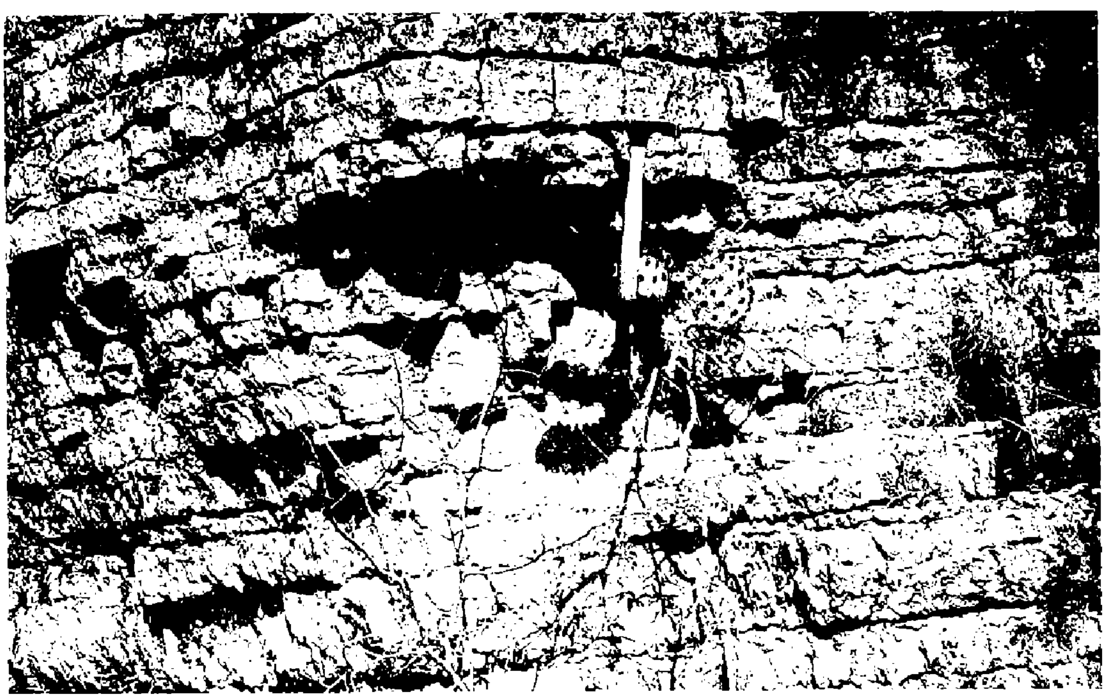


Figure 2. Close-up view of the outcrop shown in figure 1.

Figure 1. Middle laminated calcilutite of the Keel member. This picture taken in the NW¼ sec. 22, T. 1 N., R. 7 E., Pontotoc County (unit A of stratigraphic section P9; see APPENDIX).

Figure 2. Henryhouse formation; tape extended 1 foot. This picture taken in the NW¼ sec. 9, T. 2 N., R. 6 E., Pontotoc County (unit G of stratigraphic section P3; see APPENDIX).

Cochrane; compare the Clarita illustrated on plate III to the Cochrane illustrated on plate II (the Clarita-Cochrane contact is illustrated in Amsden 1957, pl. I, fig. A, and pl. II, fig. 1 of the present report).

Orange-pink plates are common in the Clarita member and Reeds called it the Pink-crinoidal member. Peels and thin sections show most of these pink plates to have the characteristic porous texture of the echinoderm skeleton (see plate XII, fig. 2), although it is generally not possible to identify them more precisely. Since the great majority of Silurian Echinodermata were stalked they are here termed pelmatozoan plates, and in all probability many do represent crinoids (Amsden 1957, p. 20). It should be emphasized that such plates are not confined to the Clarita member, and in some areas they are common in the Cochrane member (see *Clarita-Cochrane contact*).

The lower foot or so of the Clarita is commonly more argillaceous than the rest of the member and this generally weathers to produce a covered interval and a break in slope. Maxwell, who was the first to mention this zone (1936, p. 61), described it as a shale and noted that it was present throughout the Arbuckles. I have also found it to be widely distributed, although in most places it is an argillaceous limestone or marlstone rather than a true shale. In the vicinity of old Hunton townsite (C2) this basal zone carries 19 percent HCl insoluble residues, and at M5, north of Dougherty, it carries 22 percent HCl residues. I have, however, observed a true shale at Price's Falls (M12A) where there is two feet of red and green shale (93 percent HCl insoluble residue) between the typical Clarita limestone and the Cochrane limestone. This basal argillaceous zone can be helpful in locating the Clarita-Cochrane boundary because even where it is covered there is generally a topographic break.

The upper part of the Clarita in many areas has an increased silt-clay content and resembles the Henryhouse (see *Strata overlying the Clarita member*). I have observed this condition in many parts of the outcrop area, although on most sections it involves only a foot or so of beds. There are, however, a few places, notably in parts of Murray County south of Davis, where a substantial thickness of the Clarita member is quite marly (see discussion below).

The HCl insoluble content of the Clarita ranges from a fraction of a percent to almost 20 percent as shown in figure 16 (the lower shaly zone discussed above is not included on this figure). It should be noted that the typical, gray, pink pelmatozoan lithology has a much more restricted insoluble content, generally less than 6 percent. The higher residues shown on figure 16 represent,

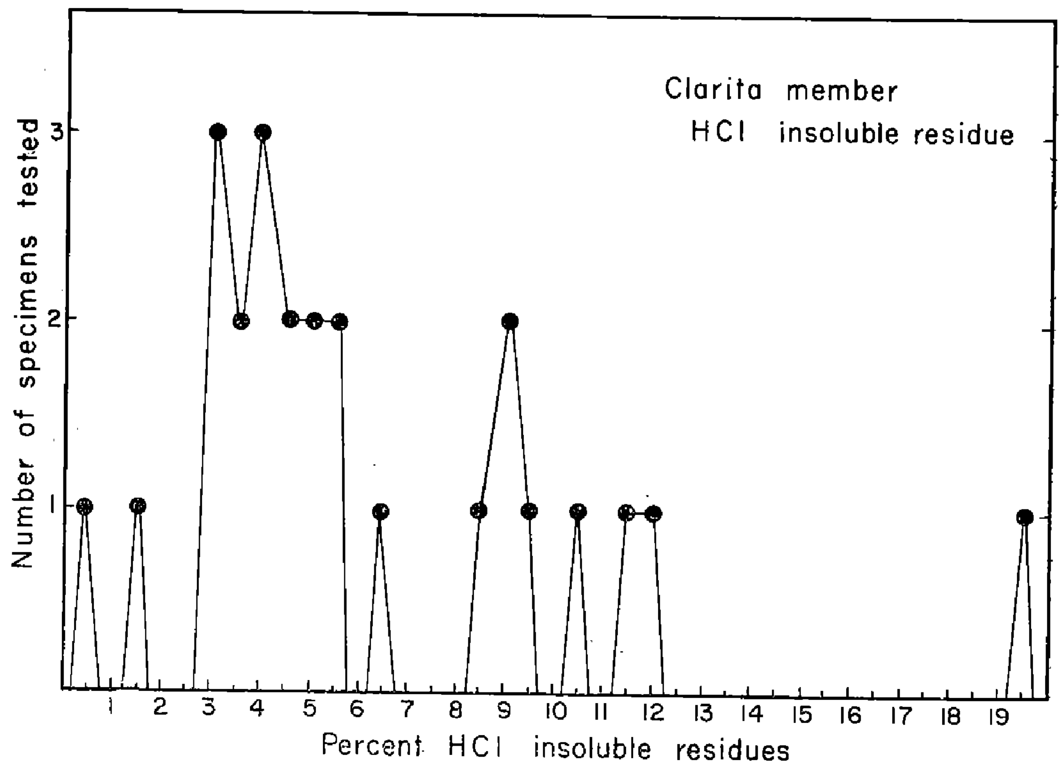


Figure 16. Frequency diagram showing the distribution of HCl insoluble residues in the Clarita member of the Chimneyhill formation. The data for this are given in the APPENDIX.

for the most part, the upper, more shaly zone. In most places this upper shaly portion is only a foot or so in thickness, but locally it is thicker and at section M8 the upper 12 feet has a relatively high insoluble content. This section, which is shown in figure 54, is also interesting because it has a mottled red color like that of the overlying Henryhouse; a similar red mottling has been observed in the Clarita at section Ca6 near Coal Creek.

The HCl insoluble residues are almost entirely in the clay-silt size range, with only a small percentage ranging into a fine sand. Residues which have been washed to remove the clay consist largely of silt size, clear, subangular quartz; only rarely are these grains subrounded and few show distinct frosting. Some mica is generally present along with minor amounts of pyrite and glauconite (I have not investigated the heavy mineral suite). Arenaceous Foraminifera are common and in many samples constitute a substantial part of the residue. The Foraminifera range throughout the Clarita, being present in both the upper and the lower shaly parts; in fact the HCl insoluble residues do not appear to show any significant change, either in grain size or lithologic character in the different parts of the Clarita.

On the basis of the data now available I do not detect any marked geographic pattern in the distribution of HCl residue percentages. The averages are plotted on the map shown in figure 17, and although there is a slight increase in eastern Murray County (T. 1 S., Rs. 2-3 E.) this is probably not enough to indicate a sediment source; quite possibly a more intense sampling of this member would produce a more uniform pattern.

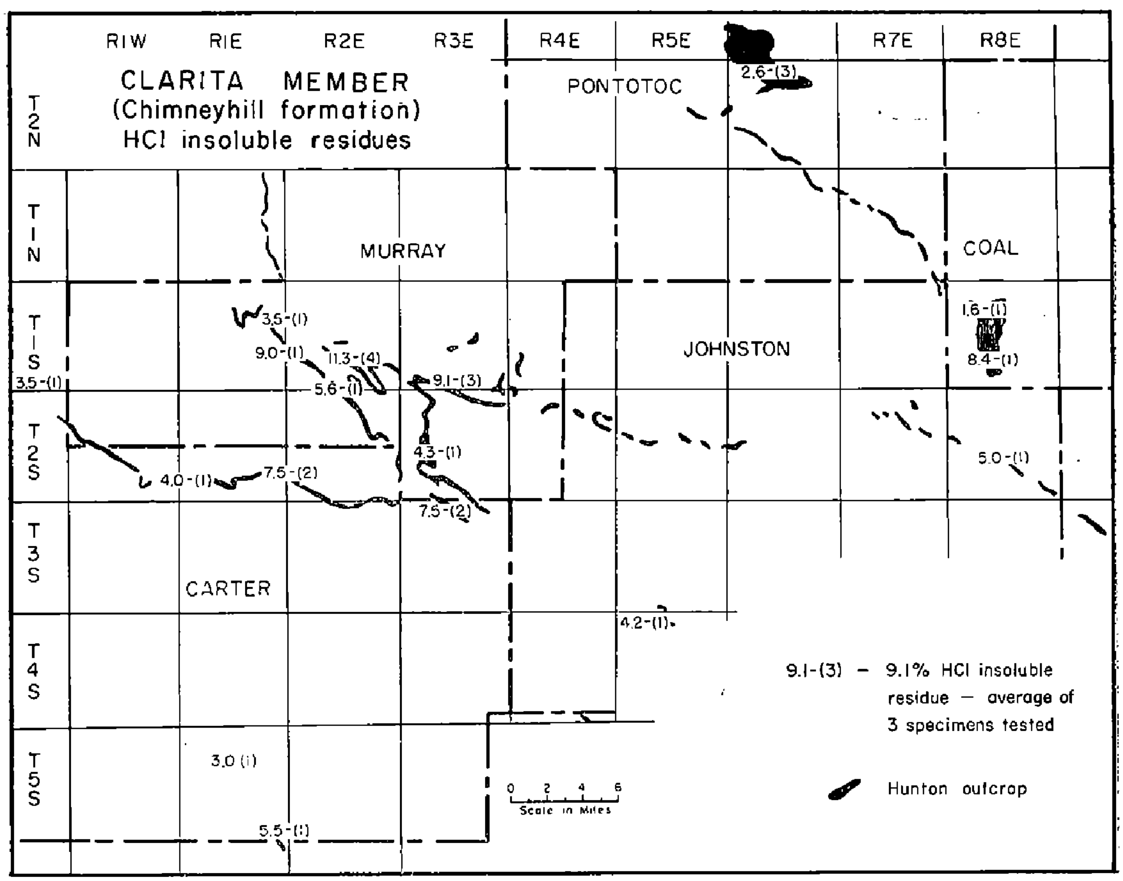


Figure 17. Map showing the distribution of HCl insoluble residues in the Clarita member of the Chimneyhill formation. Note that the figures given are averages, in some instances of widely varying percentages. The basal, shaly part of the Clarita is excluded. The data for this are given in the APPENDIX.

The $CaCO_3$ content of the Clarita member ranges from 87 to 99 percent (one specimen from the lower shaly zone yielded only 78 percent $CaCO_3$). The $MgCO_3$ content is invariably low; the highest sample tested had approximately 2 percent, and most had less than 1 percent as shown in figure 18.

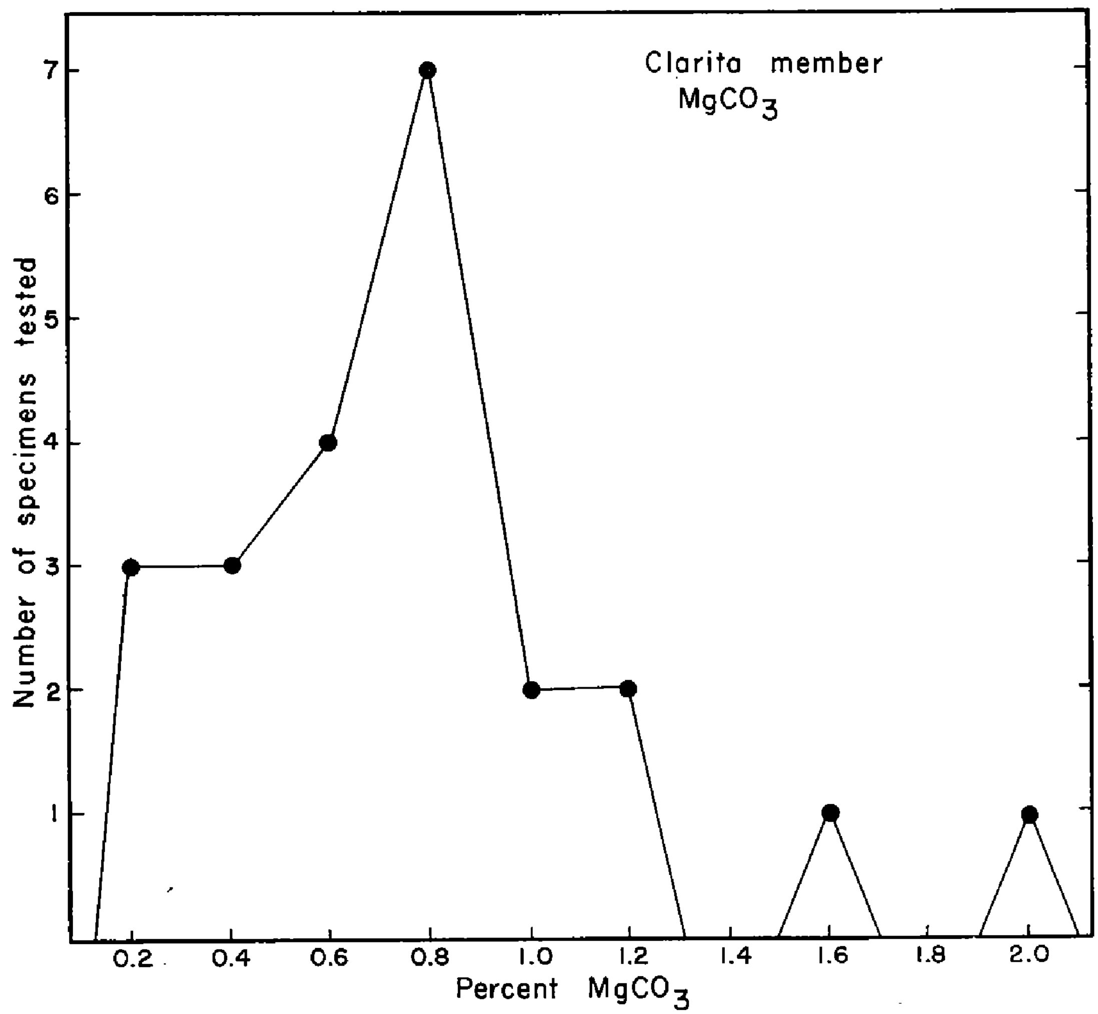


Figure 18. Frequency diagram showing the distribution of $MgCO_3$ in the Clarita member of the Chimneyhill formation. The data for this are given in the APPENDIX.

The Clarita is a bioclastic limestone and most peels and thin sections show well over 50 percent fossil material. One of the more common lithologic types is shown in figure 2 of plate XII and consists of megafossils set in a finely divided matrix. This matrix is predominantly a calcilutite texture, being composed in part of finely divided carbonate and insoluble material; however, a significant part of it consists of recognizable fossil debris, probably in part fragmentary, but also including some more or less complete microfossils. The acetic acid and HCl acid residues invariably carry a substantial microfauna of conodonts, arenaceous Foraminifera and inarticulate brachiopods, many being complete, unbroken specimens. Undoubtedly in many of the Clarita beds this microfauna is large enough to make an appreciable contribution to the bulk of the fine matrix.

The typical calcarenite texture consists of numerous megafossils set in a matrix of clear, crystalline calcite (sparry calcite of Folk, 1959) as shown in figure 3, plate XII (some clear calcite is also present in the calcilutites, but it is much more common in the coarser parts). Some of the fossil boundaries, especially the pelmatozoan plates, appear to be "corroded", indicating recrystallization, but the close association of the clear calcite with the calcarenites, which appear to be concentrated into fairly well marked beds, suggests that it is a primary part of the rock (see discussion under KEEL MEMBER, *Lithology*). Some fossils appear to be broken, indicating movement after death, but as the calcarenites, like the calcilutites, are evenly bedded this movement must have been subdued. The coarse-textured parts of the Clarita carry a microfauna similar to that of the calcilutites.

Pelmatozoan plates (pl. XII, fig. 2) are common in the Clarita throughout its outcrop area, but these are not everywhere the dominant fossil. Brachiopods, trilobites, ostracods, Mollusca and others are present, and any one of these groups may be locally so strongly concentrated as to be the principal fossil. The thin section illustrated in figure 1, plate XII, is composed in large part of ostracods, and I have observed a bed on section P9 that is made up mostly of trilobites. As noted above the conodonts and Foraminifera are almost invariably present and in some places are abundant. In the more argillaceous parts of the Clarita the fossil content is reduced and these beds grade into a fossiliferous marlstone. The megafaunal content of such beds is generally greater than that of either the Henryhouse or the Haragan marlstone, and the microfossil content is everywhere greater (see *Strata overlying the Clarita member.*)

Environment of deposition: The more significant lithologic and biologic characteristics for reconstructing the depositional environment would seem to be the following: (1) Its evenly and conspicuously bedded character. (2) It is a clastic limestone composed in large part of fossil material; fragmentation of the fossils is not extensive and in some beds is at a minimum (I have collected well-preserved specimens from the calcarenite facies, including brachiopods with the two valves in conjunction). (3) The insoluble residues, commonly less than 10 percent, are almost entirely in the silt-clay size, the latter being mostly clear, subangular quartz; arenaceous Foraminifera locally contribute substantially to these residues. (Many of the Foraminifera, as well as the conodonts from the acetic acid residues, are well-preserved, complete specimens). (4) The fauna is large and varied, and includes Foraminifera, brachiopods, mollusks and trilobites; corals are present, but there is no evidence of reef development, nor have I observed any calcareous algae. These features would seem to point to a shelf type deposit (outer neritic or outer sublittoral; Hedgepeth 1957, p. 18) with some access to land-derived detrital material. The sea must have been inhabited by a prolific invertebrate fauna, including many benthonic types. Sufficient current action was present to cause some reworking of the skeletal debris, but the amount of movement must have been slight and much of it was probably buried essentially in situ. In this connection it should be kept in mind that the Clarita member occupies a considerable geographic area (fig. 19); its fossil content never appears to be concentrated into "shell" banks, but is distributed uniformly throughout the member, making up the bulk of the rock in most places. Neither the character of the bedding nor the lithologic composition is compatable with desposition in turbulent water.

The lithologic composition of the Clarita, excluding glauconite, differs primarily from that of the Cochrane in its increased detrital (insoluble) content (see *Strata underlying the Cochrane member*). Both members have glauconite, but in the Clarita this mineral is a very minor part of the insolubles, whereas it is the dominant one in the Cochrane insolubles. Since the origin of the Cochrane glauconite is unknown, there is no way to tell precisely how its environment differed from that of the Clarita, but undoubtedly the latter was deposited in an area more accessible to quartz silt and other land-derived clastics than was the Cochrane. It is interesting in this connection to recall Cloud's (1955,

p. 49) suggestion that at least some glauconite appears to form in an environment where the sedimentary (i. e. insoluble debris) influx is slight.

Strata underlying the Clarita member: The Clarita is generally underlain by the Cochrane and in most places these two members can be easily distinguished by their contrasting lithologies. The Clarita is a conspicuously and evenly bedded limestone (pl. III) which commonly carries many pink pelmatozoan plates. In contrast the typical Cochrane has highly irregular beds which are commonly obscure (pl. II), and with many scattered grains of glauconite. These two members, both in a characteristic lithologic expression, are exposed in contact in a small quarry in the NE¼ SE¼ sec. 30, T. 3 N., R. 6 E. (pl. II; Amsden 1957, pl. I, fig. A). Excellent and complete exposures of these two members may also be seen on Chimneyhill Creek (P1), and in many other areas throughout the Arbuckle Mountain region and the Criner Hills.

Unfortunately there are some areas where the Cochrane loses its typical glauconite character and develops many pink pelmatozoan plates (Amsden 1957, p. 21-22). In all probability this member is nowhere completely free of glauconite, but in some places the amount is sufficiently reduced to make it difficult to find in the field. Pelmatozoan debris is a common constituent of the Cochrane in all parts which I have investigated (see COCHRANE MEMBER), and it is not uncommon for some of these plates to have a faint pink color. However, locally the pink color becomes pronounced and when this is accompanied by a reduction in the glauconite content it produces a rock not unlike the Clarita. As a rule the differences in bedding characteristics, plus the presence of chert in the Cochrane, will aid in separating the two members, but even these features are not always developed sufficiently to make the separation certain. The Clarita and Cochrane faunas are believed to be distinct, although only rarely can megafossils be extracted from either member. I believe the microfossils, notably the conodonts which can almost always be recovered from acetic acid residues, are of great value in distinguishing these members. A preliminary study indicates that at least the conodonts from these two members are distinct, and in my opinion a careful study of these fossils will furnish valuable data, not only for use in surface exposures, but also in the subsurface (see *Fossils and age;* also Amsden 1957, p. 22).

An excellent example of this change in lithologic character may be seen in the Cochrane exposures in the outcrop belt south of Wapanucka which includes my sections J1, J4, J5. Some of the Cochrane strata in this area develop a striking pink pelmatozoan lithology, and the stratigraphic relations are further complicated by the local removal of the Clarita by post-Chimneyhill erosion. This problem is discussed and illustrated (fig. 50) in the APPENDIX under sections J1, J4, J5. The upper part of the Cochrane on Henryhouse Creek (Cal-C) has many pink pelmatozoan plates, but here it is more easily distinguished from the overlying Clarita by its obscure bedding and marked glauconite content. There is also a considerable amount of pink pelmatozoan material in some of the Criner Hills Cochrane outcrops.

A period of erosion is believed to separate the Cochrane from the Clarita. The unconformable nature of this contact is shown in the quarry located in the NE¼ SE¼ sec. 30, T. 3 N., R. 6 E. (Amsden 1957, pl. I, fig. A) where the Clarita-Cochrane contact can be seen to cut across the bedding at a low angle. Further evidence of this unconformity can be found in the Hunton outcrop belt extending from Price's Falls west to U.S. Highway 77 (fig. 52; T. 1 S., R. 2 E.). At Price's Falls only two to three inches of Cochrane is present, while at M12B, only 100 yards or so to the west, this member has thickened to four feet; at M7 it is two feet and at M6 it appears to be completely absent, the Clarita resting directly on the Sylvan. These relations, a part of which are illustrated in figure 53, point to uplift and erosion between the deposition of the Cochrane and the Clarita, although the quantity of beds removed does not appear to have been large judging from the widespread distribution of the Cochrane member (fig. 15; panel III, pl. C).

The Clarita rests on the Cochrane member in almost all areas, as is shown in panel III, plate C. I have not observed it in direct contact with the Keel member, although at M12A, as noted above, only a few inches of Cochrane is present. At M6, a short distance west of M12A, the Clarita appears to rest directly upon the Sylvan.

Strata overlying the Clarita member: In most places the Clarita is overlain by the Henryhouse formation. These two stratigraphic units are separated by an unconformity and can, for the most part, be easily distinguished on lithologic characters. The Clarita is a gray, bioclastic limestone with scattered pink pelmatozoan plates, and an acid-insoluble content that is generally less than 10 percent. On the other hand the Henryhouse is a thin-bedded, yellowish-gray marlstone with an insoluble content which generally falls between 15 and 30 percent; the fossil content varies but only rarely comprises as much as 50 percent of the rock (compare pl. III with pl. IV, fig. 2, and pl. V, fig. 2; also pl. XII, figs. 1-3 with pl. XIII, figs. 1-2.) It is, however, not uncommon for the upper part of the Clarita to become more argillaceous and as the silt-clay content increases the rock becomes yellowish-gray, loses its pink pelmatozoan plates, and resembles the Henryhouse. This generally affects only the upper foot or so, although in a few places it may be interbedded with the more typical Clarita lithology (e. g. M10). Rarely a substantial thickness of the Clarita member is involved, one of the more extreme examples being at M8 where the upper 12 feet develops a marlstone-type lithology as shown in figure 54; some of the more argillaceous portions of this 12-foot zone have a lithology which is strikingly similar to that of the overlying Henryhouse formation, even to the presence of red mottling (red mottling is also present in the Clarita member at Ca6). It has been suggested that these upper shaly beds represent transitional strata bridging the gap between deposition of the Clarita and the Henryhouse. The evidence which I have assembled, however, indicates that the Henryhouse strata are distinctly younger than the Clarita, from which they are separated by an erosional unconformity. The unconformable nature of this contact is shown in the Hunton outcrop belt just west of the Washita River (Ca7; see panel III, pl. C), where the Henryhouse rests directly on the Cochrane; a similar relationship appears to be present in Love County (L1, L2) and in the area north of Bromide (panel II, pl. B). The megafauna of the Clarita is different from that of the Henryhouse (see *Fossils and age*), although in most places this cannot be used in the field to separate the two owing to the great difficulty of collecting satisfactory specimens. The Clarita does, however, carry a prolific microfauna of arenaceous Foraminifera and conodonts, and this fauna can be recovered from most acetic acid residues (arenaceous Foraminifera are also common in the HCl residues). This microfauna is not confined to the bioclastic, pink-pelmatozoan lithology, being almost equally well developed in the more shaly part of the Clarita. In contrast the Henryhouse has an impoverished microfauna; a few of the acetic acid residues which I have examined do have rare arenaceous Foraminifera and conodonts, but most appear to be barren. A preliminary check indicates that at least the conodonts of the Clarita are different from those of the Henryhouse; however, the abrupt decline in the microfauna between the Clarita and the Henryhouse is useful in defining the contact even without detailed species identification. It should be noted that this abrupt decline is present where the Clarita is directly overlain by the Haragan formation as the Devonian formations also have an impoverished microfauna.

The Clarita member is locally overlain by Devonian strata. On section Ca9, in the vicinity of Coal Creek, the Haragan marlstone rests directly upon the Clarita. Since the Haragan is lithologically similar to the Henryhouse, the discussion above pertaining to the Clarita-Henryhouse contact will apply equally well to the Haragan. The removal of the Henryhouse strata in the Coal Creek area and elsewhere (panel III, pl. C) is the result of the post-Henryhouse pre-Devonian period of uplift and erosion; this is discussed under the chapter on the DEVONIAN.

Thickness and distribution: The distribution and thickness of the Clarita member are shown in the isopach map, figure 19 (see also panel III, pl. C). This member reaches its maximum thickness in the outcrop belt extending from old Hunton townsite to the Lawrence uplift, locally attaining a thickness of 45 feet. It is absent in most of the area extending from Atoka County west to Mill Creek town, but is again present in much of Carter and Murray Counties, although generally thinner than in the northeastern Arbuckle region. The Clarita is present, although thin, throughout much of the Criner Hills area; it appears to be absent from the southernmost Hunton exposures in Love County.

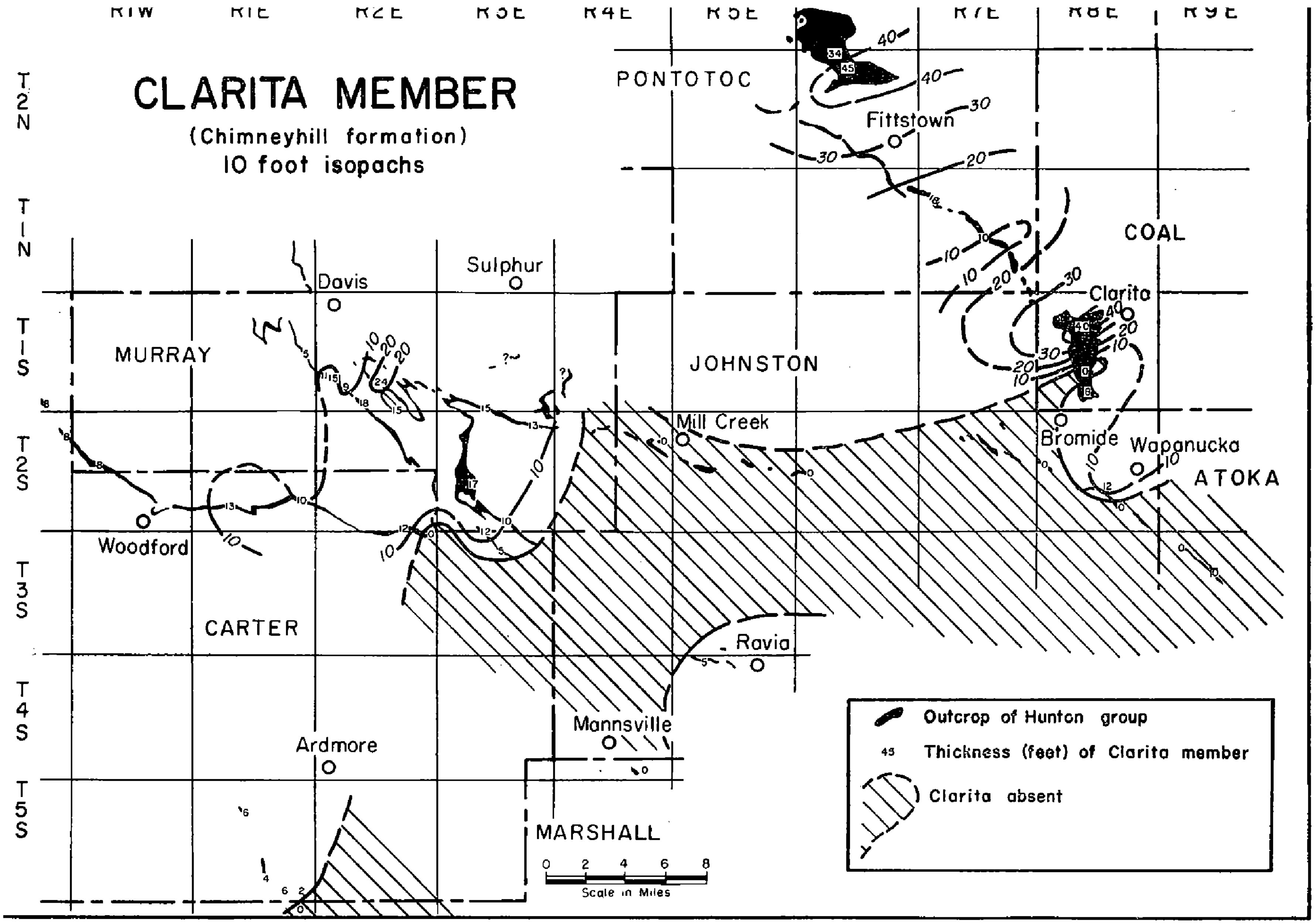


Figure 19. Isopach map of the Clarita member of the Chimneyhill formation.

The pattern shown on the isopach map, figure 19, is largely the result of two post-Clarita periods of erosion. The first of these, which preceded the deposition of the Henryhouse, did not cause extensive truncation of the Clarita as this member is commonly present where the Henryhouse is present. The second period of erosion, which took place in post-Henryhouse time, was much more extensive and in some areas all of the Silurian strata were removed at this time (see discussion under DEVONIAN).

Fossils and age: The Clarita limestone is composed in large part of fossils, although it is difficult to extract satisfactory specimens. Reeds (1911, p. 261) listed about two dozen species from his Pink-crinoidal member (equals Clarita), and Maxwell (1936, p. 67) recorded 15 species from his Dillard member (also equals the Clarita), including three corals, two brachiopods, two gastropods, two cephalopods, and six trilobites. I have collected a small fauna of megafossils from the Clarita member, most specimens coming from sections P1 and C1. This includes a number of trilobites (mostly fragmentary), some snails and several brachiopods. None of these fossils has been studied in detail, but a preliminary examination points to a similarity to the St. Clair of Arkansas (Thomas 1926, p. 385-401, pl. 54; I have also examined the collections of St. Clair brachiopods in the U. S. National Museum). Among these Clarita brachiopods are some which resemble "*Spirifer radiatus*" Thomas (not Sowerby), "*Spirifer* (*delthyris*) [sic] *sulcatus*" Thomas (not Hisinger), "*Camarotoechia*" *arkansana* Thomas and "*C.*" *marginata* Thomas; in addition there is a *Triplesia* which is similar to, if not identical with, *T. praecipta* described by Ulrich and Cooper (1936, p. 346, pl. 48, figs, 10, 11; pl. 50, fig. 3) from the St. Clair near Batesville, Arkansas. The Clarita also has a large fauna of arenaceous Foraminifera; about 60 species have been described from the Chimneyhill formation by Moreman and Ireland, and most of these probably came from the Clarita member (Amsden 1956, p. 7-14; 1957, p. 24). In addition this member has a number of conodonts, and almost any specimen of Clarita limestone which is digested in acetic acid will yield conodonts, inarticulate brachiopods and arenaceous Foraminifera (the latter are also common in the HCl residues). Recently I have digested a specimen of St. Clair limestone from the type area near

Batesville, Arkansas, in acetic acid and recovered a substantial microfauna, including conodonts, inarticulate brachiopods and arenaceous Foraminifera. A cursory examination of these microfossils shows rather marked similarities with those from the Clarita.

It should be emphasized that the foregoing tentative faunal comparison is with the St. Clair fauna of Arkansas. The St. Clair of northeastern Oklahoma, as now defined, may well include more faunal zones than either the Clarita or the St. Clair of the type area. Huffman (1958, p. 31-33) suggests that the St. Clair of northeastern Oklahoma includes correlatives of the Henryhouse-Bainbridge, Waldron, Clarita and Brassfield, and in his faunal list he provisionally identifies a number of Henryhouse brachiopods. At the present time I have little new information bearing on the relationship of the St. Clair of northeastern Oklahoma with the Hunton group. I have made a small collection of fossils from the St. Clair in the Marble City area; a preliminary check fails to show much similarity with the Clarita fossils, but this collection is too small and fragmentary to be diagnostic. Several samples from the upper part of the Oklahoma St. Clair were digested in acetic acid, but no microfossils of any kind were recovered from the residues.

Reeds (1911, p. 258) assigned his Pink-crinoidal member (equals the Clarita) to the Lower Silurian (Alexandrian). Some years later Ulrich (1927, p. 32) removed this member to the Middle Silurian and correlated it with the St. Clair of Arkansas. Maxwell (1936, p. 136) followed Ulrich's age assignment, but Miller (1956, table 1) referred all of the Chimneyhill to the Albion (Amsden 1957, p. 24). The data now available to me point to a correlation with the St. Clair of Arkansas, a formation generally assigned a Niagaran or Middle Silurian age. Eventually I hope to complete a study of the major faunal elements in the Clarita fauna, including a comparison with fossils from the St. Clair of Arkansas and the St. Clair of Oklahoma.

HENRYHOUSE FORMATION

The type locality of the Henryhouse formation is on Henryhouse Creek, about 3 miles east of Woodford (my sections Ca1, Ca1(2); SE¼ sec. 30, T. 2 S., R. 1 E.). The thickest and most fossiliferous exposures of this formation are located on the Lawrence Uplift, Tps. 2-3 N., R. 6 E. The formation is also thick in the westernmost outcrops of the Arbuckle region (Ca9), although the fossil collecting is not good in this area. For additional information on the nomenclatorial history see Amsden 1957, p. 26-27.

Before proceeding further with a description of the Henryhouse some discussion is needed on the application of the term formation to Henryhouse and Haragan strata. These two units combined made a well-defined lithologic unit (which I have informally designated the Hunton marlstone; Amsden 1957, p. 25), but the only practical method of distinguishing one from the other is by means of the fossils, the Haragan bearing a Helderbergian fauna and the Henryhouse an early Upper Silurian fauna. Therefore, in those areas where the Henryhouse is overlain by the Haragan the boundary between them is defined in terms of contrasting faunas rather than contrasting lithologies. If a formation is defined as a mappable lithologic unit, and certainly many stratigraphers so define it (Amer. Geol. Inst., Glossary, p. 114; Dunbar and Rodgers 1957, p. 259), then the Henryhouse and Haragan do not separately make valid formations. As a general rule I also prefer to define formations in terms of lithologic rather than faunal characteristics, but the present instance seems to be a justifiable exception. First, the Henryhouse and Haragan belong in different geologic periods, one being Devonian and the other early Late Silurian in age. Moreover, they are separated from one another by an erosional unconformity of some magnitude (see panel III and discussion under DEVONIAN, *Pre-Devonian unconformity*). Perhaps the most important reason of all is the fact that the Bois d'Arc formation is a facies of the Haragan, but has no relationship whatsoever with the Henryhouse. For a complete discussion of the Henryhouse-Haragan relationship see below, *Strata overlying the Henryhouse.*

Figure 1. View of Cedar Hill (SE¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County) showing a typical glade produced by weathering of Henryhouse marlstone. All of the strata in this picture are Henryhouse except for a thin cap of Bois d'Arc and Haragan at the top of the hill (stratigraphic section P3; see APPENDIX).

Figure 2. View of a small Henryhouse outcrop which has weathered to a glade surface with little or no vegetation; tape extended 1 foot. This is a small exposure on the west side of the road, SE¼ sec. 32, T. 3 N., R. 6 E., Pontotoc County (P7; see APPENDIX).

Figure 1. Chert nodules in the Cravatt member of the Bois d'Arc formation (case is 3 inches wide). About 4 miles west of Wapanucka, SW¼ sec. 18, T. 2 S., R. 8 E., Johnston County (stratigraphic section J6-D; see APPENDIX).

Figure 2. Porous, brown-weathering chert nodules in the basal part of the Cravatt member, Bois d'Arc formation. Top of Cedar Hill, SE¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County (stratigraphic section P3, unit AA; see APPENDIX).

Lithology: The Henryhouse is a silty and argillaceous calcilutite which is here called a marlstone (this term is discussed in the chapter on STRATIGRAPHIC SECTIONS, APPENDIX). Its fossil content varies widely, fossils being common in some areas such as the Lawrence Uplift, and rare in others. The color is characteristically some shade of yellowish gray (5Y 7/2 to 5Y 8/4), rarely with a greenish cast (10Y 8/2). Beds of reddish brown (10R 5/4) to reddish gray (10R 4/2) are present in some areas. This red color may be in the form of solid red beds which are interbedded with the typical, yellowish-gray strata, or, more commonly, it is developed as a red mottling. The Henryhouse strata on the Lawrence Uplift are almost entirely free of red color, but in other areas such beds may be present, and in the vicinity of Henryhouse Creek (Cal, Cal (2)) about 65 percent of the formation is red or mottled red and yellowish gray. It should be emphasized that red beds are not confined to the Henryhouse. This color is known to be present in the underlying Clarita member (Ca6; M8, see fig. 54), and in the overlying Haragan (P10) and Bois d'Arc (Ca8) formations.

The Henryhouse is thin bedded, the beds ranging up to three inches (pl. IV, fig. 2) and commonly weathering with an irregular, "nodular" appearance (pl. V. fig. 2). The Henryhouse and overlying Haragan marlstone generally disintegrate to produce rubble-covered slopes which are relatively free of vegetation, bearing only scattered clumps of grass and a few juniper trees (pl. V, fig. 1). Such bare, weathered areas, often called glades (Amsden 1957, p. 27), make the best collecting localities as the fossils commonly weather out free.

The HCl insoluble residue content of the Henryhouse varies greatly, the lowest specimen tested yielding about 7 percent and the highest almost 50 percent. The average of 64 analyses (rock specimens) is 20 percent, and the frequency distribution of these analyses is shown in figure 20. Almost all of the residues fall in the clay-silt size range, few ranging into a fine sand. The washed residues consist largely of clear, subangular, silt size quartz. Some mica is generally present, but other minerals are rare (locally pyrite is common and in some beds pyrite nodules up to an inch or more in diameter are moderately plentiful; I have collected some well-formed clusters of pyrite crystals at M18-G). Arenaceous Foraminifera are absent from most residues, although I have seen a few specimens; Ireland has described three Henryhouse

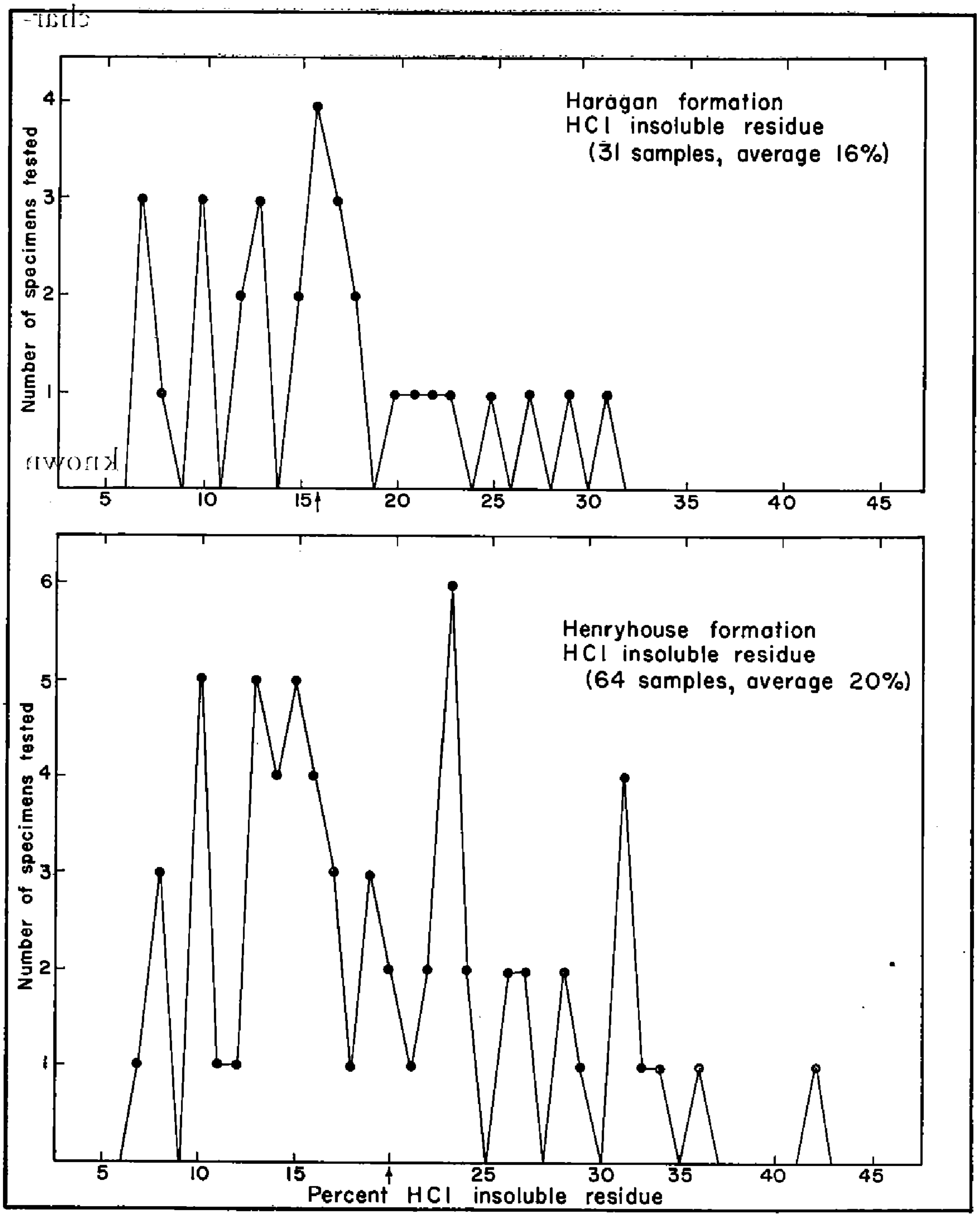


Figure 20. Frequency diagram showing the distribution of HCl insoluble residues in the Haragan formation (above) and the Henryhouse formation (below). The Henryhouse specimen Cal-I (49%) and the Haragan bioclastic calcarenite PI-U (2½%) are not included. The data for this are given in the APPENDIX.

species (see Amsden 1956, p. 15). Silicified fossils are rare in the Henryhouse formation, and few insoluble residues yield evidence of even incipient silicification. I have not observed any chert in the Henryhouse. The geographic distribution of the HCl insoluble residues is shown in figure 21. For a further discussion of the acid insolubles see below under *Strata overlying the Henryhouse formation.*

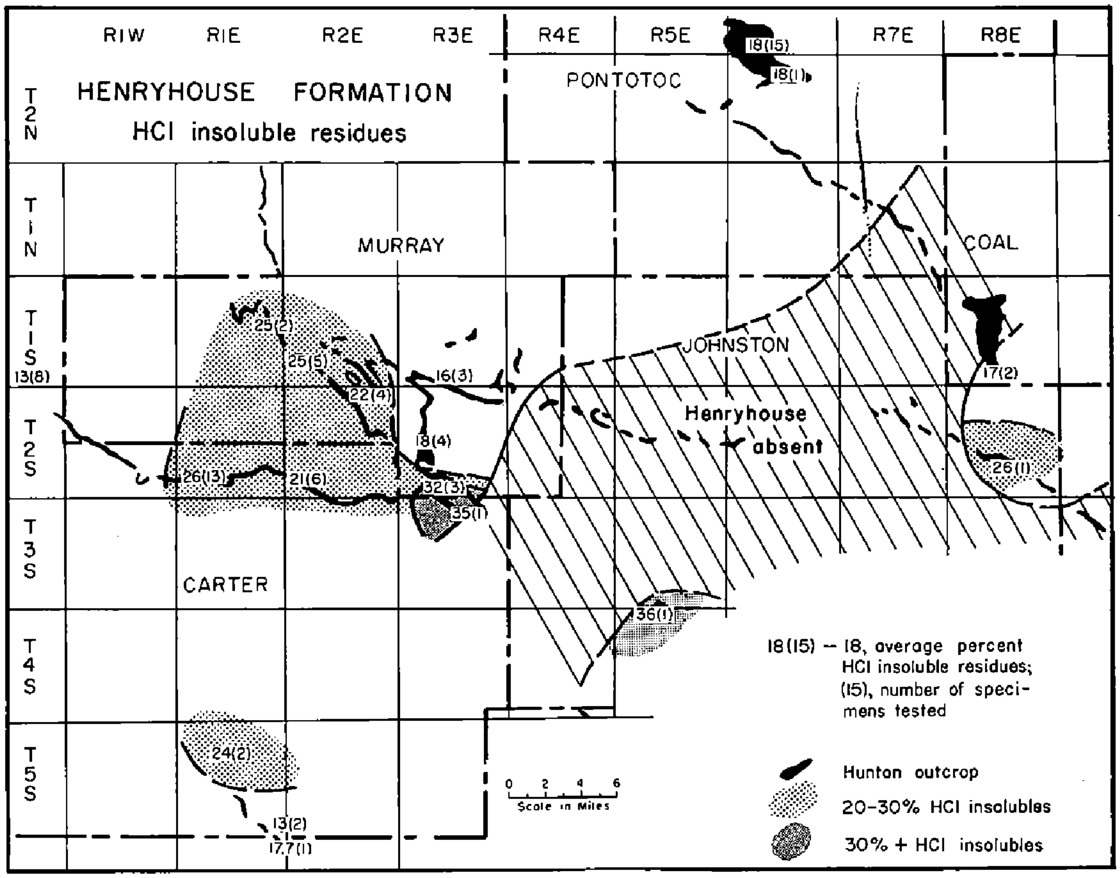


Figure 21. Map showing the geographic distribution of the HCl insoluble residues in the Henryhouse formation. Note that the figures given are averages, in some instances of rather widely varying percentages. The data for this are given in the APPENDIX.

A number of acetic acid residues have been prepared and a few of these have yielded rare conodonts and arenaceous Foraminifera. The paucity of the Henryhouse microfauna stands in marked contrast to the abundance of these fossils in the Clarita member (see CLARITA MEMBER *Strata overlying the Clarita member*).

Most Henryhouse beds have a low $MgCO_3$ content. The average of 64 rock analyses is 3.2 percent, but as shown in the frequency diagram (fig. 22), the strongest concentration is below 2 percent. The geographic distribution of $MgCO_3$ is also variable, as shown in figure 23. There is a marked concentration on the Lawrence

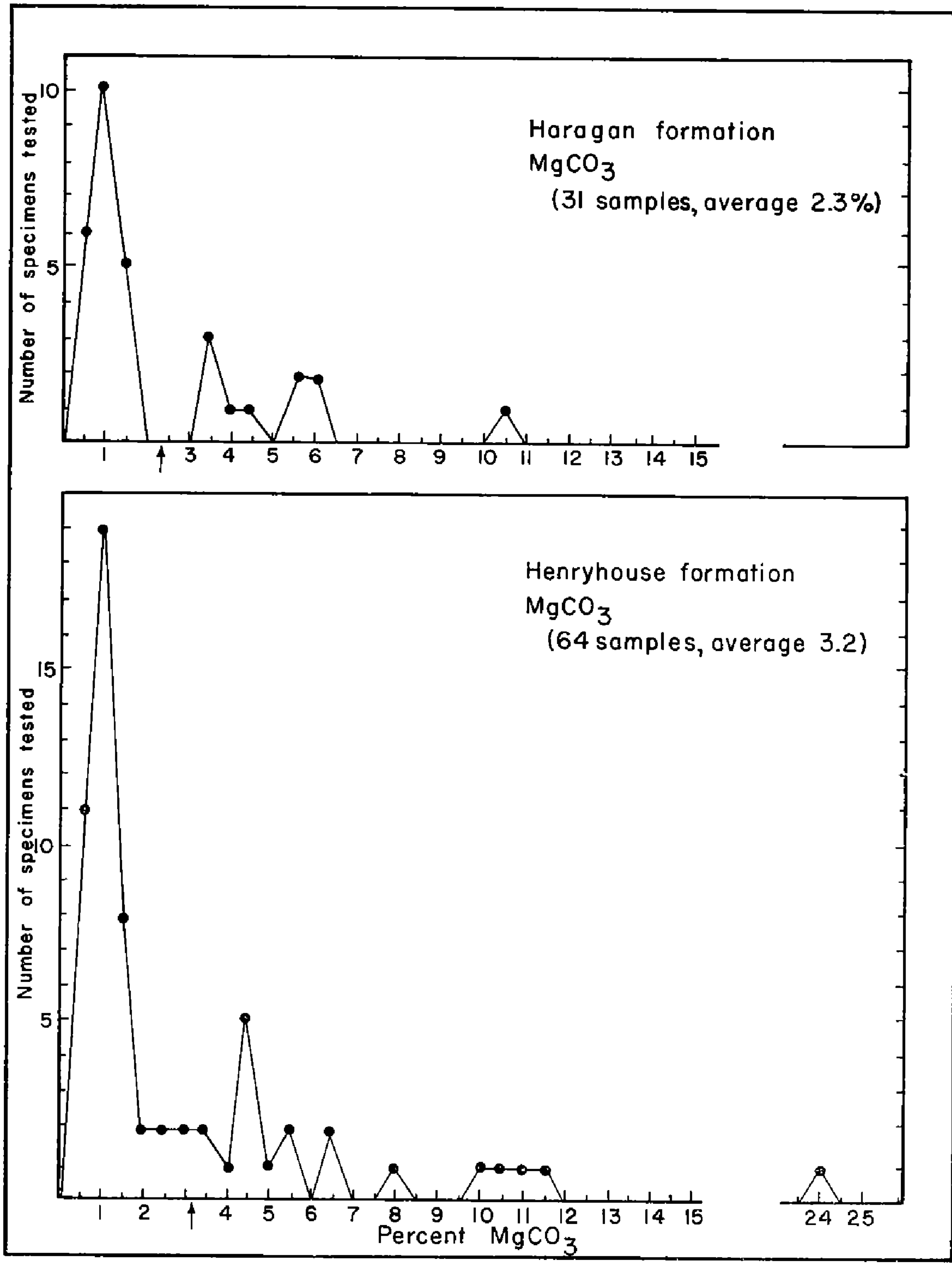


Figure 22. Frequency diagram showing the distribution of $MgCO_3$ in the Haragan formation (above) and the Henryhouse formation (below). The data for this are given in the APPENDIX.

Uplift where the rock specimens and the channel sample (Burwell 1955, p. 9) all show a magnesium content above the average. The highest analysis obtained is 24 percent at section Ca4 in the eastern part of Carter County, but on this section the Henryhouse is directly overlain by the Woodford and this may represent local dolomitization associated with the Woodford unconformity. A further discussion of the Henryhouse $MgCO_3$ is given below under *Strata overlying the Henryhouse.*

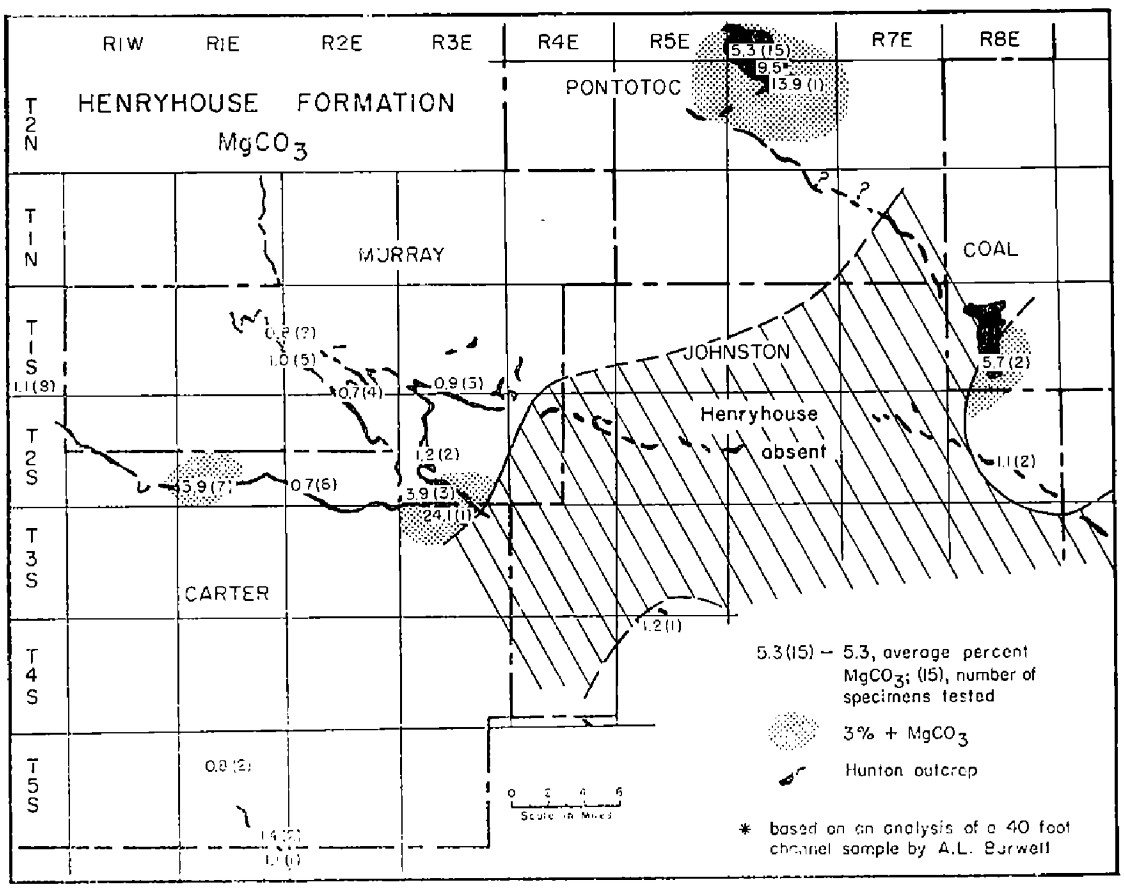


Figure 23. Map showing the geographic distribution of $MgCO_3$ in the Henryhouse formation. Note that the figures given are averages, in some instances of rather widely varying percentages. The data for this are given in the APPENDIX.

A rather interesting relationship is shown in the analyses from sections Ca1 and Ca1 (2) (APPENDIX). These two sections describe the Henryhouse in its type area; Ca1(1) covers the somewhat weathered strata exposed on a glade about 300 feet west of Henryhouse Creek, whereas Ca1 (2) is based on the relatively fresh rock exposures in the bed of the creek. Six Henryhouse specimens were collected from the glade section (section Ca1) and these average 33 percent HC1 insolubles, a percentage which is substantially higher than the average of 20 percent (7 specimens) obtained from section Cal(2) in the creek bed. Since these sections are only 300 feet apart it would seem reasonable to interpret the difference as due to the greater leaching of the more deeply weathered glade exposures. The $CaCO_3$ content seems to confirm such an interpretation as it averages 75 percent on the creek exposures (Cal. (2)) and only 65 percent on the glade exposures (Cal); some $MgCO_3$ also appears to have been leached as it averages 3.9 percent on the creek exposures (Cal(2)) and only 1.1 percent on the glade exposures (Cal). This factor undobtedly affects many of the analyses given in the APPENDIX as most of the sections which I have described cover more or less deeply weathered exposures. Even if the analyses do tend to have the HC1 insolubles increased at the expense of the carbonate fraction, this is not thought to be significant in making relative comparisons (i. e. Henryhouse with Haragan) as most of the analyses are of rock samples taken from outcrops which have undergone about the same degree of weathering.

The $CaCO_3$ content of the Henryhouse beds ranges from 37 to 91 percent, the average being 76 percent. This average, based on the rock analyses given in the APPENDIX, is higher than the 66.7 percent obtained by Burwell (1955, p. 9) from an analysis of a 40-foot channel sample; however, his specimen came from the Lawrence Uplift where the Henryhouse has, as noted above, a substantially higher dolomite content than is normal in other areas. Burwell's data are also interesting because they include analysis of other elements in addition to calcium and magnesium.

Several thin sections and a number of paralodion peels have been prepared (pls. XII and XIII). These show the Henryhouse to be primarily a calcilutite bearing scattered fossils. Excluding fossils, the fragments making up the matrix rarely exceed 0.05 mm, and most are much smaller. A substantial part of the rock is composed of silt and clay size insoluble debris (see above) which is clearly detrital material derived from outside of the basin of deposition. The finely divided carbonate fraction is difficult to study owing to its small size. This is the material Folk (1959, p. 8) terms microcrystalline calcite ooze, and which he considers to form as a "chemical or biochemical precipitation in sea water, settling to the bottom and at times suffering some later drifting by weak currents." It is further classified as an orthochemical constituent which originates as a "normal precipitate". Folk illustrates (pl. 2, fig. 16) a specimen of Devonian Hunton (presumably Haragan) marlstone as an example of a biomicrite; i. e. fossils set in a matrix of microcrystalline ooze. It is possible that some of the pieces making up the finely divided carbonate of the Hunton marlstones may be clastic (allochemical) in origin, but it must be admitted that these marlstones give every evidence of deposition in quiet waters (see HARAGAN FORMATION, *Environment of deposition*) where comminution of fossil debris was at a minimum. It should be kept in mind, however, that the marlstones (such as those illustrated on plates XII and XIII) include a substantial account of clay and silt size clastic insoluble detritus (terrigenous).

Fossils are scattered through this finely divided matrix in varying degrees of concentration. On most specimens the recognizable fossil debris appears to be well below 50 percent (pl. XIII, figs. 1, 2), and on some specimens isolated fossils are widely dispersed, although I have never seen a Henryhouse thin section or peel that did not show some organic material. A few Henryhouse beds carry more than 50 percent fossil material, and in rare instances it is sufficiently concentrated to approach a bioclastic limestone (pl. XII, fig. 4). This is, however, unusual, and most Henryhouse beds have less than 25 percent recognizable organic material. For the most part, Henryhouse fossils appear to be randomly distributed and oriented, with little tendency toward concentration into well-defined beds. In this connection it should be noted that most Henryhouse fossils are well preserved and show little or no evidence of abrasion.

Environment of deposition: The Henryhouse is lithologically and stratigraphically so similar to the Haragan that the two must have been deposited under similar conditions, and therefore a discussion of this topic is deferred to the HARAGAN FORMATION.

Strata underlying the Henryhouse formation: The Henryhouse is separated from older Hunton strata by an erosional unconformity. This unconformity is not of great magnitude in terms of strata removed and throughout much of its its outcrop area the Henryhouse rests upon the Clarita member of the Chimneyhill formation (the Henryhouse-Clarita relationship is discussed under the CLARITA MEMBER; see also panel III, pl. C).

The unconformable nature of the pre-Henryhouse boundary is shown in the stratigraphic relations at the south end of the old Hunton townsite belt (panel II, pl. B). In the southernmost portion, around section C1, the lower part of the Hunton consists of Cochrane, Clarita, Henryhouse and Haragan, in ascending order. A short distance north of C1, the Clarita member is cut out under the pre-Henryhouse unconformity and the latter rests on Cochrane beds. Unfortunately, throughout much of the central and northern parts of this outcrop belt the lower part of the Hunton marlstone is covered so that the Henryhouse-Chimneyhill relations are not observable. The Henryhouse may again be observed in direct contact with the Cochrane member at section Ca7 in the eastern part of Carter County. No Clarita beds were seen in sections L1 and L2 in the southern part of the Criner Hills, and the Henryhouse is presumed to rest upon the Cochrane. I have not observed the Henryhouse in contact with the Keel or Ideal Quarry members of the Chimneyhill formation. The above cited stratigraphic relations (shown on panel III, pl. C), plus the marked faunal differences between the Henryhouse and earlier units (see below, *Fossils and age*) point to a period of emergence and erosion prior to the deposition of the Henryhouse.

Strata overlying the Henryhouse formations. The Henryhouse is separated from the overlying Devonian strata by an unconformity of some magnitude. This unconformity is discussed in the chapters on the SILURIAN (*unconformities*) and DEVONIAN, and is illustrated in the maps and stratigraphic sections on panel III.

The Henryhouse is overlain by the Haragan formation throughout most of its outcrop area. I have observed the Bois d'Arc in direct contact with the Henryhouse in only one small area on the Lawrence Uplift (P8; see illustration and discussion in Amsden 1957, p. 30-31, fig. 6, pl. II figs. A-B). In a number of places the Lower Devonian strata have been removed by post-Hunton erosion, thus bringing the Woodford in contact with the Henryhouse. This condition can be seen in the northern part of the Lawrence Uplift (panel III, pl. A), in the eastern part of Carter County (Ca3, Ca4, Ca5, Ca6, Ca7), in the vicinity of Camp Classen (M15), and in parts of the Criner Hills (Ca13, Ca14). The pre-Woodford unconformity is shown on the subcrop map, panel III, plate A, and on the stratigraphic sections, panel III, plate C).

The relationship of the Henryhouse to the Haragan is one of the most interesting features of Hunton stratigraphy. Lithologically these formations are alike, and I have not been able to discover any feature, other than fauna, which can be consistently used to separate the two. Moreover, in only one place have I found clearly defined physical evidence of an unconformity (section P8, Bois d'Arc Creek; Amsden 1957, p. 31, text fig. 6 pl. II, figs. A, B; footnote, p. 34). The Henryhouse-Haragan boundary is thus an excellent example of a paraconformity as that term is used by Dunbar and Rodgers (1957, p. 119). The only reliable method of distinguishing Henryhouse from Haragan strata is by means of the fossils, and it is fortunate that the faunal evidence is clear and unambiguous, both in terms of the local faunal succession and in terms of regional faunal succession. The faunal evidence has already been discussed at some length (Amsden 1958A, p. 15-16, 145-147; 1958B, p. 24-26) and the details will not be reviewed here, but a general survey of the nature of the evidence seems to be warranted since the validity of paraconformities has recently been questioned. Two types of evidence can be adduced with respect to the Henryhouse-Haragan unconformity: the *first* is concerned exclusively with the biostratigraphic relations within the outcrop area, and the *second* with the relative ages as determined from regional and world-wide Silurian-Devonian relationships. Both sets of data point to a time gap and break in the sedimentary record of some magnitude, but the one here stressed is the first. Within the outcrop area of the Arbuckle Mountains and Criner Hills the Henryhouse and Haragan faunas are everywhere distinct; where the two are in contact the faunal boundary is sharply defined and repeated collecting across this boundary shows absolutely no transitional faunas whatsoever bridging the gap between the two. In places the Haragan fauna rests upon the Henryhouse, in other places on the Chimneyhill, and even locally on the Sylvan (panel III, pl. C), but regardless of its stratigraphic position it is everywhere a well defined faunal entity, and this is equally true of the Henryhouse. This relationship is brought out in the described stratigraphic sections and accompanying faunal lists given in the APPENDIX (especially P3, P8, M1, Ca1). The evidence for this relationship is completely independent of the age assigned to either of these faunas, or to any stratigraphic or faunal relationship which may exist in the type area of the Silurian and Devonian (or any place else for that matter). One may not agree with the interpretation of the facts as given in this report, but the Henryhouse-Haragan paraconformity cannot be suppressed or eliminated on the grounds that the Silurian-Devonian relations in the type area or elsewhere have been misinterpreted. In actual fact, the local evidence for a post-Henryhouse pre-Haragan unconformity is fully supported by the age relationship of these two faunas as determined from a comparison with faunal successions as determined in other areas. The Haragan is early Devonian (Helderbergian) and the Henryhouse is early Late Silurian (Ludlovian), and thus the two are separated by a time interval covering most of the Late Silurian.

I have already described and illustrated the Henryhouse-Haragan lithologic relations (1957, p. 30-32, text fig. 6, pl. II, figs. A, B; See also fig. 56 of the present report) and therefore will limit the present discussion to supplying some additional information on the HCl insoluble residues and $MgCO_3$ content of these formations. Both formations are predominantly calcilutites which are composed of finely divided insoluble and carbonate particles, most of which fall in the silt-clay size range. Fossils are scattered through this fine-textured matrix in varying amounts (compare figs. 1 and 2 with 3 and 4 pl. XIII). The composition of the HCl insoluble material is substantially the same in both formations, the washed residues (clay removed) being composed largely of silt size, subangular, clear detrital quartz (no study has been made of the heavy mineral suite). In both formations the quantity of insoluble material varies widely from bed to bed, and the range of variation is roughly the same. However, when a number of analyses are compiled it appears that the Henryhouse has a greater quantity of insoluble detritus than does the Haragan. A frequency diagram (fig. 20) shows that the range (6% to 44%) and the average (20%) in the Henryhouse is greater than the range (6% to 31%) and the average (16%) in the Haragan. A more significant comparison can be made if the insolubles are broken down and compared by separate stratigraphic sections as had been done in figure 24. Eight of the ten sections for which comparative data are available have distinctly different (average) amounts of insolubles in the Henryhouse than in the Haragan, whereas only two (M2, M17) have approximately equal residues; on all but two (M10, M17) the Henryhouse is the larger. The geographic distribution of residues (averages) of the Henryhouse (fig. 23) also has little in common with the Haragan (fig. 29). I would infer from the foregoing data that the Henryhouse and Haragan

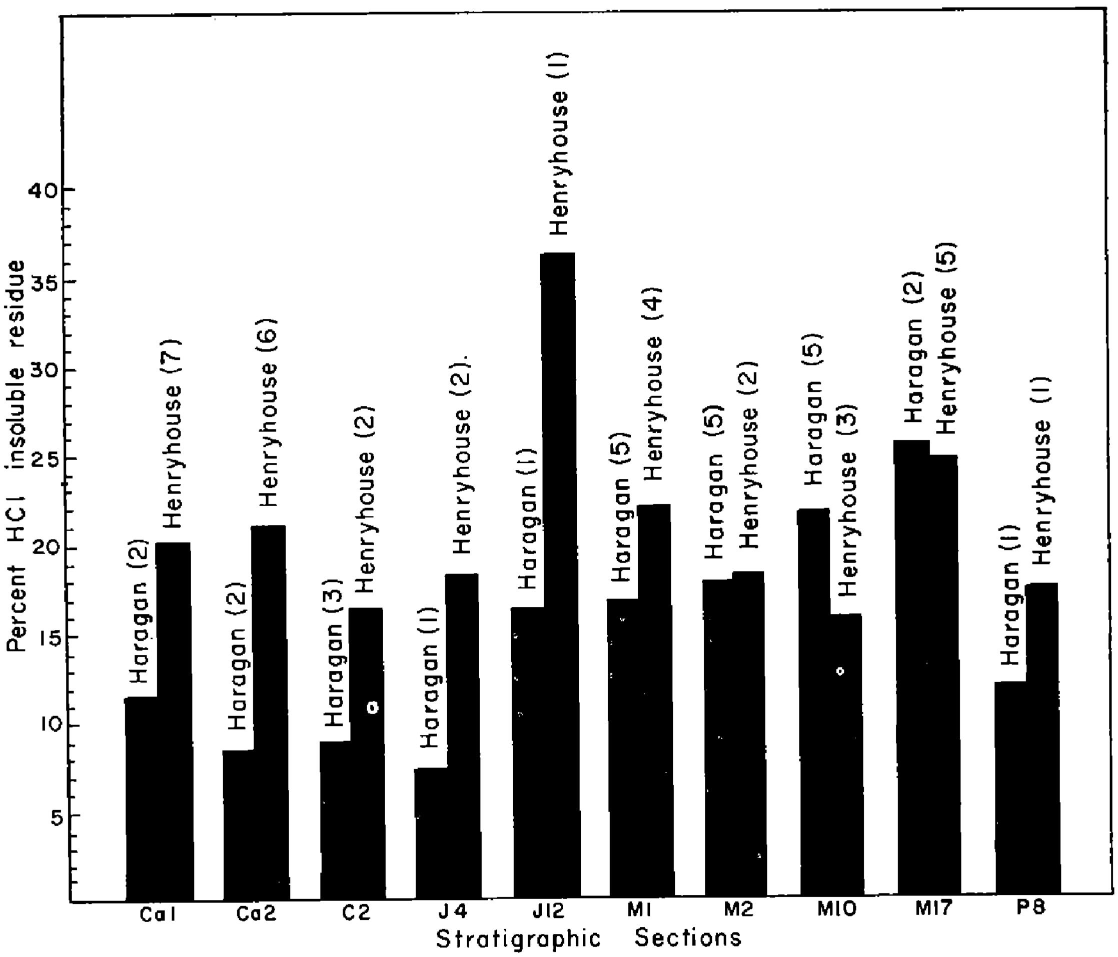


Figure 24. Bar diagram comparing the Henryhouse and Haragan HCl insoluble residues from 10 different stratigraphic sections. The amount shown for each section is an average; the figure in parenthesis (7) indicates the number of analyses on which the average is based. The data for this are given in the APPENDIX.

were deposited under similar conditions; in both considerable silt-clay size extra-basinal detritus was available, the amount varying from place to place and from time to time. On the whole the Henryhouse received the greatest quantity of material although in a few places the amount was about equal, and, quite locally, the relative proportions were reversed. This evidence, although admittedly based on a rather small number of analyses, seems to fit in well with the faunal evidence that the two formations were deposited in different seas at different times (Amsden 1958A, p. 15-16).

The distribution of $MgCO_3$ in the Henryhouse-Haragan sequence would appear to be somewhat different from that of the HCl insoluble residues. The frequency diagram, figure 22, shows a similar pattern for both formations. Excluding the highest Henryhouse analysis of 24 percent (which is discussed below), the

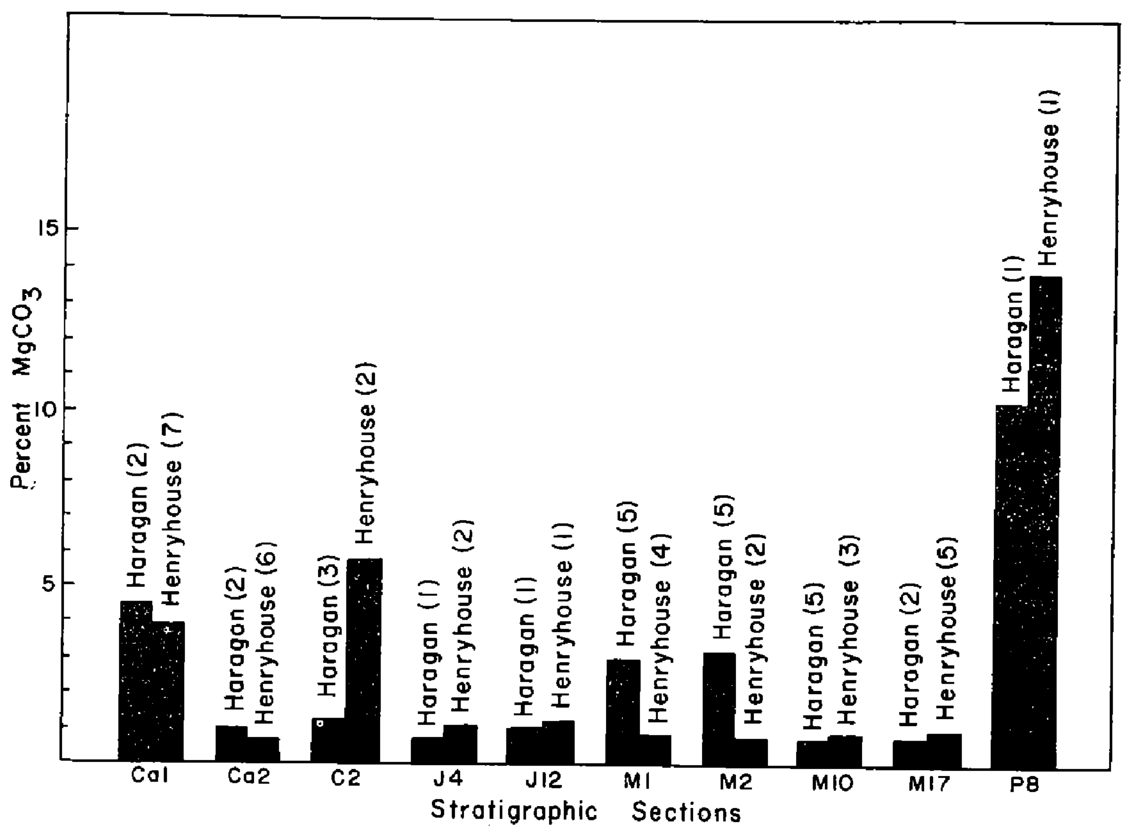


Figure 25. Bar diagram comparing the Henryhouse and Haragan $MgCO_3$ content from 10 different stratigraphic sections. The amount shown for each section is an average; the figure in parenthesis (7) indicates the number of analyses on which the average is based. The data for this are given in the APPENDIX.

range (½% to 11%) and the average (3.2%) of the Henryhouse is similar to the range (½% to 10½%) and average (2.3%) of the Haragan. A more interesting comparison can be made if the $MgCO_3$ analyses are broken down and compared by stratigraphic sections as has been done in figure 25. Six of the ten sections illustrated show a Henryhouse-Haragan $MgCO_3$ average that is nearly the same. On section P8 the amount is somewhat different but the two are alike in having a magnesium content that is far above the average; on this section the lower part of the

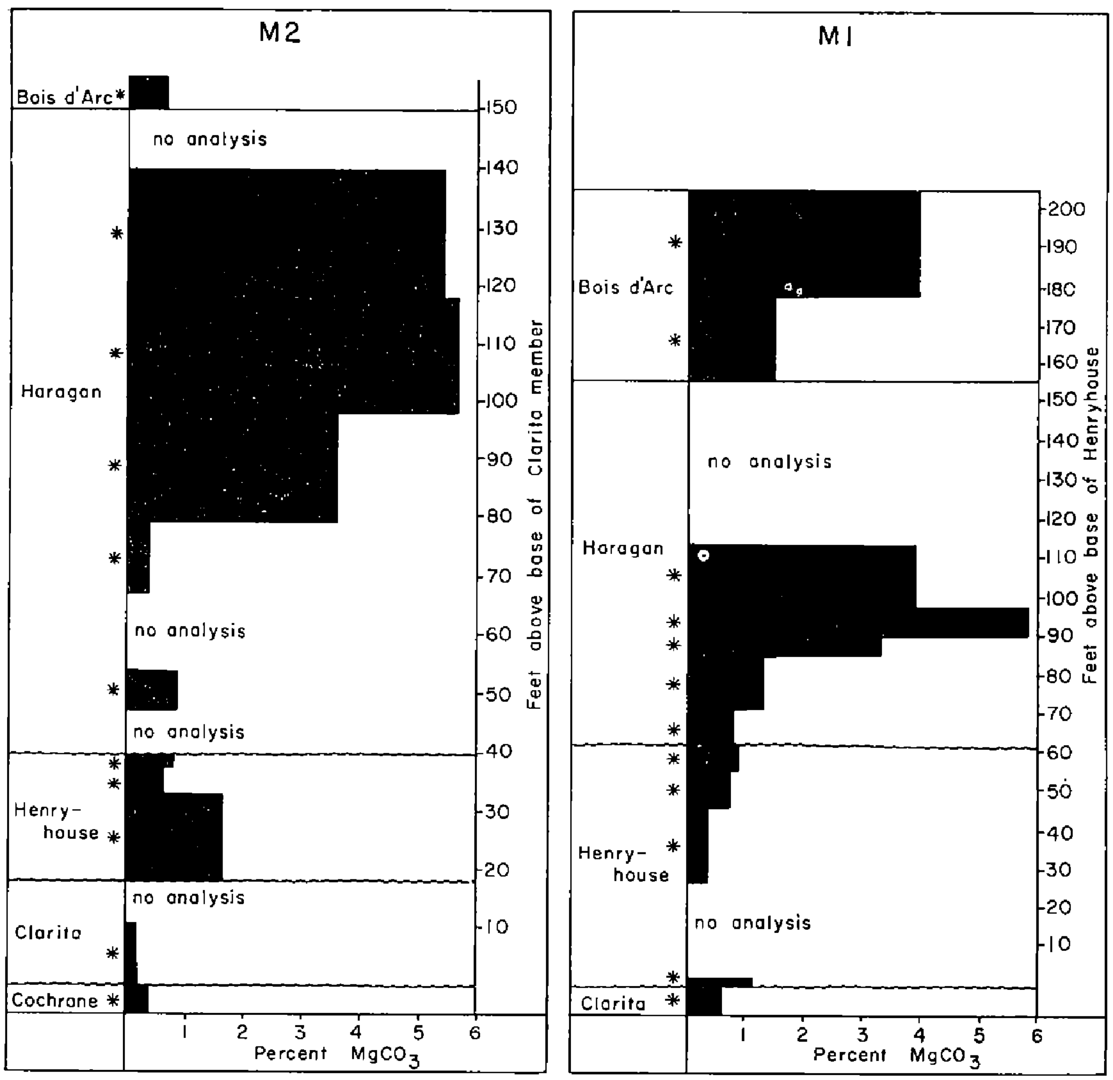


Figure 26. Bar graph showing the distribution of $MgCO_3$ in the Hunton group at sections M1 and M2. This is based on analyses of rock samples, each asterisk (*) representing a single analysis. The vertical height of the bar opposite each asterisk is related to the stratigraphic divisions which I recognized when describing the sections. The stratigraphic and chemical data for this are given in the APPENDIX.

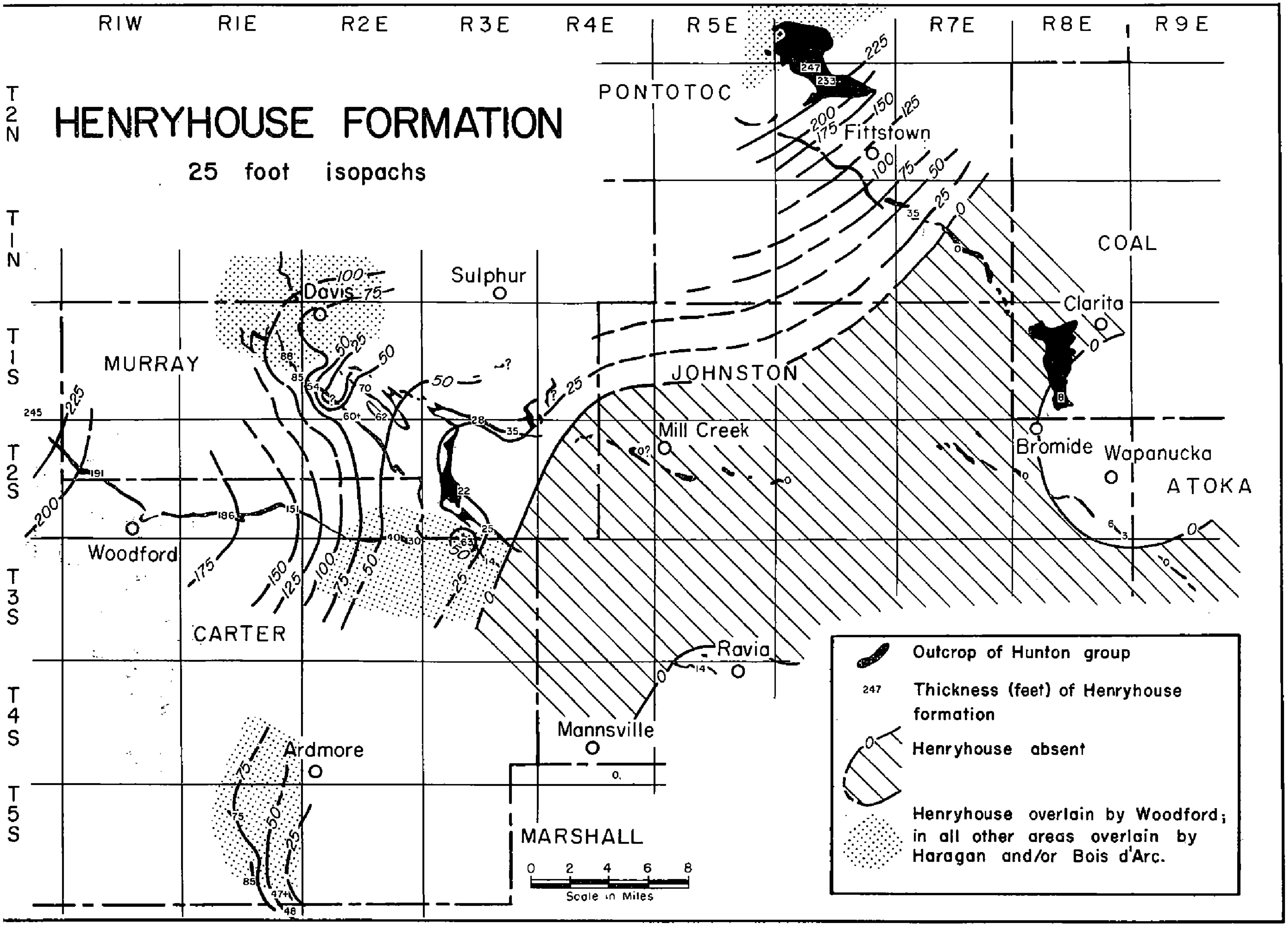
Cravatt member also has a $MgCO_3$ content well above the average (fig 4). There are three sections (C2, M1, M2) in which the quantity of $MgCO_3$ is substantially defferent from that of the Haragan. On one of these, C2, the break in $MgCO_3$ content appears to take place at or near the Henryhouse-Haragan boundary (see APPENDIX), but in the other two sections the big increase in $MgCO_3$ is not related to this boundary, taking place within the Haragan formation. This is clearly shown in figure 26 which is a diagram prepared to show the range and distribution of $MgCO_3$ in the Hunton group at sections M1 and M2. The geographic distribution of $MgCO_3$ in the Henryhouse (fig. 23) also has some similarity to that of the Haragan (fig. 30), the areas of greatest concentration (i. e. Lawrence Uplift) being the same in most places.

Some remarks have already been made concerning the origin of Hunton dolomite and evidence has been adduced suggesting a secondary origin (HUNTON GROUP, *Hunton $MgCO_3$*). The foregoing data, which point to a similarity of Henryhouse and Haragan $MgCO_3$ content might be interpreted as further support for such an hypothesis. If the $MgCO_3$ were introduced after the deposition of both formations, they could be expected to show some similarity in amount and in geographic distribution, although there would be no reason to expect a precise correlation as the magnesium content in the Hunton is known to be quite erratic in its development (figs. 3, 4, 5). Nevertheless a general geographic correlation could be expected in those areas which show a higher than average amount (i. e. P8, Lawrence Uplift). If, on the other hand, the magnesium were entirely primary (defined to include a penecontemporaneous replacement), and if the quantity were varying in different geographic areas (as the analyses show), then such a correlation would be entirely fortuitous as the Henryhouse and Haragan strata were laid down in unrelated seas separated by a considerable time interval. It must, however, be admitted that whereas the present data are suggestive, they are really not adequate to establish with certainty a relationship between Henryhouse and Haragan $MgCO_3$ content; the similarity that is shown on figure 24, especially on those sections showing a low content, might be interpreted as indicating only that both formations were receiving insignificant amounts of $MgCO_3$ at the time they were laid down. More analytical data are needed before any firm conclusions can be reached.

The method whereby the magnesium was introduced, assuming the hypothesis of secondary dolomitization to be correct, is not clear. There is some evidence of minor dolomitization under the pre-Woodford unconformity, but this appears to be a local development. For example, the Henryhouse formation at Ca4 (24%), the Cravatt member at M1 (21%), and the Fittstown member at M3 (11%) are dolomitic where they are in contact with the Woodford; however, most analyses of Hunton strata which are near to, or in contact with, the Woodford do not show an unusual $MgCO_3$ content (see CHEMICAL ANALYSES, APPENDIX). This effect, therefore, appears to be quite local and most of the Henryhouse-Haragan dolomite concentration shown on the maps (figs. 23, 30) cannot be related to the pre-Woodford unconformity. For example, the concentration on the Lawrence Uplift affects the Henryhouse-Haragan marlstones in an area where they are overlain by a thick sequence of Bois d'Arc and Frisco beds which are low in $MgCO_3$ (see analyses of section P8). This is also true in the vicinity of Henryhouse Creek where both the Henryhouse and Haragan average about 4 percent $MgCO_3$ whereas the Fittstown strata, which are in contact with the Woodford, average less than one percent.

Thickness and distribution: The thickness and distribution of the Henryhouse in the Arbuckle Mountain and Criner Hills regions are shown on the isopach map, fig. 27. The formation attains its maximum thickness in two areas, 247 feet in the northernmost outcrops on the Lawrence Uplift, and 245 feet in the westernmost outcrops. From these two maxima the formation thins to the south and east, being absent or thin throughout the central and southeastern parts of the Arbuckles.

At the close of Henryhouse time its thickness undoubtedly varied somewhat due to inequalities in the rate of sedimentation, but I have no means of ascertaining the amount of this original primary variation. Following deposition, the Henryhouse strata were affected by two periods of erosion (excluding, of course, the present time); one of these took place in post-Henryhouse pre-


HENRYHOUSE FORMATION
25 foot isopachs
RIW
RIE
R2E
R3E
R4E
R5E
R7E
R8E
R9E
T2N
T1N
T1S
T2S
T3S
T4S
T5S
PONTOTOC
COAL
MURRAY
JOHNSTON
ATOKA
CARTER
MARSHALL
Fittstown
Davis
Sulphur
Clarita
Mill Creek
Bromide
Wapanucka
Woodford
Ravia
Mannsville
Ardmore
Outcrop of Hunton group
247 Thickness (feet) of Henryhouse formation
Henryhouse absent
Henryhouse overlain by Woodford; in all other areas overlain by Haragan and/or Bois d'Arc.
0 2 4 6 8
Scale in Miles

Haragan time, and the other in post-Hunton pre-Woodford time. I have indicated on the isopach map the areas where the Henryhouse is directly overlain by Woodford, because in those places the Henryhouse thickness has been affected by both periods of erosion. In all other areas the Henryhouse is directly overlain by the Haragan and its thickness is therefore only influenced by the post-Henryhouse pre-Haragan erosion. A further discussion of the Henryhouse-Haragan unconformity is given under SILURIAN STRATA (*Unconformities*) and under the DEVONIAN STRATA (*Unconformities*).

Fossils and age: The quantity of fossil material in the Henryhouse ranges widely (see above, *Lithology*). In a few areas, such as the Lawrence Uplift, it is richly fossiliferous and many well-preserved free specimens can be collected, but in other places the fossils are scarce and the collecting lean (Amsden 1957, p. 32).

The megafauna is strongly dominated by the brachiopods, although locally some beds carry many corals. Both solitary and colonial corals are present, but there is no evidence of reef development. Individual specimens of bryozoans and trilobites are common in many places; however, these represent a relatively small number of species. Reeds (1911, p. 262-263) recorded a substantial megafauna of corals, bryozoans, brachiopods, crinoids, gastropods and trilobites. Some years later Maxwell (1936, p. 71-76) listed an even larger fauna of 104 species, including one sponge, 20 corals, three graptolites, seven crinoids, 15 bryozoans, 38 brachiopods, one pelecypod, five gastropods, seven cephalopods and five trilobites. I have described 40 species of brachiopods (Amsden 1951, p. 69-96; 1958A, p. 145-157), and Decker has described 16 species of graptolites (1935, p. 434-446). A study of Henryhouse Bryozoa is being made by T. G. Perry, but this investigation is not completed and only a summary has been published (Perry 1958, p. 1628-1629). Strimple has described several crinoids and in some beds crinoidal debris is abundant. However, except for small inadunate crinoids like *Pisocrinus*, complete dorsal cups are uncommon. Locally the bulbs of *Scyphocrinites* (*"Camarocrinus"*) are abundant and there has been some attempt to use these in working out Hunton stratigraphy. Springer was of the opinion that these bulbs could not be identified to species, and since they are known to be present in the Henryhouse, Haragan and Bois d' Arc their use as zone fossils is unreliable. My *Catalog of Hunton Fossils* includes a discussion of *Scyphocrinites* (1956, p. 59-61) in addition to a complete list of described and illustrated Henryhouse fossils.

The acetic and HCl insoluble residues are commonly barren of microfossils. I have observed a few arenaceous Foraminifera and conodonts, but in comparison with the Clarita member these fossils are conspicuously reduced in numbers.

The Henryhouse is commonly correlated with the Brownsport formation of western Tennessee (Amsden 1949, p. 49) and the brachiopod faunas, in particular, are quite similar to one another (Amsden 1951, p. 70-71). It should, however, be noted that T. G. Perry finds considerable difference between the Bryozoa faunas of these two formations (1958, p. 1629). The Henryhouse formation has also been correlated with the Bainbridge limestone of Missouri, the Louisville limestone of Kentucky, and certain unnamed dolomites in the Chicago area (Amsden 1949, p. 32-36).

This formation has been assigned a Niagaran (Middle Silurian) age in the past, but more recent information points to an early Late Silurian (early Ludlovian) age. The evidence for this revised age assignment is discussed in my 1958 paper (1958A, p. 15, 147). The Henryhouse fauna is thus distinctly different in age and in content from the underlying Clarita member (Niagaran) and the overlying Haragan formation (Helderbergian).

HUNTON DEVONIAN STRATA

The Devonian part of the Hunton group is referable to three formations, Haragan, Bois d'Arc and Frisco, named in ascending order. All of these units belong in the Lower Devonian, the Haragan and Bois d'Arc being Helderbergian and the Frisco Deerparkian in age. The Frisco is a relatively thin calcarenite which is lithologically and faunally distinct from the underlying Helderbergian strata. In those areas where the Helderbergian sequence (Haragan-Bois d'Arc) is thick and reasonably complete, the stratigraphic succession consists of marlstone (Haragan), followed by cherty marlstone (Cravatt member), which grades upwards into calcarenites (Fittstown). This change is accompanied by an irregular, but progressive decrease in the acid insolubles (figures 4, 5, 20, 36). These lithologic divisions are erratic in their development and there is considerable evidence for local, as well as regional, lateral graduation from one type to the other (plate C, panel III). The stratigraphic distribution thus points to a facies relationship between the Haragan and the Bois d'Arc, and this interpretation is fully supported by the faunal evidence (see below under HARAGAN and BOIS D'ARC FORMATIONS).

Unconformities: The deposition of Helderbergian strata was preceded by a period of erosion which exposed different Silurian formations and, in one area, the Sylvan shale (plates B, C, panel III). The Silurian strata show considerable truncation over their entire outcrop area, but the surface upon which the Devonian was deposited must have been one of little relief because the total thickness of Hunton Silurian (fig. 8) rarely exceeds 300 feet, and had the pre-Devonian surface been one of much relief these strata would surely have been pierced in many places (see SILURIAN, *Unconformities*). In many places there is little or no physical evidence of an unconformity, but locally (e. g. A2-B) a conglomerate is present in the basal part of the Devonian.

The Lower Devonian subcrop map (panel III, pl. B) shows that the most extensive erosion took place in the central and southeastern parts of the Arbuckles. Throughout much of this area the Silurian beds are thin, and in one area they are absent. I do not see any resemblance between the pattern shown on this map (including the Silurian isopachous map) and the structure of the Arbuckle region shown on the recent map of W. E. Ham (1954).

The Frisco strata are believed to be separated from the Helderbergian beds by an unconformity and there is some evidence of minor pre-Frisco erosion (see section A-A', plate C, panel III). However, the Frisco has such a limited outcrop area within the Arbuckle region that the information on this point is meager.

The Lower Devonian strata are everywhere overlain by the Woodford shale from which they can be easily distinguished on lithologic grounds. There is an erosional unconformity of some magnitude separating the Hunton from the Woodford so that at one place or another within the outcrop area the latter comes into contact with all of the Hunton Devonian units. This unconformity is illustrated in plates A, C of panel III, and is discussed under the chapter on the WOODFORD FORMATION.

Thickness and distribution: The thickness and distribution of Devonian strata are shown on the isopach map, figure 28. The area in which Frisco beds are present is indicated by stippling, whereas in all other places the Devonian consists only of Haragan-Bois d'Arc strata. If the Frisco outcrop is excluded, this is, in effect, an isopach map showing the combined thickness of the Haragan and Bois d'Arc formations (i. e. the Helderbergian part of the Hunton). Actually the Frisco does not greatly affect the total Devonian thickness because, except for the Lawrence Uplift (P11; 60 feet), this formation is generally less than 20 feet (fig. 42).

Excluding primary variations in the original quantity of sediments deposited, the thickness pattern shown in figure 28 is primarly the result of post-Hunton pre-Woodford erosion. There are several places on the map where the Devonian has been completely stripped away, allowing the Woodford to rest directly upon the Silurian. The thickest zone of Devonian sediments is in the area extending from Mill Creek (294 feet, J11) to old Hunton townsite (325 feet, C1); at the latter place the Frisco is present and the Haragan makes up a considerable part of the Helderbergian, but at Mill Creek the Frisco is absent and a substantial part of the Devonian is in the Bois d'Arc lithofacies (panel III, plate C).

HARAGAN FORMATION

The Haragan formation was named by Reeds (1911, p. 263) for a small creek located a short distance north of White Mound. In 1957 I designated the SE¼ NE¼ sec. 20, T. 2 S., R. 3 E., as the type section; this is my section M2, situated about 1,000 feet southeast of White Mound (see description and map, fig. 51, in the APPENDIX). The Haragan strata in the White Mound area are richly fossiliferous and many excellent collections had been made from here before it was closed to the public. There is also a good section of fossiliferous Haragan in the vicinity of old Hunton townsite, although the basal part of the formation is covered (C1, APPENDIX; plate B, panel II). A discussion of

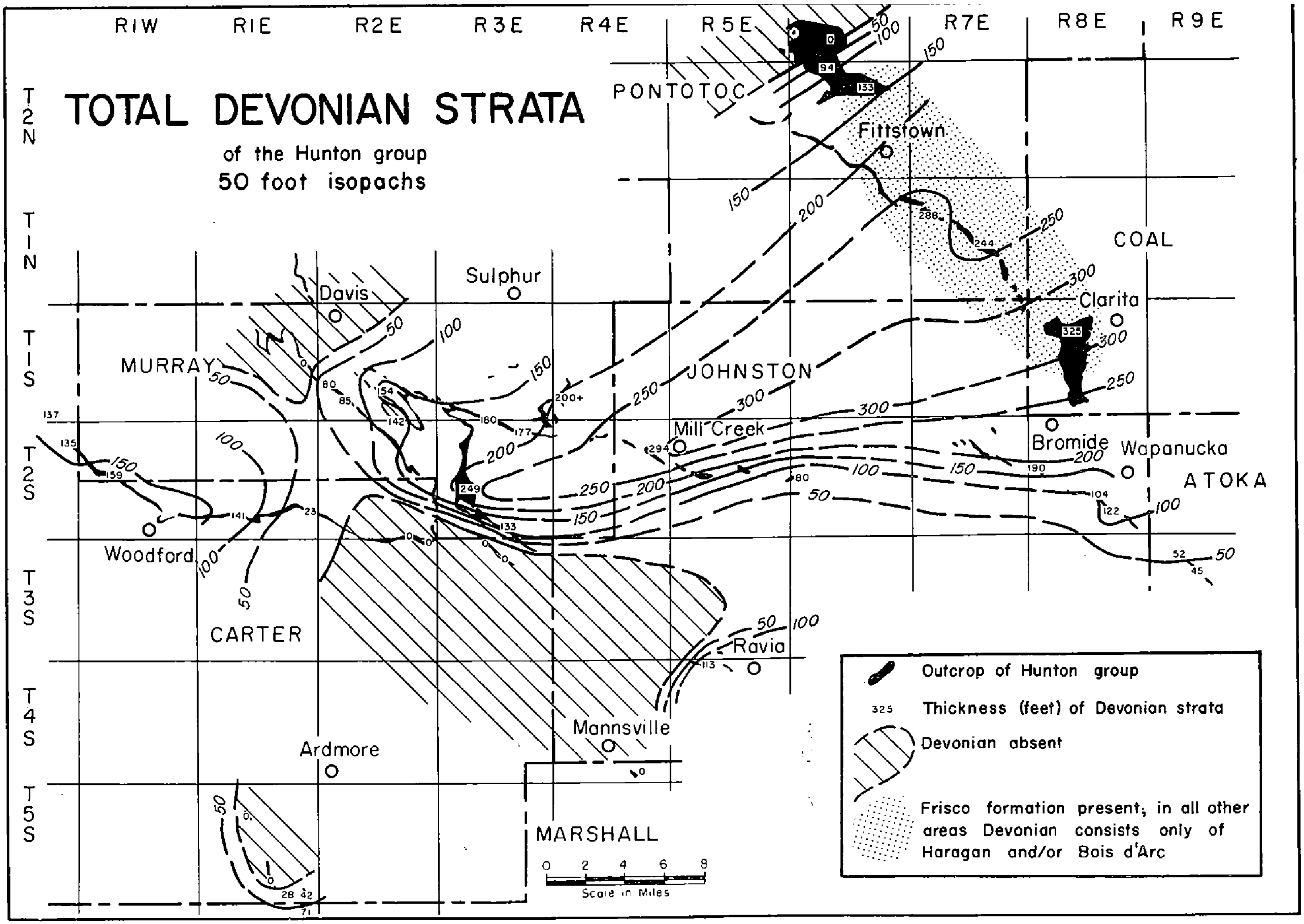


Figure 28. Isopach map showing the total thickness of Devonian strata in the Hunton group.

the term formation as applied to the Henryhouse and Haragan strata is given in the introductory portion of the section on the HENRYHOUSE FORMATION, and the nomenclatorial history of the Haragan formation is discussed in my 1957 paper (p. 35).

Lithology: The Haragan is a silty and argillaceous calcilutite, or marlstone, in beds to three or four inches (Amsden 1957, pl. II, A). Its fossil content is variable, but in most areas fossils are common and a moderate to substantial megafauna can easily be collected. Haragan strata are generally some shade of yellowish gray (5Y 7/2 to 5Y 8/4), less commonly with a greenish cast (10 8/2). In places the beds are red, or mottled red and gray (10R 6/2; 10R 7/4; 10R 5/4; 10R 4/2); a good example of Haragan red beds can be seen at section P10, southeast of Fittstown (see APPENDIX). The Haragan marlstones (and also the Henryhouse marlstones) show little color difference between the weathered and the fresh rock.

The Haragan is almost entirely free of chert, the chert bearing portion of the Hunton Helderbergian strata being referred to the Bois d'Arc formation (see below, *Haragan-Bois d'Arc relationship*). In a few places I have included thin, discontinuous cherty zones within the Haragan. An example of this can be seen at section C1, near old Hunton townsite, where a 9-foot zone of marlstone with tripolitic chert has been retained with the formation; these cherty beds, which form a small topographic bench, are separated from the overlying main body of chert-bearing strata (Bois d'Arc) by almost 60 feet of marlstone with no chert. This zone can be traced south for a mile or so before it disappears as shown on the geologic map of the old Hunton townsite area (pl. B, panel III), and in stratigraphic section A-A' (pl. C, panel III). A similar bed has been included in the Haragan at section P10 (unit I), although here the chert is thinner and shows even less lateral persistence. The significance of these chert beds is discussed below, under *Haragan-Bois d'Arc relationship*.

The Haragan characteristically has a calcilutite texture and in only one small area on the Lawrence Uplift (P1) have I observed any calcarenite. In this area the Haragan includes a lens (maximum thickness of two feet) of bioclastic calcarenite with the low insoluble residue (2½%) that is so typical of almost all coarse-textured Hunton limestones. This bed is overlain and underlain by marlstone, and traced laterally may be seen to lens out into marlstone. It is described and illustrated in the APPENDIX (fig. 55) and is discussed below under *Haragan-Bois d'Arc relationship.*

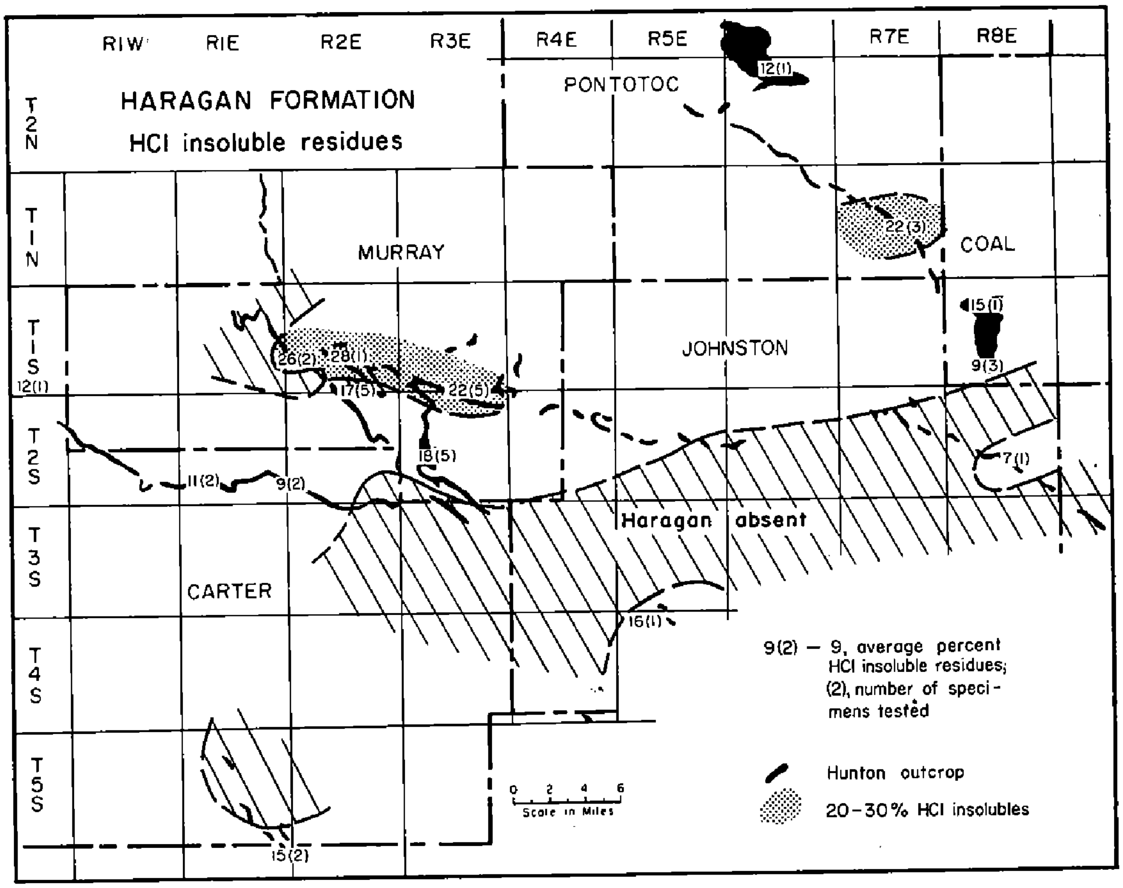


Figure 29. Map showing the geographic distribution of HCl insoluble residues in the Haragan formation. Note that the figures given are averages, in some instances of rather widely varying percentages. The data used in compiling this are given in the APPENDIX.

The HCl insoluble residue content of the Haragan ranges widely, the highest tested being slightly over 30 percent and the lowest 2½ percent; however, the latter is from the bioclastic calcarenite cited above (P1-U) and the lowest residue obtained from a rock with calcilutite texture is about 7 percent. The average of 31 analyses (rock samples) is 16 percent, and their frequency distribution is shown on figure 20 (the distribution by stratigraphic sections is illustrated in figure 24). Almost all of the residues fall in the silt-clay size range, few ranging into a fine sand. The washed residues (clay removed) consist largely of clear, subangular, silt size quartz with some mica (no study has been made of the heavy mineral suite). Arenaceous Foraminifera are rare or absent in most residues; Ireland has described a few Haragan species (Amsden 1956, p. 39). Some of the acid residues include a few fragments of silicified fossils, but on the whole the Haragan exhibits little silicification. The geographic distribution of HCl insoluble residues is shown in figure 29.

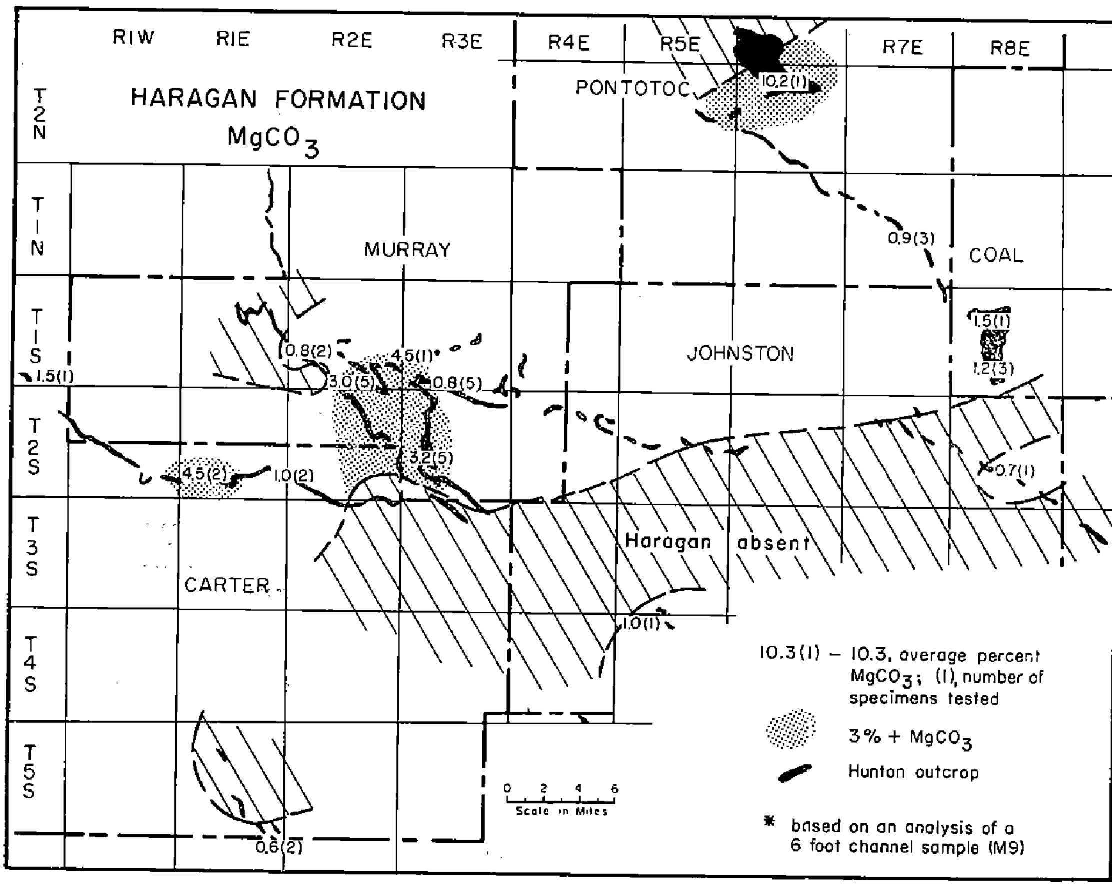


Figure 30. Map showing the geographic distribution of $MgCO_3$ in the Haragan formation. Note that the figures given are averages, in some instances of rather widely varying percentages. The data used in compiling this are given in the APPENDIX.

The Haragan strata have a low $MgCO_3$ content. The highest specimen tested yielded 10½ percent, the rest falling between ½ percent and 6 percent as shown in the frequency diagram, figure 22; the average of 31 analyses is 2.3 percent. The distribution of $MgCO_3$ by stratigraphic sections is shown in figure 25, and its geographic distribution is illustrated in figure 30. A complete list of analyses is given in the APPENDIX, and the geographic and stratigraphic distribution of $MgCO_3$ is discussed in the chapters on the HUNTON GROUP (*Hunton $MgCO_3$*) and the HENRYHOUSE FORMATION (*Strata overlying the Henryhouse formation*).

The $CaCO_3$ content of the Haragan ranges from 66 percent to 91 percent, averaging 80 percent. This compares with an average Henryhouse $CaCO_3$ content of 76 percent.

One thin section and a number of paralodion peels have been prepared (pl. XIII, figs. 3, 4; Folk 1959, pl. 2, fig. 16 illustrates a Haragan [?] thin section) and these show a texture and composition similar to that of the Henryhouse marlstone. The Haragan is primarily a calcilutite bearing scattered fossils. Excluding the fossils, it is almost entirely fine grained, the fragments making up the matrix rarely exceeding 0.05 mm in diameter. A substantial part of the rock is composed of silt and clay size insoluble detritus which was clearly derived from outside of the basin of deposition; the finely divided carbonate particles may also be, in part, of detrital origin (see HENRYHOUSE, *Lithology*). The calcarenite bed P1U (discussed above) is composed in large part of fossils, but almost all of the marlstone has less than 50 percent recognizable fossil debris, and a good deal of it is well below 25 percent. For the most part the fossils appear to be randomly distributed and oriented, exhibiting little tendency towards concentration into well marked beds. Most Haragan fossils are well preserved and show little evidence of abrasion.

Henryhouse-Haragan environment of deposition: The Henryhouse and Haragan strata were deposited in unrelated seas which were separated by a time interval covering most of the Upper Silurian epoch. These formations are, however, lithologically so much alike that they must represent sediments deposited under silimar conditions. Some differences are known to exist; a study of the insoluble residues shows the Henryhouse received more extrabasinal detritus than did the Haragan (see HENRYHOUSE FORMATION, *Strata overlying the Henryhouse*), and undoubtedly a more detailed petrographic study of these rocks than I have made would reveal other differences. Nevertheless the major characteristics of these formations are enough alike to indicate that both were laid down in similar environments.

The Henryhouse and Haragan formations have a number of lithologic and biostratigraphic features in common. The most important of these, in so far as an environment of deposition is concerned, are given below:

(1). Faunal Characteristics. The Henryhouse and Haragan faunas differ in their generic and specific composition, but are similar in their general biologic composition. Over a hundred species are known from each, indicating that the seas must have teemed with life as only a small part of these ancient faunas are believed to be preserved as fossils, even under the most favorable circumstances. Most of these faunas (at least that part which left a fossil record) belong to the vagrant and sessile benthos, the latter being especially well represented by a large and varied brachiopod assemblage. Both solitary and colonial corals are present and individual specimens are common, but there is no evidence of reef development (Cloud 1952, p. 2126), nor does there appear to have been much tendency to concentrate into biostromes (Cloud 1952, p. 2128). I have never collected calcareous algae from the Hunton marlstones, nor have I seen any in thin sections or peels.

(2). Distribution and preservation of fossils. The fossils are, for the most part, extremely well preserved and show little evidence of movement by wave or current action. Most brachiopod shells still have their valves articulated, and many of the lacy Bryozoa are preserved with their delicate fronds intact. The fossils are almost nowhere concentrated into shell banks, and this, coupled with their excellent state of preservation, points to a biocoenose.

(3). Texture. The sedimentary material which encloses the fossils, and which makes up most of the rock, is uniformly fine grained. The extra-basinal detritus is almost entirely in the silt-clay size, only rarely ranging into a fine sand. The silt particles are subangular and without frosting.

(4). Absence of shallow water features. I have examined the Hunton marlstone throughout its outcrop area and find an almost complete absence of cross-bedding, channeling, wave or ripple marks, and mud cracks. The bedding tends to be somewhat "nodular", but except for this moderate irregularity it is evenly bedded.

The foregoing data seem to point clearly to deposition in quiet, nonturbulent water (Pettijohn 1957, p. 593) well removed from the zone of effective wave action. The paucity of shallow-water depositional features indicates an offshore environment, and the fine-grained texture also suggests deposition in quiet water with only enough movement to transport clay and silt. The bottom must have been covered with a mud composed of terrigenous and carbonate sediments. On the other hand, the rich and varied marine fauna, predominantly benthonic, which is enclosed in what is essentially a carbonate rock, would seem to rule out any really deep-water, abyssal type of deposit. It is not possible on the basis of present data to assign precise depth limits to these deposits. The depth to which active wave action can penetrate is dependent upon a number of factors (Pettijohn 1957, p. 593-598), and undoubtedly varied from place to place during Paleozoic times just as it does today. The environment outlined above would seem to correspond roughly to the present day zone called the outer neritic or outer sublittoral as defined by Hedgepeth (1957, p. 18-19).

Strata underlying the Haragan: The pre-Haragan unconformity is discussed under the chapters on SILURIAN STRATA (*Unconformities*) and DEVONIAN STRATA (*Unconformities*). In most areas the Haragan rests upon the Henryhouse (pl. B, C, panel III), and a discussion of these two formations can be found in the section on HENRYHOUSE FORMATION, *Strata overlying the Henryhouse*. Locally the Haragan rests upon the Clarita members, or the Cochrane member of the Chimneyhill formation (sections A-A' and B-B' of plate C, panel III). The Haragan is easily distinguished on the basis of lithologic characters from any of the Chimneyhill members and this relationship presents no particular stratigraphic problems. I have not observed the Haragan in contact with the Keel or Ideal Quarry members.

Haragan-Bois d'Arc relationship: The Bois d'Arc formation overlies the Haragan formation in most areas, but there is substantial stratigraphic and faunal evidence of a lateral, as well as a vertical, gradation of one into the other (Amsden 1958B, p. 8-15). These two formations are believed to comprise closely related strata which were laid down in the same sea and, to a considerable extent, at the same time. This stratigraphic sequence thus represents a facies relationship which is composed of a Haragan lithofacies and a Bois d'Arc lithofacies, and a Haragan biofacies and a Bois d'Arc biofacies. A discussion of this terminology is given in the INTRODUCTION.

The Bois d'Arc fauna is similar to that of the Haragan, both being Helderbergian in age and closely related to the New Scotland of New York. Such differences as do exist can be related to lithology and point to an ecological rather than a chronological control. In an earlier paper I have discussed the relationship of the Haragan-Bois d'Arc brachiopod faunas in some detail (Amsden 1958B, p. 13-14, 17-25, text figs. 3, 4, 5; the intimate relationship of these two brachiopod faunas is shown in the range chart, figure 49, in the APPENDIX of the present report). A preliminary check leaves little doubt that the other faunal elements will confirm the evidence of the brachiopod study.

The Haragan formation is much like the Cravatt member of the Bois d'Arc, the Haragan consisting of silty and argillaceous calcilutite whereas the Cravatt, which is also a calcilutite, contains varying amounts of chert. The quantity of chert in the Bois d'Arc varies considerably; in some areas, such as the Lawrence uplift (P3, fig. 40), chert is confined to a thin zone at the base of the formation, whereas in other places (e. g. J11, fig. 40) it ranges throughout the formation. A few thin chert zones have been included within the Haragan where these can be demonstrated to be thin and discontinuous (see above, *Lithology*). Except for chert, the Cravatt member is lithologically (and faunally) much like the Haragan, and in those areas where the basal Bois d'Arc chert is thin the strata above are indistinguishable from the Haragan (this contact is illustrated in Amsden 1957, pl. I, B). The Cravatt, as a whole, does have a reduced insoluble content, its average being 11½ percent (fig. 36) as compared to 16 percent (fig. 20) for the Haragan, but it should be kept in mind that the Cravatt average includes the upper, more calcareous parts. In many areas the insoluble content of the Cravatt decreases upward; beds of calcarenite, which are rare in the lower part, become increasingly numerous and finally this member grades into the Fittstown bioclastic calcarenites which have a low insoluble residue (average 4.5%). There is a marked difference in lithology between the typical

Haragan and the typical Fittstown, although no well defined boundary separates them; moreover, it should be kept in mind that calcarenite beds do appear low in the Helderbergian sequence, and on the Lawrence Uplift a thin bed of bioclastic calcarenite is present in the Haragan (Pl-U; see fig. 55, APPENDIX). In general the Haragan-Bois d'Arc strata represent a gradational sequence which exhibits a progressive, but highly irregular, decrease upwards in insolubles (figs. 5. 6), accompanied by an irregular, but progressive increase in the quantity of fossil material (figs. 33, 34); as the fossil content increases the rock becomes coarser grained.

There is ample evidence for a lateral, as well as a vertical, gradation from one lithologic type into another. For example: the calcarenite bed in the Haragan at P1 (fig. 55, APPENDIX) lenses out into marlstone within a few hundred feet; the cherty beds in the Haragan at sections P9 (unit I) and C1 (unit L; see pl. B, panel II, and pl· C, panel III) can be traced laterally into typical Haragan marlstone. The regional stratigraphic relations furnish even more convincing evidence of a facies relationship. Section A-A' of plate C, panel III, shows the Haragan to be thick and well developed in an area extending from section P10 to C1, whereas to the north, on the Lawrence Uplift, this same stratigraphic position is taken over by the Cravatt-Fittstown lithofacies. An even more marked change takes place at the southern end of this belt where the Haragan lithofacies is entirely replaced by the Bois d'Arc lithofacies in a distance of about five miles. Throughout this outcrop belt extending from the Lawrence Uplift south to Atoka County a similar Helderbergian fauna can be collected from the Haragan-Bois d'Arc strata (Amsden 1957, fig. 4), and thus the combined stratigraphic and faunal evidence would seem to point unmistakably to a lateral gradation from one unit into the other. A similar relationship is present in the area just west of Price's Falls (section B-B', pl. C, panel III; fig. 53, APPENDIX), and in the westernmost Arbuckle outcrops (section C-C', pl. C, panel III).

A lithofacies map of the Hunton Helderbergian strata is shown in figure 31. Two rock types are recognized: a Haragan lithofacies consisting of cherty marlstones (Cravatt) and calcarenites (Fittstown). This map brings out the fact that the Bois d'Arc is the predominant facies throughout most of the Arbuckle region (see also pl. C, panel III).

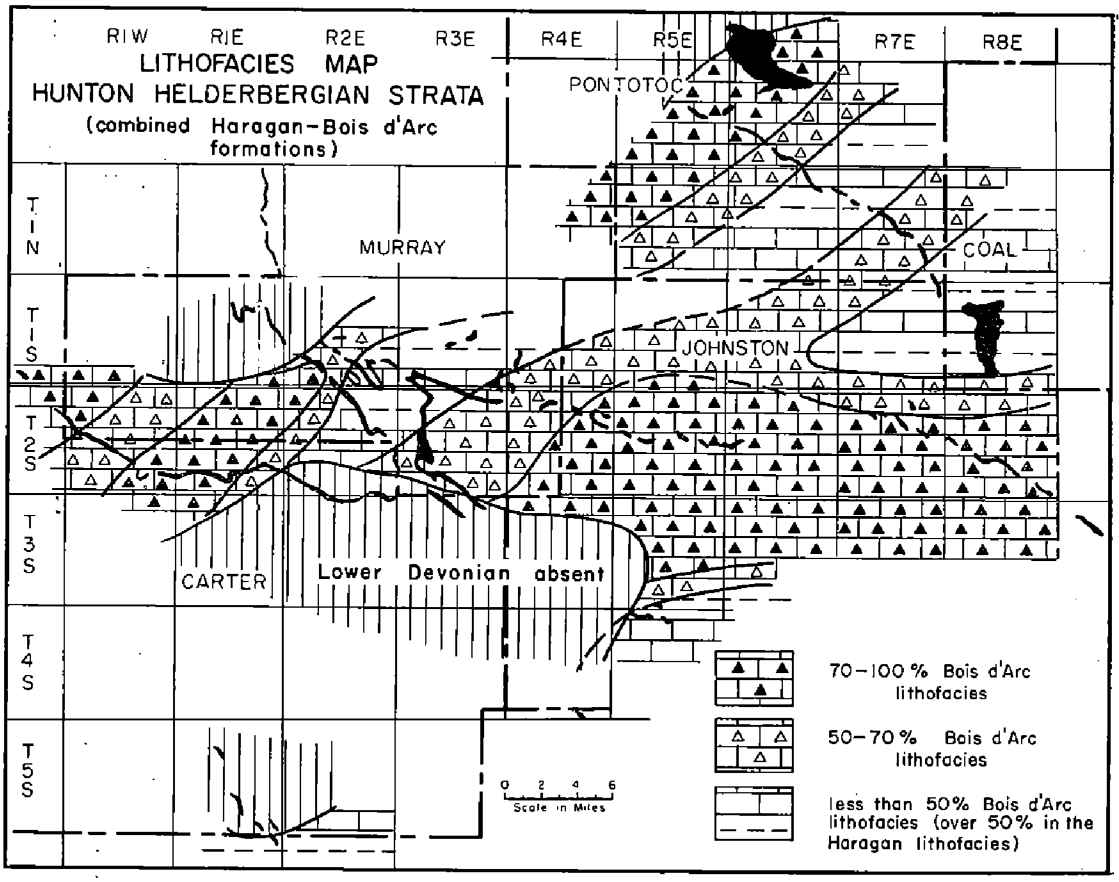


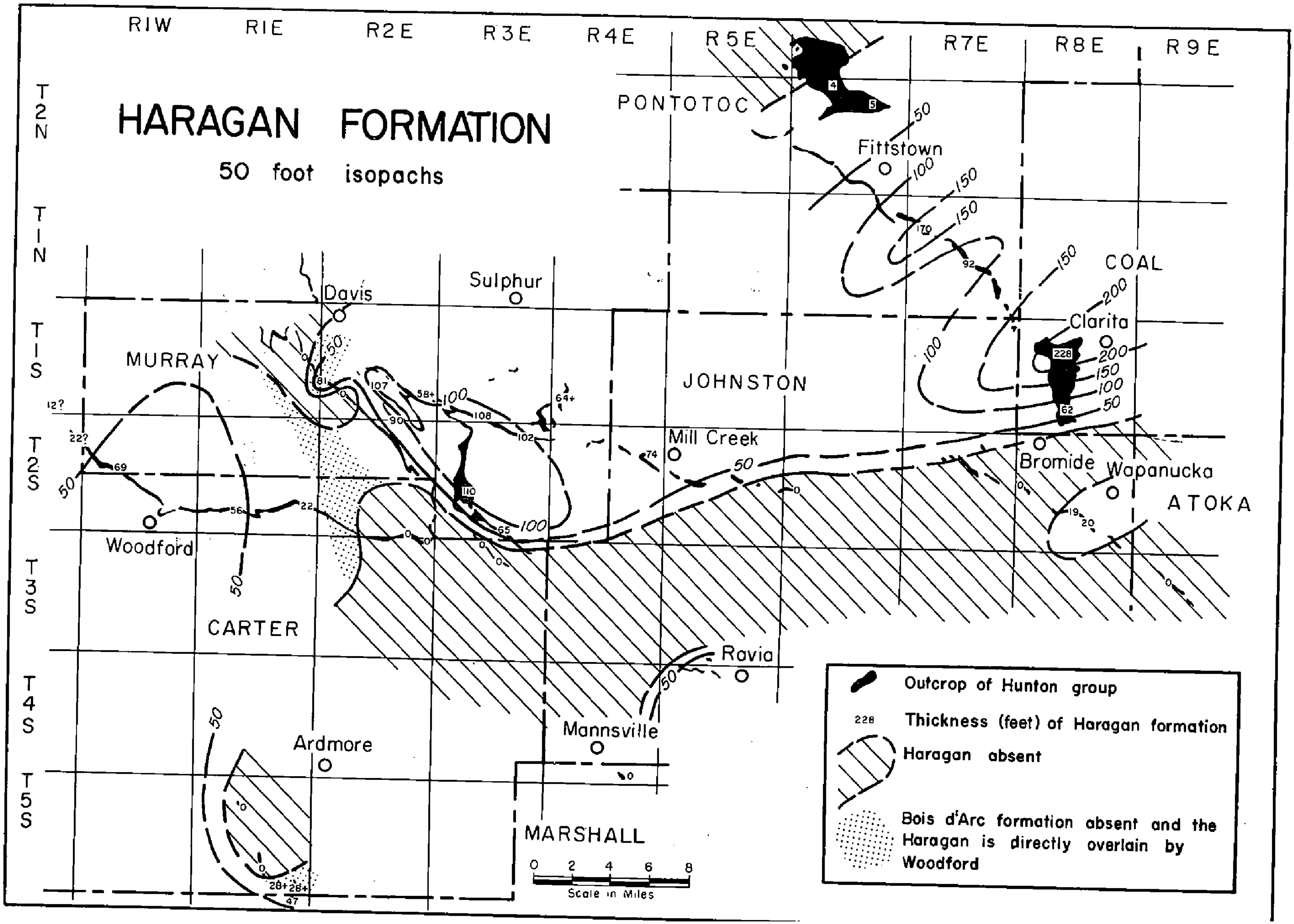
Figure 31. Facies map showing the relationship of the Bois d'Arc and Haragan lithofacies. For a discussion of this map see the text.

Haragan-Woodford contact: In some areas post-Hunton erosion has stripped away the Frisco and Bois d'Arc strata, thus bringing the Woodford shale into contact with the Haragan (pls. A, C, panel III). This relationship may be seen at section M17 on U. S. Highway 77, and at M5 on the road to Price's Falls; the Woodford is almost in contact with the Haragan at Ca2 near Tulip Creek, as only two feet of Cravatt beds separate the two. This is the inferred relation at section Ca11 near Rock Crossing in the Criner Hills. The Woodford shale in these areas is lithologically unlike the Haragan marlstone and presents no special stratigraphic problems. The Hunton-Woodford boundary is discussed in the section on the WOODFORD FORMATION.

Thickness and distribution: The thickness and distribution of Haragan strata are shown on the isopach map, figure 32. This formation attains a thickness of 228 feet in the vicinity of old Hunton townsite, but in most other areas is less than 100 feet. On this map I have indicated by stippling those areas where the Haragan is directly overlain by Woodford; in all other places it is overlain by Bois d'Arc and is thus unaffected by post-Hunton pre-Woodford erosion. Much of the thickness variation shown by the Haragan is the result of lateral gradation into the Bois d'Arc lithofacies, and for this reason the thickness pattern of the total Helderbergian strata in the Hunton is of more significance. This information can be obtained from the total Devonian isopach map (fig. 28) because, excluding the small area where Frisco beds are present (stippled), this map represents the combined Haragan-Bois d'Arc thickness.

Fossils and age: The Haragan formation yields numerous well-preserved Helderbergian fossils. In many places the Haragan marlstones disintegrate to form glades on which the fossils weather out free. Some of these Haragan glades, such as White Mound and old Hunton townsite, are among the better Paleozoic collecting grounds in this country. Other fine Haragan collecting areas are located on Vines Dome (M1) and the Buckhorn Ranch (M10).

The Haragan megafauna is strongly dominated by the brachiopods, but it also includes a number of snails, bryozoans and trilobites. Individual coral specimens are common, most being either various species of small, solitary tetracorals, or a tabulate similar to *Favosites conicus*; there appears to be no tendency to develop reefs. Crinoidal material is common and locally the bulbs of *Scyphocrinites* ("*Camarocrinus*"; see Amsden 1956, p. 59-61) are abundant (e. g. P9, M1). The Haragan also has a large and well preserved ostracod fauna. In 1911 Reeds (p. 264) listed about 30 species from the Haragan, and some years later Maxwell (1936, p. 89-91) recorded 82 species from his Kite group (approximately equal to the combined Haragan-Cravatt of this report; Amsden 1957, p. 39). Maxwell's faunal list included one sponge, five corals one crinoid, 12 bryozoans, 37 brachiopods, three pelecypods, 14 snails, five cephalopods, and four trilobites. Since Maxwell made his study other faunal elements have been described, including


HARAGAN FORMATION
50 foot isopachs
RIW RIE R2E R3E R4E R5E R7E R8E R9E
T2N T1N T1S T2S T3S T4S T5S
PONTOTOC
JOHNSTON
COAL
ATOKA
MURRAY
CARTER
MARSHALL
Fittstown
Davis
Sulphur
Clarita
Mill Creek
Bromide
Wapanucka
Woodford
Ravia
Mannsville
Ardmore
Outcrop of Hunton group
228 Thickness (feet) of Haragan formation
Haragan absent
Bois d'Arc formation absent and the Haragan is directly overlain by Woodford
0 2 4 6 8
Scale in Miles

some graptolites, crinoids, trilobites and ostracods. My 1957 *Catalog of Hunton fossils* gives a list of the Hunton fossils which had been described up to that time. In 1958 I described the Haragan articulate brachiopod fauna (38 species).

Microfossils (excluding ostracods) are uncommon in the Haragan (no investigations have been made of spores or other extremely small organisms). I have observed a few arenaceous Foraminifera in the HCl residues and 7 species have been described (Amsden 1957, p. 39). No conodonts have been found in the acetic acid residues, but presumably they could be recovered if enough rock were treated.

The Haragan fauna is Helderbergian in age and closely related to that of the New Scotland beds of New York. It is believed to correlate with the Ross limestone (Ross limestone-Birdsong shale) of western Tennessee, and the Bailey limestone of Missouri. This fauna, or one which is very similar, appears to be present in the Pillar Bluff limestone of central Texas (Barnes, Cloud and Warren, 1945, p. 166-169). For a more extended discussion on the age and correlation of the Haragan formation see Amsden (1958A, p. 18-24).

BOIS D'ARC FORMATION

Reeds (1911, p. 265) named the Bois d'Arc formation for exposures along Bois d'Arc Creek on the Lawrence Uplift. In the original description he included all of the upper Hunton strata in this formation, but some years later (1926, p. 13) he removed the upper, massive-bedded limestones and placed them in his Frisco formation. Reeds' description of these formations are brief, but there is little doubt that his Bois d'Arc and Frisco formations are essentially the same as used in this report. There are good exposures of this formation along Bois d'Arc Creek, in the NW¼ sec. 11, T 2 N., R. 6 E. (P8, P11), but a thicker and more complete section is exposed along Chimneyhill Creek in the SE¼ sec. 4, T. 2 N., R. 6 E., and in 1957 (p. 39) I designated this as the type section (see geologic map, pl. A, panel II). There are also fine sections of Bois d'Arc exposed near Mill Creek town (J11) and along Haragan Creek near White Mound (M3; fig. 51, APPENDIX). The nomenclatorial history of this formation is discussed at some length in my 1957 paper (p. 38-40).

The Bois d'Arc formation is divided into two members, a lower Cravatt member and an upper Fittstown member. These members, in their typical development, are lithologically distinct, but there is strong evidence for a facies relationship as they grade into one another, both laterally as well as vertically (Amsden 1958B, p. 8-20). The Cravatt is composed in large part of silty and argillaceous calcilutites or marlstone with varying amounts of chert, and the Fittstown is primarily a bioclastic calcarenite which may or may not include chert. There is no well defined boundary between the two and the Cravatt commonly has beds of calcarenite

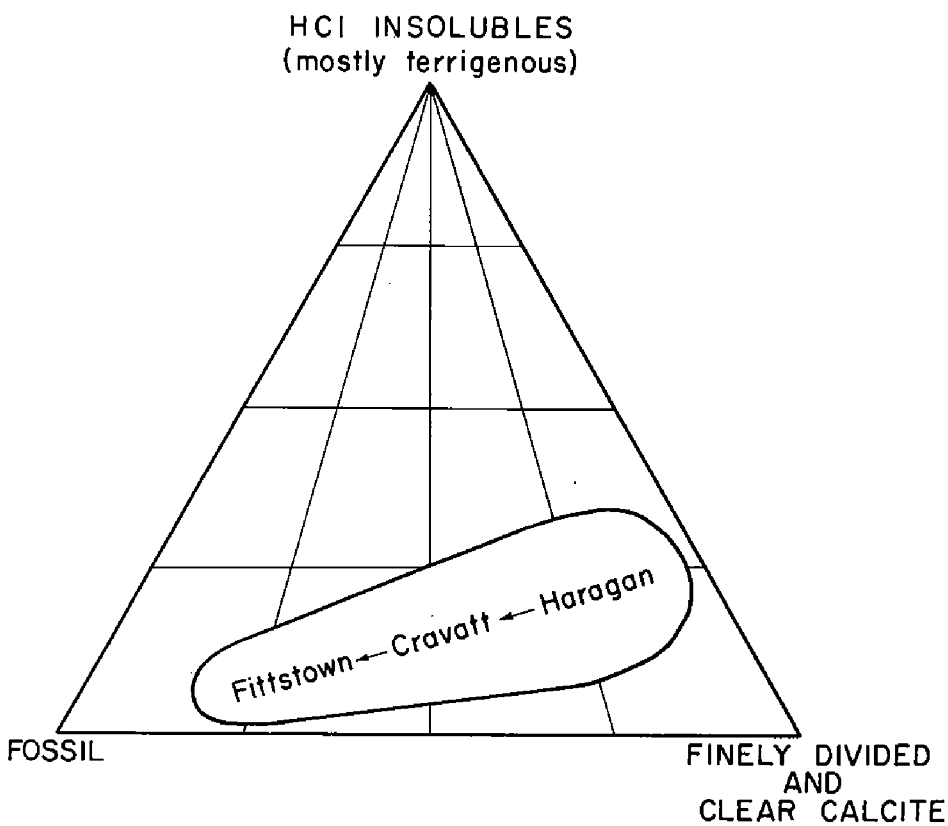


Figure 33. Triangular diagram showing the range in composition and texture of the Hunton Helderbergian strata. A discussion of the 3 end members is given in the text.

in its upper part, and the Fittstown commonly includes some marlstones. In those areas where the Helderbergian sequence (which includes the Haragan) is thick and reasonably complete, there is a progressive, but highly irregular increase upwards (as well as laterally) in the quantity of recognizable fossil material, and a corresponding decrease in the HCl insolubles (figs. 20, 36). This is shown diagrammatically in figure 33, which is a triangular diagram (modified from Folk 1959, fig. 2) based on the following end members: (1) HCl insoluble residues which are largely made up of extra-basinal detritus (terrigenous sediments). (2) Fossils; only clearly recognizable fossil material included. (3) Clear, crystalline calcite (sparry calcite of Folk) and finely divided calcite ("lime mud"; microcrystalline calcite of Folk). The relationship of marlstone to calcarenite can also be shown on a quaternary diagram in which the clear, crystalline calcite is separated from the finely divided calcite. Such a diagram is shown in figure 34 in which the

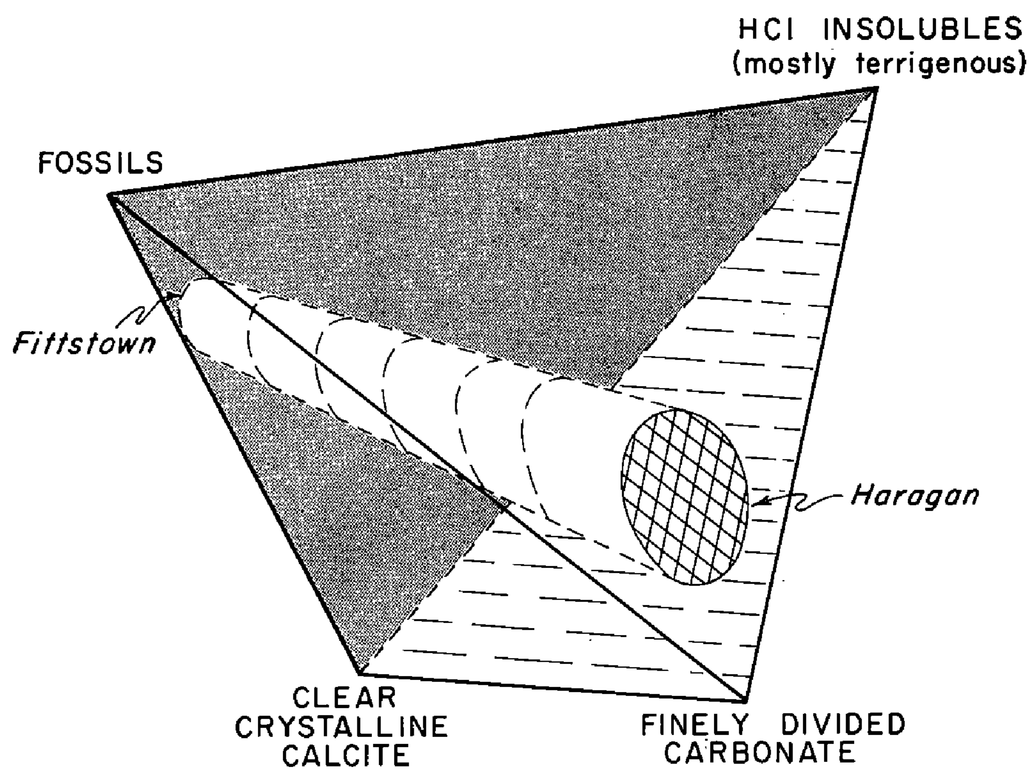


Figure 34. Quaternary diagram showing the range in composition and texture of the Hunton Helderbergian strata. The 4 end members are discussed in the text.

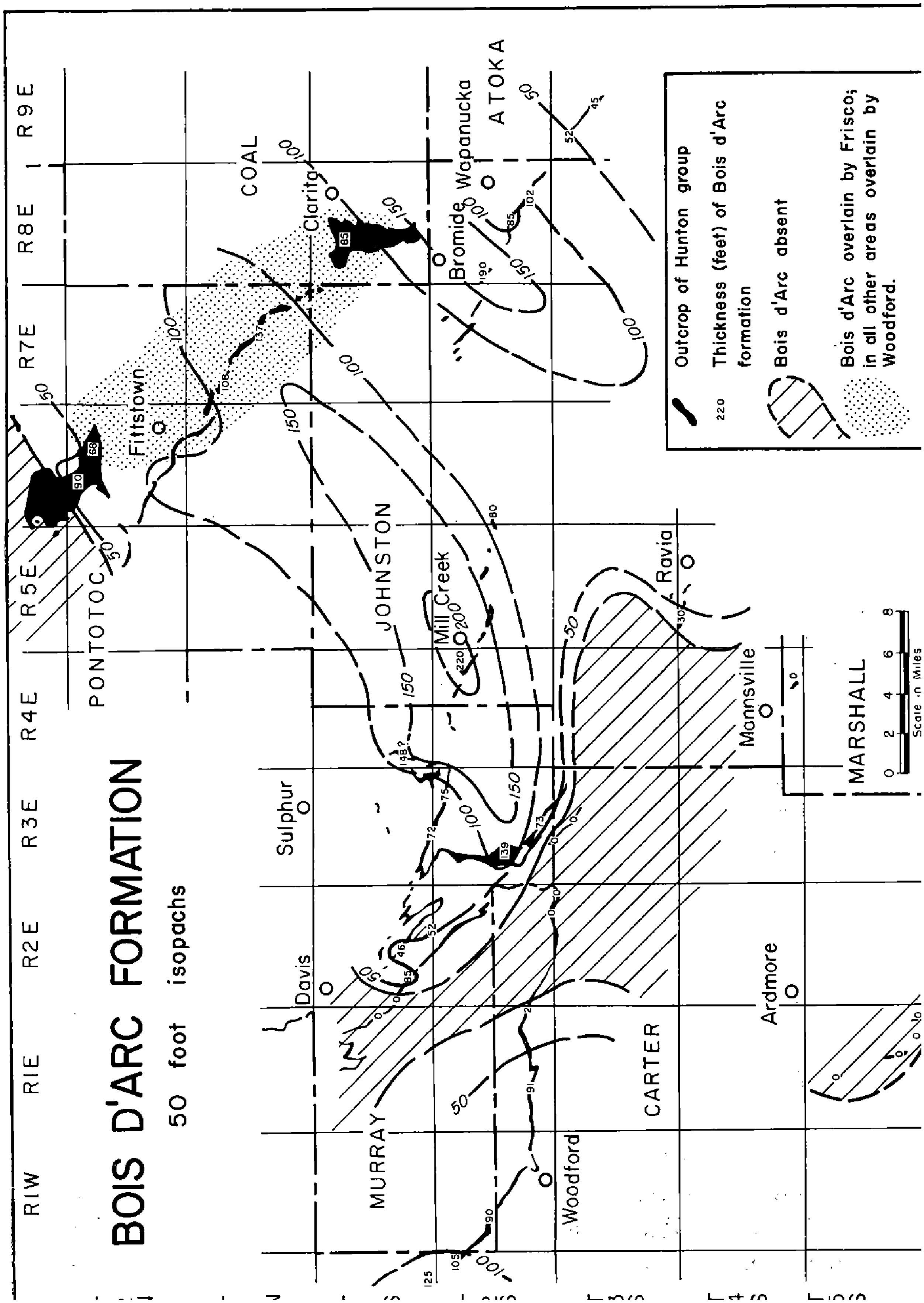
Haragan marlstone represents one end member and the Fittstown calcarenite the other. This brings out the fact that the lithologic transition from Haragan to Fittstown involves not only a decrease in insoluble content and an increase in fossil content, but is also accompanied by a change in the character of the matrix; the Haragan marlstone is almost invariably composed of scattered fossils set in a matrix of finely divided carbonate (and acid insolubles), whereas the Fittstown calcarenites are almost everywhere set in a matrix of clear, crystalline calcite (with decreased acid insoluble content). The lithologic extremes of this series are illustrated in the photomicrographs, figures 3, 4 of plate XIII (Haragan) and figures 5, 6 of plate XIV (Fittstown). The origin of these two types of matrix is a problem (see discussion under KEEL MEMBER, *Lithology*). The finely divided carbonate may be in part or entirely a precipitate, or it may include considerable organic material such as comminuted fossils which are no longer recognizable as such (see discussion under HENRYHOUSE FORMATION, *Lithology*). The clear calcite has been regarded by some as the product of recrystallization, although others, such as Folk (1959, p. 29-35), think that most sparry calcite is a primary feature of the rock. Peels and thin sections of the Hunton bioclastic calcarenites do show some unmistakable evidence of recrystallization, especially associated with pelmatozoan plates, but there is reason to doubt that this is the dominant process. The consistent lithologic pattern exhibited by the Haragan-Bois d'Arc strata, with the fossil-rich calcarenites almost everywhere having a clear calcite cement, suggests that this is a primary feature of the rock. If it were largely due to recrystallization one would expect it to have a more irregular, patchy distribution. Quite possibly this originated by the process which Bathurst (1958, p. 14) called granular cementation, accompanied by some rim cementation (see KEEL MEMBER, *Lithology*). This subject is discussed further under FITTSTOWN MEMBER, *Environment of deposition*.

The quantity of chert in the Bois d'Arc formation is highly variable. It is everywhere present in the basal part since this is, by definition, the criterion used to separate the Cravatt from the Haragan. On the Lawrence Uplift chert is confined to the lower few feet of the Bois d'Arc (P3, P8), but in other areas (e. g. J11) it is fairly well distributed throughout both members. The chert is in almost every case in the form of small, irregular nodules like those shown in plate VI, although in a few places, such as section Ca8 in the western part of the Arbuckles, it develops into elongate lenses having almost a bedded appearance. In almost all of the sections I have studied the chert from the lower part of the Bois d'Arc is a porous, brown-weathering, tripolitic type, whereas that from the upper part of the Cravatt and throughout the Fittstown is commonly a vitreous type. Many of the chert nodules are fossiliferous.

The cherty beds of the Bois d'Arc formation are more resistant to erosion than are the Haragan and Henryhouse marlstones (the increased carbonate content of the Bois d'Arc probably also increases its resistance), and this formation almost everywhere makes a ridge. In those areas where the Hunton strata have a moderate to high dip, the scarp face of this ridge exposes Haragan and Henryhouse marlstones, with the Bois d'Arc contact located near the crest, and the upper Cravatt and Fittstown strata making the dip slope. On the Lawrence Uplift, where the dip is gentle, the Bois d'Arc beds make a fairly wide bench of high ground with a west- to northwest-facing scarp exposing the Henryhouse-Haragan marlstone (pl. A, panel III).

Thickness and distribution: The thickness and distribution of the Bois d'Arc formation is shown on the isopach map (fig. 35). Its maximum development is in the area around Mill Creek town (J11) where it attains a thickness of 220 feet with both the Cravatt and Fittstown members well represented. The next greatest thickness (190 feet) is in the area just west of Wapanucka (J6) where, surprisingly, the entire formation is in the Cravatt lithofacies. In most other places the Bois d'Arc formation is around a hundred feet or less in thickness. The entire formation has been removed by post-Hunton pre-Woodford erosion throughout much of the Criner Hills, and in a northwest-southeast trending belt in eastern Carter and central Murray Counties. It should be kept in mind that the thickness variation shown on the isopachous map is in part the result of a lateral gradation from the Bois d'Arc lithofacies into the Haragan lithofacies (see HARAGAN FORMATION, *Thickness and distribution*). The distribution of the Cravatt and Fittstown members is discussed at greater length below (see also pl. C, panel III).

Fossils and age: The Bois d'Arc formation carries a Helderbergian fauna which is much like that of the Haragan. Both the Cravatt and Fittstown members have yielded substantial mega-


BOIS D'ARC FORMATION
50 foot isopachs
R1W
R1E
R2E
R3E
R4E
R5E
R7E
R8E
R9E
PONTOTOC
COAL
ATOKA
JOHNSTON
MURRAY
CARTER
MARSHALL
Fittstown
Clarita
Bromide
Wapanucka
Mill Creek
Ravia
Mannsville
Sulphur
Davis
Ardmore
Woodford
Outcrop of Hunton group
Thickness (feet) of Bois d'Arc formation
Bois d'Arc absent
Bois d'Arc overlain by Frisco; in all other areas overlain by Woodford.
Scale in Miles

faunas, although it is more difficult to extract good specimens from these strata than from the underlying Haragan. The faunal content of each member is discussed at greater length below.

CRAVATT MEMBER

Maxwell (1936, p. 135) redefined Reeds' Bois d'Arc formation and restricted it to the upper calcarenites, which are roughly equal to the Fittstown member of this report. The lower cherty calcilutites were named the Cravatt formation and united with the Haragan formation to form his Kite group. In 1957 I proposed to restore the Bois d'Arc to its original meaning and to eliminate Maxwell's Kite group. The Cravatt was retained with approximately its original stratigraphic meaning, but it was treated as the lower member of the Bois d'Arc formation; the upper calcarenites (about equal to the restricted Bois d'Arc of Maxwell) were assigned to the Fittstown member (new). This stratigraphic terminology is defined and discussed at some length in my 1957 paper (p. 38-41); additional lithologic and stratigraphic information on this member is given in my paper on Bois d'Arc brachiopods 1958B, p. 10-15).

Maxwell took the name Cravatt from the original allotment owner, Katy Cravatt, whose farm was in the NE¼ SW¼ SW¼ sec. 2, T. 2 N., R. 7 E. There are excellent exposures of this member and of the overlying Fittstown member along Chimneyhill Creek, and in 1957 (p. 41) I designated this the type section (E½ sec. 4, T. 2 N., R. 6 E.; see P3, APPENDIX; location shown in pl. A, panel II). Other fine exposures of Cravatt and Fittstown beds may be seen at section J11 near Mill Creek town, and section M3 north of White Mound (fig. 51, APPENDIX). This member is also well exposed at section J6 west of Wapanucka, a section which is interesting because the Bois d'Arc formation is thick (190 feet) and consists entirely of the Cravatt lithofacies.

Lithology: The Cravatt consists primarily of silty and argillaceous calcilutites with varying amounts of fossil material. The insoluble residue content is reduced from that of the Henryhouse and Haragan marlstones (see below), but its texture and composition are similar and I have commonly applied the term marlstone to the Cravatt strata. Chert is everywhere present in the lower part of the Cravatt member, this being the character used to distinguish it from the Haragan (see HARAGAN FORMATION, *Haragan-Bois d'Arc relationship,* and BOIS D'ARC FORMATION). Above this basal zone the quantity of chert is highly variable, being absent in some places (e. g., the Lawrence Uplift; P3, P8, fig. 40) and abundant in other areas (e. g., around Mill Creek town, J11, and White Mound, M3; fig. 40). It is commonly in the form of irregular nodules which are generally small (pl. VI). These nodules may be slightly elongate in the plane of the bedding (pl. VI, fig. 1), and at Ca8 in the vicinity of West Spring Creek, the chert is much attenuated into elongate lenses which have some resemblance to bedding. The chert in the lower part of the Cravatt is mostly a brown-weathering, porous type (tripolitic), whereas that of the middle and upper parts is commonly a vitreous type. In places the chert nodules have a "brecciated" appearance even where there is no evidence of faulting. The chert may be fossiliferous, in places abundantly so.

The typical color is some shade of yellowish gray (5Y 7/2 to 5Y 8/4) similar to that of the Haragan. Some parts of the Cravatt are red (10R 6/2; 10R 7/4) or mottled red and gray; examples of this may be seen at Ca8 near West Spring Creek, and at A2 southwest of Wapanucka.

The Cravatt is a fairly evenly bedded rock with the beds at few places exceeding 4 or 5 inches in thickness (pl. VI). The bedding is much like that of the Haragan (Amsden 1957, pl. I, fig. B), although this resemblance is most marked on relatively fresh exposures as the Cravatt strata generally do not weather to a glade surface. The greater resistance of Cravatt strata to weathering is probably due in large part to their increased carbonate content, aided to some extent by the presence of chert. This also explains why it is more difficult to collect fossils from the Cravatt as it commonly does not disintegrate enough for the fossils to weather out free.

The Cravatt is characteristically a fine-textured calcilutite, although it generally includes some beds of highly fossiliferous calcarenite with a low insoluble content. Such beds are few or absent in the lower part, but in many areas they become increasingly

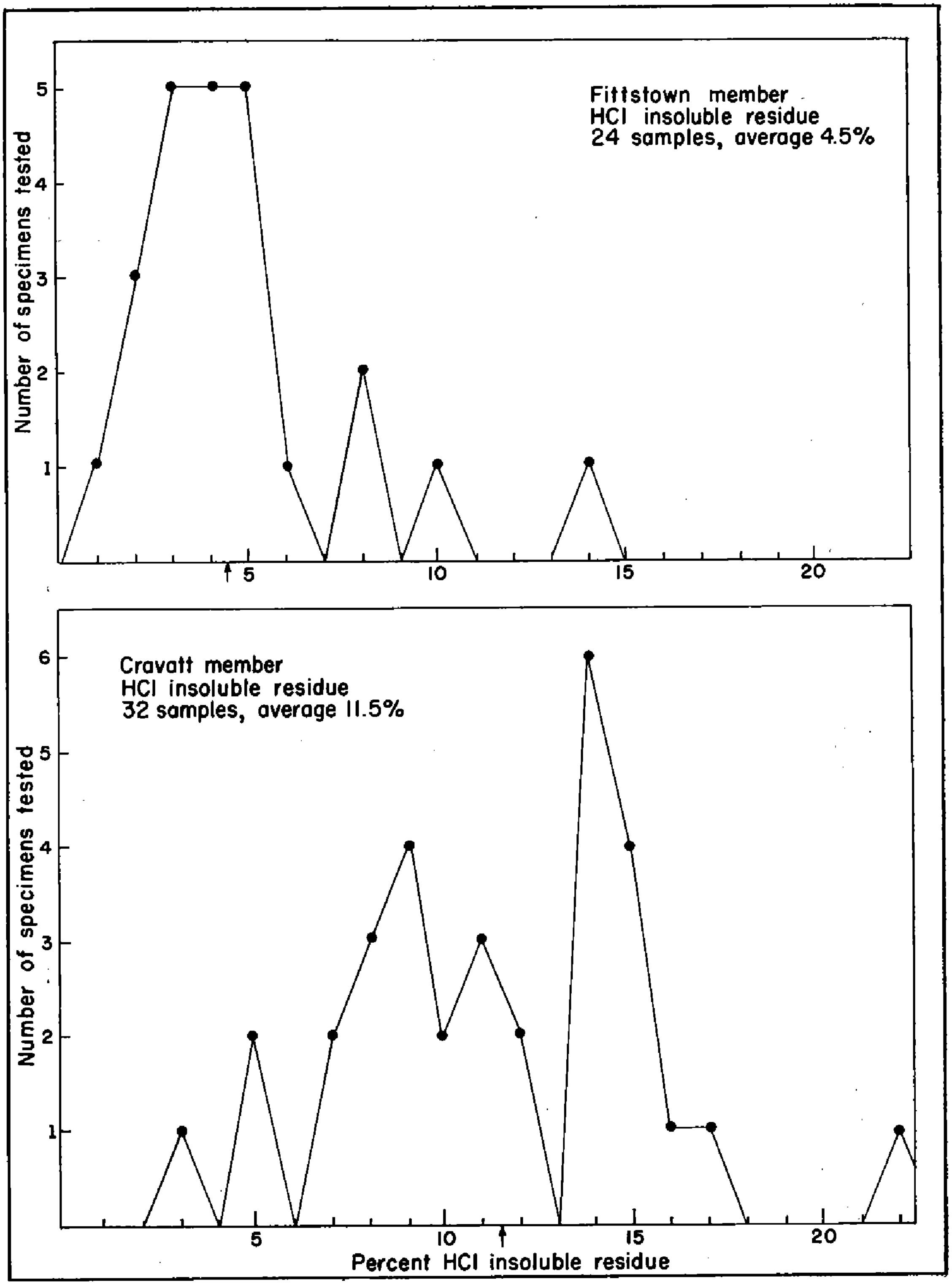


Figure 36. Frequency diagram showing the distribution of HCl insoluble residues in the Cravatt member (below) and the Fittstown member (above) of the Bois d'Arc formation. Two Cravatt residues are omitted: 63 percent from P8 and 52 percent from P3; if these are included the average is increased to about 13 percent. The data for this are given in the APPENDIX.

numerous in the upper part and this member grades into the Fittstown calcarenites. These lithologies are discussed at greater length under BOIS D'ARC FORMATION and under FITTSTOWN MEMBER.

A number of HCl insoluble residues have been made from Cravatt rock specimens. In each case an effort was made to select chert free samples for analysis, but a binocular examination of the residues shows that most include some spongy silica which may represent incipient chert. In part this acts as a binder which holds the other insoluble elements such as detrital quartz and glauconite together. In addition to this spongy material all residues include some clay and silt size detritus, and in many samples this makes up a substantial part of the residue. The clay size material is too small to study under a binocular microscope, but the silt size debris consists largely of clear, subangular quartz grains, with some mica. In addition most residues include silicified fragments, some of which are clearly fossils. Glauconite is commonly present in small amounts and in a few cases is abundant. No study has been made of the heavy mineral suite.

The frequency distribution of 32 HCl insoluble analyses is given in figure 36. These range from three to 22 percent, averaging 11.5 percent. Two analyses of 63 percent (P8-D) and 52 percent (P3, fig. 40) are not shown on this figure and if these are included the average is increased to about 13 percent. The average Cravatt insoluble residue is thus decreased by a few percentage points from that of the Haragan (16 percent). However, the decrease in silt and clay size detritus (extrabasinal terrigenous material) is considerably greater than these figures indicate as almost all Cravatt residues show some spongy silica (probably incipient chert) in addition to the detritus, whereas this material is rare in the Haragan.

The Cravatt has, for the most part, a low $MgCO_3$ content. The frequency distribution of 33 analyses ranges from less than one percent to eight percent, averaging 2.4 percent (fig. 37). One analysis of a rock specimen from the upper three or four feet of the Cravatt member on Vines dome (M1-0) which tested 21 percent is not shown on figure 37, and if it were included the average would be increased to about three percent. This high magnesium content at M1-0 is confined to a small area and probably represents local dolomitization, possibly associated with the Woodford-Hunton unconformity. The Hunton dolomites are discussed at greater length under the HUNTON GROUP, *Hunton* $MgCO_3$, and the HENRY-

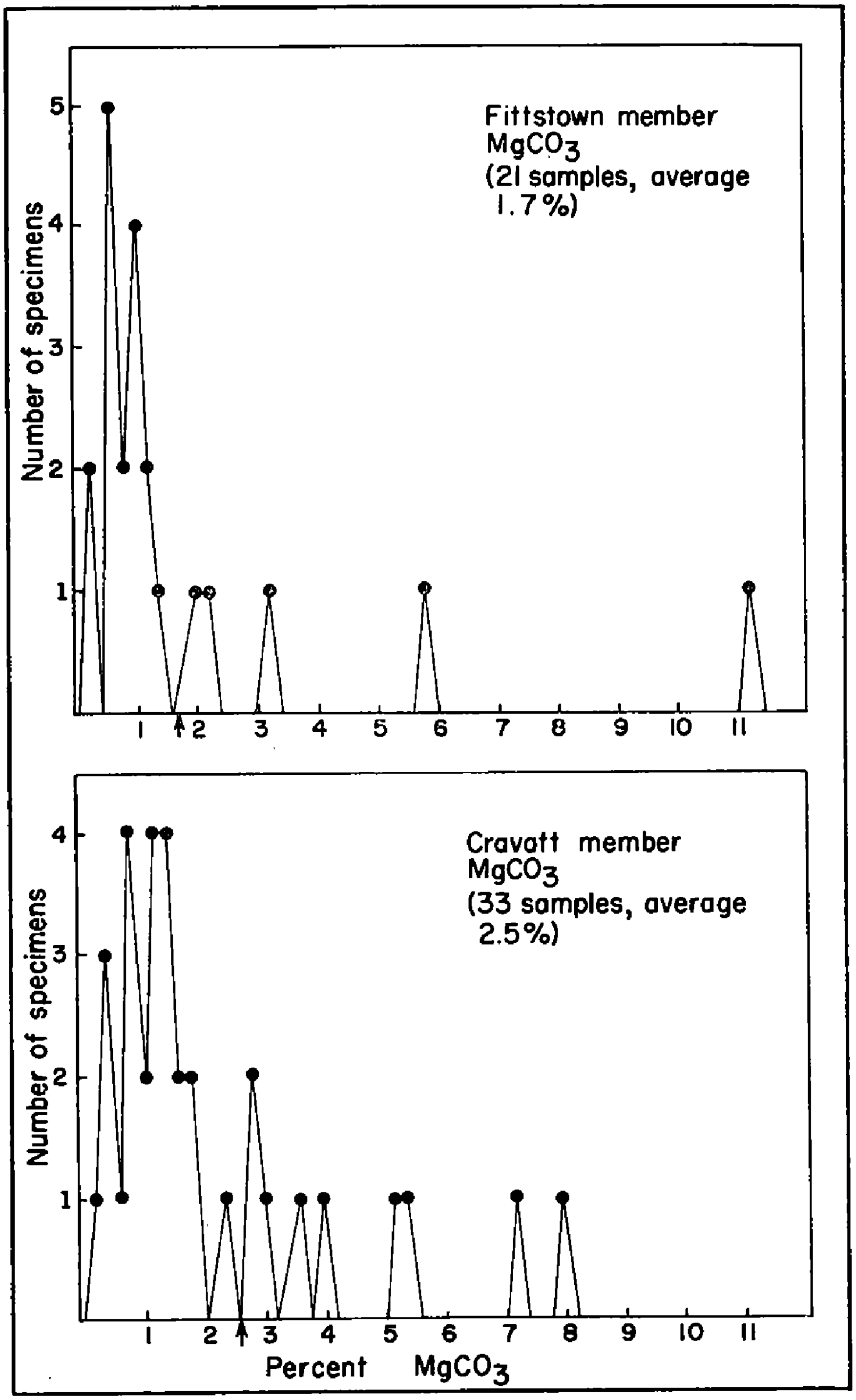


Figure 37. Frequency diagram showing the range of $MgCO_3$ in the Cravatt member (below) and the Fittstown member (above) of the Bois d'Arc formation. Note that the Cravatt does not include the analysis of 21 percent from M1-O(3). The data for this are given in the APPENDIX.

HOUSE FORMATION, *Strata overlying the Henryhouse...* The geographic distribution of Cravatt $MgCO_3$ is shown in figure 38; compare with the distribution maps of the Haragan (fig. 30) and the Henryhouse (fig. 23).

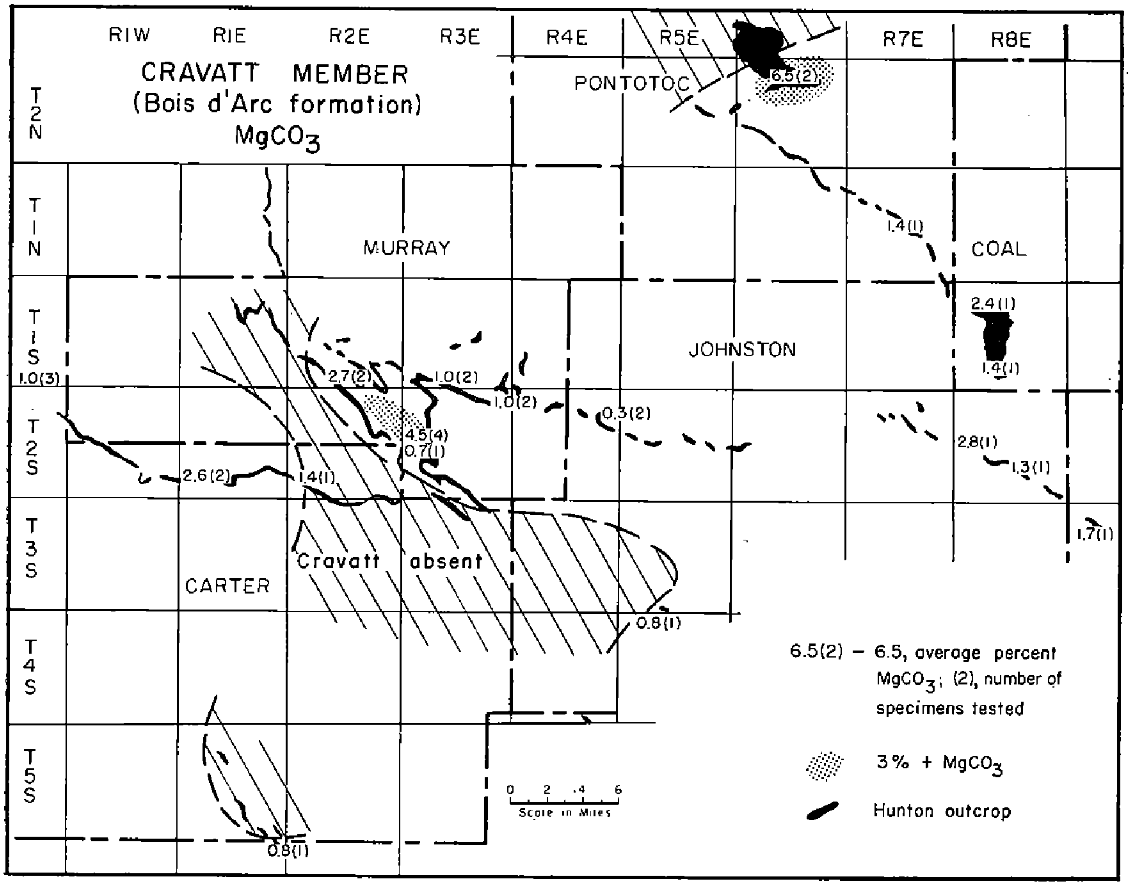


Figure 38. Map showing the geographic distribution of $MgCO_3$ in the Cravatt member of the Bois d'Arc formation. Note that the figures given are averages, in some cases of rather widely varying percentage. The data for this are given in the APPENDIX.

The $CaCO_3$ content of the Cravatt member ranges from 31 percent (P8-D) to 94 percent, averaging about 85 percent. This compares with an average Haragan content of 80 percent, and an average Henryhouse content of about 76 percent.

One thin section and several paralodion peels have been prepared of the typical Cravatt marlstone (pl. XIII, figs. 5-6). Excluding the chert, most of these show a rock with a calcilutite texture bearing scattered fossils. The matrix is composed of finely divided carbonate and insoluble debris, the individual particles rarely exceeding 0.05 mm. Much of the insoluble material is composed of clay and silt size detritus which was derived from outside of the basin of deposition (see above). The origin of the finely divided carbonate particles is in question, but at least some of it may be detrital (see HENRYHOUSE FORMATION, *Lithology*). The quantity of fossil material is highly variable (pl. XIII); on some specimens the fossils are widely dispersed, whereas on others they are abundant and approach a bioclastic calcarenite (see BOIS D'ARC FORMATION). It should be kept in mind that these remarks apply to the characteristic Cravatt strata which have a fine texture like that of the Haragan and Henryhouse marlstones. There are, however, beds of richly fossiliferous calcarenites present in this member, especially in the upper part, but since these are like the Fittstown lithology they will be discussed under that member.

I have not undertaken a detailed investigation of the Bois d'Arc cherts, but such information as I do have points to a close relationship between the porous and the vitreous types. A paralodion peel of the tripolitic chert shows a gradational boundary between the chert and the surrounding calcilutite; furthermore there appears to be considerable spongy silica in the calcilutite as well as carbonate in the chert (both chert and calcilutite are fossiliferous). The distinction between the porous and vitreous chert is not everywhere well marked in the field, and I have found some porous chert nodules with a vitreous core. These data suggest a gradation from a calcilutite with a considerable amount of spongy silica, through a porous chert, to a vitreous chert.

Fossils exhibiting varying degrees of silicification are not uncommon in the Cravatt member. Silicified steinkerns are fairly common in places and since these are resistant to erosion they may weather out and wash down onto the underlying Henryhouse strata where they are mingled with the Silurian fossils. Since silicified fossils (excluding corals) are rare in the Henryhouse, any such steinkern found loose on the surface of this formation should be suspect. Much of the silicification associated with the Cravatt is incomplete and some appears to be confined to the outer surface of the rock. I have found only one place (P2) where the silicification is excellent and from which it was possible to etch out a moderately large and well preserved fauna (Amsden 1958B, p. 17).

Environment of deposition: The typical Cravatt calcilutite, excluding chert, is much like the Haragan and it is reasonable to infer that both represent similar conditions of deposition (see HARAGAN FORMATION, *Environment of deposition*). The bedding, texture and general composition of the Cravatt is like the Haragan, and whereas the HCl insoluble content is reduced somewhat this change is not great and the composition of the residues (excluding spongy silica) is essentially the same. The character and distribution of fossil material is similar, and although it is easier to collect satisfactory specimens from the Haragan (Amsden 1958B, p. 17), the Cravatt probably contains a somewhat greater proportion of fossil debris. The Cravatt fauna, like that of the Haragan, is primarily benthonic, the sessile benthos being especially well represented (Amsden 1558A, p. 11-14; 1958B, p. 15).

The problem of chert and its significance in terms of depositional environment is an extremely difficult one, and beyond the scope of this paper. The first question which arises concerns the time at which the silica composing the chert was introduced into the rock. Is this silica a primary constituent of the Bois d'Arc which was introduced at the time of deposition (either precipitated from solution or as a penecontemporaneous replacement), or was it brought in at some later time after deposition? The general stratigraphic distribution of Hunton cherts suggests introduction at the time of deposition (see INTRODUCTION, *Hunton chert*) although this does not preclude a partial or complete reorganization at some later date. (There is clear evidence of replacement in the silicified fossils, some of which are associated with chert). Whatever its origin there is both stratigraphic and faunal evidence that the chert-free parts of the Helderbergian strata are a facies of the cherty parts.

Cravatt-Haragan relationship: This is discussed under the HARAGAN FORMATION, *Haragan-Bois d'Arc relationship.*

Cravatt-Haragan relationship: This is discussed under the *Fittstown-Cravatt relationship.*

Thickness and distribution: The thickness and distribution of the Cravatt member are shown in the isopach map, figure 39. The member is present throughout most of the Arbuckle Mountain region, being absent only in the northern part of the Law-

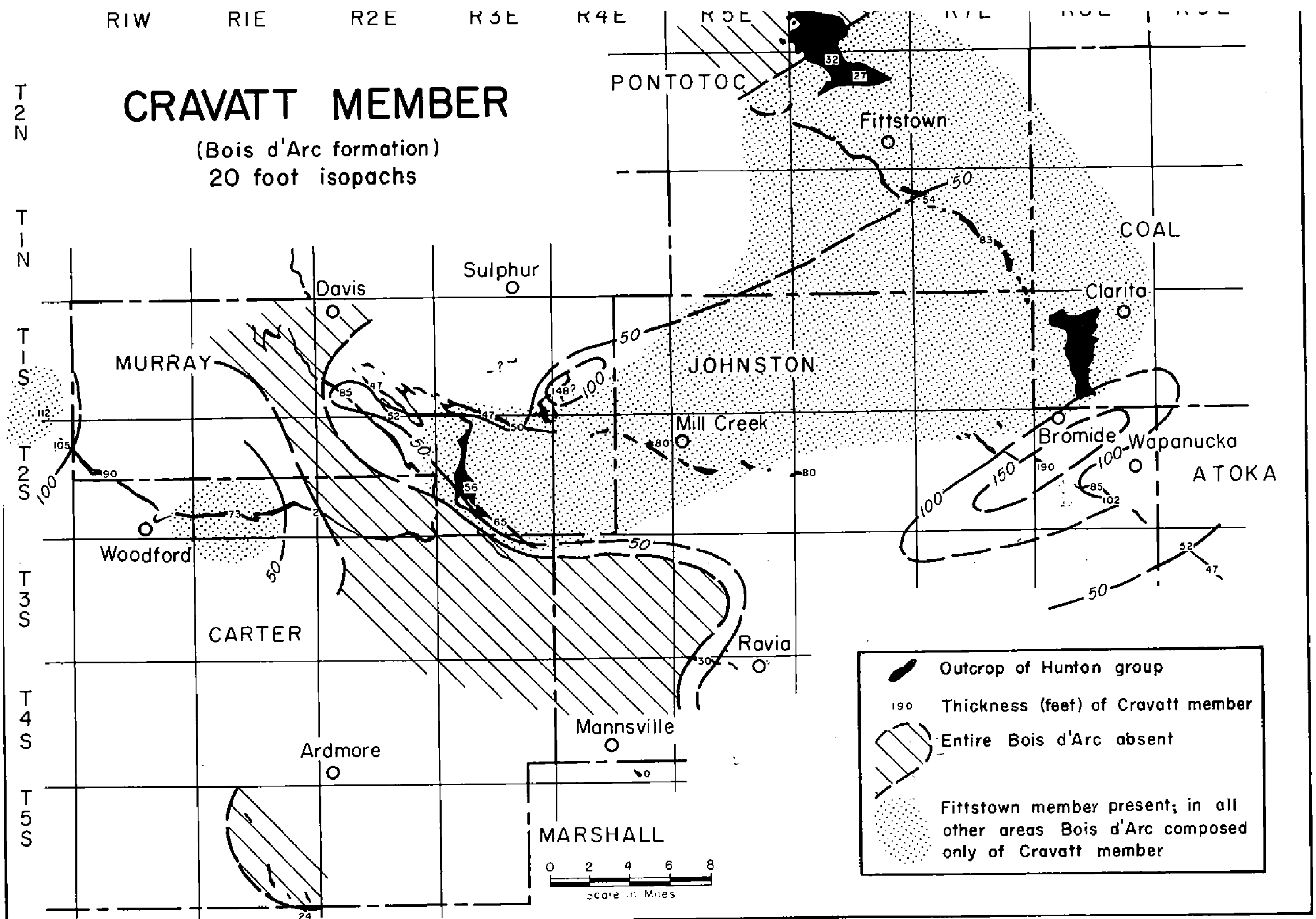


Figure 39. Isopach map of the Cravatt member of the Bois d'Arc formation.

rence Uplift, and in a small area extending from Murray County into eastern Carter County. In the Criner Hills it is confined to the southernmost outcrops. This member attains a thickness of 190 feet in the area south of Bromide (J6), but in most other places is around a hundred feet or less. It should be kept in mind that the pattern shown on the isopach map is in part the result of lateral gradation, on one hand into the Haragan lithofacies and on the other into the Fittstown lithofacies. This point is discussed under the BOIS D'ARC FORMATION (see also pl. C, panel III).

Fossils and age: The Cravatt member has a substantial megafauna. My collections include some 60 to 70 species of which about half are brachiopods (Amsden 1958B, p. 15). In addition to the brachiopods there are trilobites, snails, pelecypods, cephalopods and bryozoans. The coral fauna is similar to that of the Haragan; most of the species are small and there is no tendency towards reef formation. Crinoidal debris is common in some beds, and locally the bulbs of *Scyphocrinites* are numerous (*"Camarocrinus"*; Amsden 1956, p. 59-61). Four specimens of the blastoid *Troosticrinus* were found at P17-D. I have not observed any arenaceous Foraminifera in the HCI insouble residues although I presume they are sparingly represented since a few have been recovered from the Haragan. One conodont was recovered from the acetic acid residues and I am sure more could be found if enough material were treated.

Reeds (1911, p. 265-266) recorded about two dozen species from the Bois d'Arc (including both the Cravatt and Fittstown divisions). Maxwell's faunal list of the Cravatt was combined with the Haragan, the two totaling 82 species. No Bois d'Arc species is listed in my *Catalog of Hunton Fossils* and to my knowledge the only ones which have been described are the articulate brachiopods (Amsden 1958B).

The Cravatt fauna is Helderbergian in age and much like that of the Haragan and the Fittstown (Amsden 1958B, fig. 4, p. 20). The combined Bois d'Arc-Haragan fauna is closely related to the New Scotland of New York; for other correlatives see HARAGAN FORMATION, *Fossils and age.*

FITTSTOWN MEMBER

I proposed the name Fittstown for the upper member of the Bois d'Arc formation (Amsden 1957, p. 45). The name is taken from the town of Fittstown in Pontotoc County, but the type section is on Chimneyhill Creek, SE¼ NE¼ sec. 4, T. 2 N., R. 6 E.; this is my section P3 which is described in the APPENDIX, and is indicated on the geologic map, plate A, panel II. There are also fine exposures of the Fittstown member near Mill Creek town (J11) and along Haragan Creek to the north of White Mound (M3). A discussion of the nomenclatorial history of these strata is given in my 1957 paper (p. 38-40, 45); additional stratigraphic information is given in my paper on Bois d'Arc brachiopods (1958B, p. 10-14).

Lithology: The Fittstown in its typical lithologic expression consists of fossiliferous calcarenites in beds up to six or eight inches. The bedding is somewhat irregular, showing some tendency to "pinch and swell" (pl. VII, fig. 1) although this is not a conspicuous feature. The Fittstown is composed in large part of beds of fossiliferous calcarenite with a low silt-clay content, separated from one another by thin, marly partings. The dominant color is yellowish-gray, in places with an orange cast (5Y 8/1; 10 YR 7/4). Beds of argillaceous calcilutite or marlstone like those in the underlying Cravatt may be present; these are most common in the lower part (pl. VII, fig. 2), but thin zones may be found throughout the Fittstown (fig. 40). Only rarely is the Fittstown composed exclusively of calcarenites.

In most places the Fittstown carries some nodules and small lenses of chert. Locally, as on the Lawrence uplift, chert is rare or absent, but in most areas some cherty beds are present although they may be quite irregular in their distribution (fig. 40). Almost all of the Fittstown chert is the vitreous type; in only a few places have I observed nodules of porous chert.

Fossils are a conspicuous and integral part of the Fittstown limestones. In those areas where the dip is gentle and the strata well exposed, as along Bois d'Arc Creek (P11), the bedding surfaces are literally covered with brachiopod shells.

In considering the HC1 insoluble residues of the Bois d'Arc members it should be kept in mind that this formation includes diverse rock types. The typical Cravatt lithology is a silty and

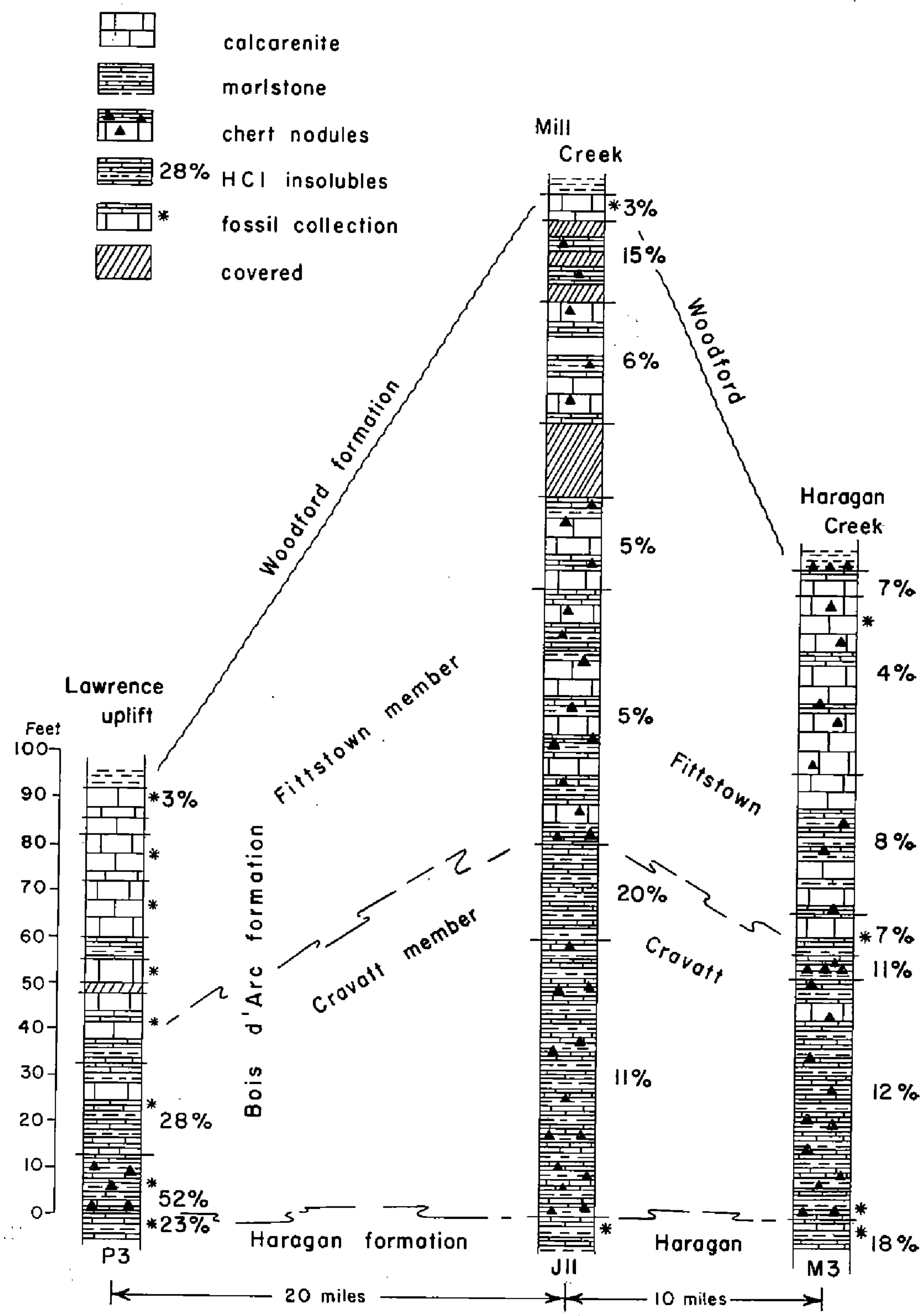


Figure 40. Three columnar sections showing the Fittstown-Cravatt relationship. These sections are described and located in the APPENDIX; see also plate C, panel III. (After Amsden 1958B).

Figure 1. Upper part of the Fittstown member, Bois d'Arc formation; Bois d'Arc Creek, NE¼ sec. 11, T. 2 N., R. 6 E., Pontotoc County (stratigraphic section P11, unit A; see APPENDIX).

Figure 2. Basal part of the Fittstown member (Bois d'Arc formation) consisting of interbedded calcarenite (M) and argillaceous calcilutite (C); tape is extended 1 foot. East bank of Chimneyhill Creek, SE¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County (stratigraphic section P3, unit CC; see APPENDIX).

Figure 1. A weathered bed of Frisco limestone exposed on a dip slope, showing the characteristic pitted or "pot-holed" surface. South side of Bois d'Arc Creek, NW¼ sec. 11, T. 2 N., R. 6 E., Pontotoc County.

Figure 2. View of a typical outcrop of Frisco calcarenite (tape extended 1 foot); compare the Frisco bedding shown in this picture to that of the Fittstown shown in plate VII, figure 1. North side of Coal Creek, NW¼ sec. 22, T. 1 N., R. 7 E., Pontotoc County (stratigraphic section P9, unit R; see APPENDIX).

argillaceous calcilutite which, excluding chert, has much in common with the Haragan marlstone. On the other hand, the typical Fittstown is a markedly different rock with a significantly increased fossil content and a reduced silt-clay content. Both types are found interbedded with one another, especially near the boundany of these two members; moreover, both show variation in insoluble content and actually grade into one another, so whereas the lithologic extremes are distinct, the intermediate types are not (see figs. 33, 34). The following remarks apply primarily to the characteristic Fittstown strata with the more obvious beds of marlstone and marly partings excluded.

The Fittstown has, for the most part, a low HC1 insoluble content. The analyses of 24 samples, selected to exclude chert in so far as possible, range from 1 to 14 percent, the greatest concentration falling between 1 and 6 percent (fig. 36). The average is 4½ percent, which represents a substantial reduction from that of the Cravatt (11½ percent). Partial silicification of fossils is common in the Fittstown and fragments of replaced fossils generally make up a considerable part of the residues. Most residues also show some drusy quartz and pyrite. Glauconite may be present in minor amounts and locally it is abundant; it generally has a polylobate or fossil shape similar to that of the Cochrane glauconite (pl. XVII, figs. 5, 6). In addition the washed residues include some silt-size, clear, subangular detrital quartz; a few sand size, well rounded quarts grains may also be present. Between the typical Haragan marlstone and the typical Fittstown bioclastic calcarenite there is a decrease in average insoluble residue from 16 percent to 4½ percent; however, there is an even greater decrease in the quantity of extra-basinal detritus because the Haragan residues are composed largely of clay and silt sized detritus, whereas only a small part of the Fittstown residues are clearly detrital in origin.

I have prepared several paralodion peels and two of these are illustrated on figures 5 and 6 of plate XIV. The characteristic Fittstown lithology is a bioclastic calcarenite consisting of fossils set in a matrix of clear calcite. Recognizable fossil material makes up well over half the rock and on some specimens I would estimate that 80 to 85 percent of the rock is clearly organic. Pelmatozoan debris is by far the dominant constituent and much of the

Fittstown is a crinoidal sand or encrinite. Brachiopods are next in abundance, followed by trilobites and a few Bryozoa; corals are rare and I have never observed calcareous algae. The grain size is controlled in large measure by the pelmatozoan material, most of which falls in the sand size. A few of these plates do exceed 2 millimeters and many of the brachiopods and other fossils are much larger; however, some of the larger fossils appear to be broken and this tends to hold down the grain size. It is, as noted below, difficult to separate the effect of recrystallization from that of breakage, but there is good evidence of some fragmentation and quite possibly this has been fairly extensive. The Fittstown is predominantly a calcarenite, although locally enough coarse material is present to produce a calcirudite.

The matrix surrounding the fossils is almost entirely clear crystalline calcite (pl. XIV, figs. 5, 6), and I have only one peel which shows a few small patches of finely divided carbonate. As noted in the introductory discussion of the BOIS D'ARC FORMATION, a considerable part of this clear calcite is believed to be a primary constituent of the rock. There are, however, several features indicating that some of this, especially that associated with pelmatozoan plates, is the result of recrystallization: (1) Many of the pelmatozoan plates have an irregular outline that seems to be "corroded", and which appears to merge into the clear calcite. (2) Some of the clear calcite crystals include within their boundaries remnants of pelmatozoan plates. (3) The cleavage of the clear calcite in some cases extends through the adjacent pelmatozoan plate. Thus the fossil debris which is the dominant constituent in the Fittstown, appears to have been acted on by two different processes: (1) mechanical breakage, and (2) recrystallization. It is sometimes difficult to separate the results of these two processes, and I am uncertain as to how extensively the Fittstown rock has been affected by recrystallization. Possible pelmatozoan debris made up a considerably greater percentage of the original composition, with later changes resulting in the increase in clear calcite at the expense of these plates (see *Environment of deposition*).

Partial replacement of fossils by silica is fairly common in the Fittstown, but both the peels and the HCl insoluble residues show that this process has rarely proceeded beyond an early stage.

I have prepared one peel of a partially dolomitized specimen from M3-F on Haragan Creek (11.2% $MgCO_3$). The $MgCO_3$ is in the form of small rhombs which make irregular patches and stringers through the rock. The location of the dolomite appears to be partially controlled by the fossils as the crystals generally line the outer and inner margins of the various fossil fragments.

The Fittstown has, for the most part, a low $MgCO_3$ content (fig. 37). The 21 specimens analyzed range from a fraction of a percent up to 11 percent, with 16 having less than 1½ percent· The average of 1.7 percent is similar to that of the Cravatt (2..4%) and the Haragan (2.3%). The highest Fittstown specimen tested (M3-F) yielded 11.2 percent $MgCO_3$; this came from the upper five feet of the Fittstown and may represent local dolmitization under the Woodford contact (HUNTON GROUP, *Hunton* $MgCO_3$).

The $CaCO_3$ content of the Fittstown member ranges from 81 percent to 95 percent, averaging 95 percent. This is the highest est of any Helderbergian stratigraphic unit, the Cravatt having an average $CaCO_3$ content of 85 percent, and the Haragan 80 percent. The increase in calcium is closely paralleled by a decrease in the HCI incoluble residue; the Haragan averages 16 percent, the Cravatt 11.5 percent, and the Fittstown 4½ percent. In contrast the average $MgCO_3$ content varies by less than 1½ percent (Fittstown 1.7 percent, Cravatt 2.4 percent, Haragan 2.3 percent).

Fittstown-Cravatt relationship: The stratigraphic and faunal relationship of the Cravatt and Fittstown indicates clearly that these members are, to a large extent, facies of one another. I have already discussed this topic in my paper on the *Bois d'Arc articulate brachiopods* 1958B, p. 8-25) and have made some additional comments in the present paper under the section on the HARAGAN FORMATION, *Haragan-Bois relationship,* and in the chapter on the BOIS D'ARC FORMATION. On almost all sections studied there is no well-defined lithologic (nor faunal) boundary between these members, and the Cravatt calcilutites grade into the Fittstown calcarenites through a considerable stratigraphic thickness (fig. 40; pl. VII. fig. 2). Moreover, beds of calcarenite which are lithologically indistinguishable from those of the Fittstown may be found low in the Helderbergian section (in one place in the

Haragan; P1, fig. 55), and, conversely, beds of marlstone range almost throughout the Fittstown (fig. 40.) There is strong evidence of a lateral as well as a vertical gradation of one member into the other. A good example of this may be found in the outcrop belt extending from the Lawrence Uplift south to old Hunton townsite (section A-A', C, panel III). On the Uplift the Fittstown facies is well developed and appears quite low in the Helderbergian section, whereas at P10 and P9, a short distance to the south this lower part is entirely in the Haragan marlstone lithofacies. Furthermore, at P17, about two miles south of P9, only the upper five feet of the Helderbergian strata are in the Fittstown lithofacies. A similar relationship is found in the western belt of outcrops (section C-C, pl. C, panel III); at M18 near Spring Creek and Ca8 near West Spring Creek there is no Fittstown present (although the Helderbergian strata reach a maximum of about 150 feet), whereas at Ca9, about a mile to the west of Ca8 there is 16 feet of Fittstown calcarenites. Since both members carry a similar Helderbergian fauna, it would appear reasonably certain that both were deposited in the same sea, and, to a large extent, contemporaneously.

Fittstown-Frisco relationship: This is discussed in the chapter on the FRISCO FORMATION, *Frisco-Fittstown relationship.*

Environment of deposition: In discussing the deposition of the Fittstown only the low insoluble, bioclastic calarenite will be considered. Before taking up this question it will be helpful to contrast the typical Haragan marlstone with the typical Fittstown calcarenites as these represent the two lithologic extremes of the Hunton Helderbergian strata (figs. 33, 34). The Haragan marlstone consists of finely divided (silt-clay) carbonate and acid insoluble material with scattered fossils. There is some question concerning the origin of the fine carbonate (see HENRYHOUSE FORMATION, *Lithology*) but the insoluble fraction, which averages some 16 percent is largely extra-basinal detritus. The quantity of fossil material varies greatly, but in most cases is well below 50 percent. There is very little clear, crystalline calcite. The Fittstown calcarenite is a much coarser textured rock which is made up predominantly of fossils with some parts having as much as 80 percent recognizable fossil debris. Its matrix is almost entirely clear, crystalline calcite, and the insoluble detritus has dropped to less than 4 percent (excluding replacement silica). There is evidence of both fragmentation and recrystallization. (For a dis cussion of the chert see CRAVATT MEMBER, *Environment of deposition*).

There are some interesting faunal changes (biofacies) accompanying these lithologic changes. (The following data derived from both fossil collections and thin sections, and peels). The Haragan Cravatt and Fittstown all have a Helderbergian fauna with similar generic and specific compositions, but there are some changes in the relative proportions of certain groups (the fossils from these different units are believed to be essentially indigenous; see below). Brachiopods are very well represented in the megafaunas in all facies of the Helderbergian strata although there is some variation in the relative abundance of certain species (Amsden 1958B, fig. 4). The Haragan also carries a number of trilobites, snails and Bryozoa. Its coral fauna is small in terms of species; however, my collections do include several hundred specimens, most of which represent a species of *Favosites,* various species of small horn corals, and a *Pleurodictyum.* The Cravatt fauna is similar to that of the Haragan although there is a marked decline in the corals and my collections only include about 25 specimens. The brachiopods continue to be abundant in the Fittstown, both in numbers of species and number of individuals, but the pelmatozoans now become the dominant part of the megafauna. Pelmatozoan plates, which are common in the Haragan and Cravatt, become so abundant in the Fittstown that in many places they actually make up a large part of the rock. There is no way to determine how varied a crinoid-blastoid-cystoid fauna is represented because the fossils consist almost entirely of isolated plates and stem fragments which cannot be identified. Some of the stems are remarkable for size and I have one specimen with a diameter of almost 45 mm. Trilobites are common in some parts of the Fittstown; dalmanitid trilobites seem to be the best represented and locally (e.g. P17) fragments of this trilobite, some of which may be quite large, are abundant. Corals are rare in the Fittstown and my collections include only two specimens (a *Pleurodictyum* and a small horn coral). It would seem reasonable to infer from the foregoing data that, as a group, the Helderbergian brachiopods and trilobites had a greater ecological tolerance than did some of the other groups (some brachiopod species more than others). The crinoids were adapted to both environments although they much preferred the clearer, somewhat more agitated water of the Fittstown. Surprisingly, the corals show a preference for the quieter more turbid waters of the Haragan. No calcareous algae have been observed in any of the Helderberg strata.

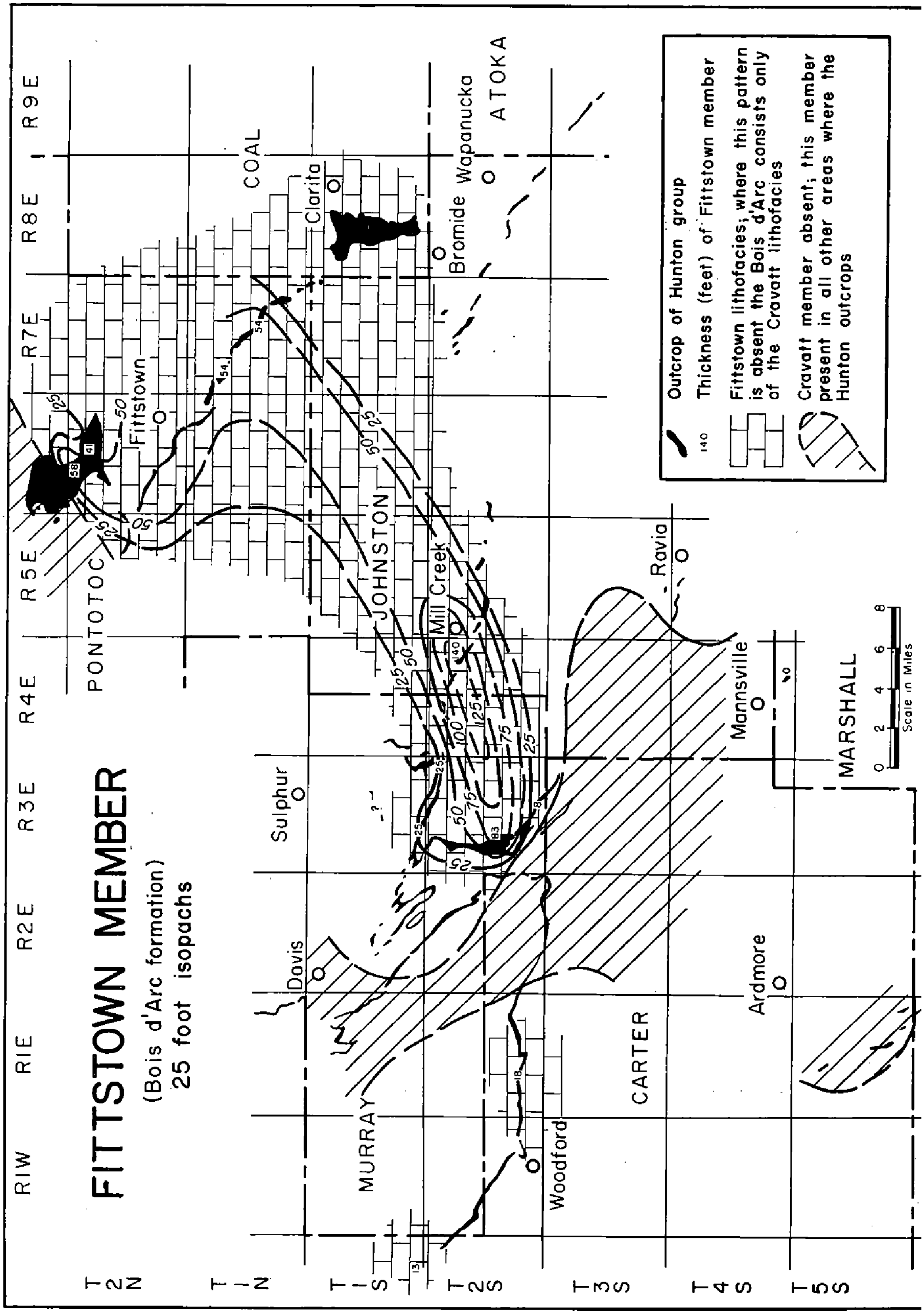
The Fittstown must have been deposited in relatively clear water as there is little extra-basinal detritus present in the rock; the bottom was largely a calcareous sand with little mud. Colonies of crinoids and other stalked pelmatozoans were present in great profusion and to a considerable extent the Fittstown is a pelmatozoan biostrome. Several lines of evidence point to deposition in water which was moderately agitated by currents or waves: (1) Some of the fossils have been mechanically broken. (2) Disarticulated brachiopod shells are common; both the Haragan and Cravatt brachiopod faunas include many articulated valves, a condition which is relatively uncommon in the Fittstown. (3) The Fittstown beds show a tendency to "pinch and swell" (pl. VII, fig. 1), suggesting moderate channelling by wave or current action. This movement was probably enough to cause some shifting and concentration of the fossils, and in part the faunas represent a thanatocoenose; however, it seems most unlikely that the distance involved was ever very great and the Fittstown fossils are believed to be essentially indigenous. Certainly there is no evidence of turbulent, strongly agitated water, and it seems probable that the Fittstown strata were deposited far enough away from shore to be out of the strongest wave action. The Fittstown thus appears to be an offshore deposit similar to the Haragan, but probably representing shallower water.

The genesis of the clear crystalline calcite presents a problem (see discussion under KEEL MEMBER, *Lithology,* and BOIS D'ARC FORMATION). This may be a secondary feature, developed by alteration of a finer textured matrix such as that found in the marlstones. Certainly some recrystallization has taken place in the Fittstown, especially around the pelmatozaon plates, but

I am inclined to the view that this sparry calcite is mostly a primary feature of the rock since it is so invariably associated with the bioclastic calcarenites in the Hunton Helderbergian strata. Folk (1959, p. 29-34) has an interesting discussion on the origin of clear crystalline calcite cement (sparry calcite). He notes that this type of cement is mostly associated with calcarenites where the allochems (i. e. shells and other fragments) are packed close together, whereas the finely divided calcite (microcrystalline ooze) is present where these fragments are loosely packed, like fruits in a fruit cake (or plums in a plum pudding). From this he concludes that the sparry calcite forms in an environment where current action has swept out the microcrystalline ooze ("lime mud"). The relationship of the Haragan-Cravatt-Fittstown lithofacies (see figs. 33, 34, and discussion under BOIS D'ARC FORMATION) seems to fit in with such an explanation as the Fittstown bioclastic calcarenites appear to have been laid down in more agitated water than were the Haragan marlstones.

Considering the Hunton Helderbergian strata as a whole, there appears to have been a tendency for the waters to become shallower towards the close of deposition; the silt clay content was reduced, the waters cleared and pelmatozoan colonies grew in profusion. The brachiopod and trilobite faunas were not greatly affected by these ecological changes, but other groups, such as the corals, show a marked decline. These changes were not everywhere present and in places the deposition of marly strata continued to the last. Moreover, the areas receiving lime sands shifted from time to time and from place to place, thus producing an intimate mixing of the different lithologic types.

Thickness and distribution: The Fittstown member is irregular in its thickness and distribution (isopach map, fig. 41). Part of this irregularity results from its lateral gradation into the Cravatt lithofacies (pl. C, panel III)), and part is due to truncation beneath the Woodford unconformity (see WOODFORD FORMATION). The Fittstown member reaches its greatest thickness in the Mill Creek to White Mound area where it ranges from 83 to 140 feet. Elsewhere it is 50 feet or less in thickness, and is absent in many places.


FITTSTOWN MEMBER
(Bois d'Arc formation)
25 foot isopachs
RIW
RIE
R2E
R3E
R4E
R5E
R7E
R8E
R9E
T 2 N
T 1 N
T 1 S
T 2 S
T 3 S
T 4 S
T 5 S
PONTOTOC
COAL
ATOKA
JOHNSTON
MURRAY
CARTER
MARSHALL
Fittstown
Clarita
Wapanucka
Bromide
Mill Creek
Ravia
Mannsville
Sulphur
Davis
Ardmore
Woodford
Outcrop of Hunton group
Thickness (feet) of Fittstown member
Fittstown lithofacies; where this pattern is absent the Bois d'Arc consists only of the Cravatt lithofacies
Cravatt member absent; this member present in all other areas where the Hunton outcrops
Scale in Miles
0 2 4 6 8

Fossils and age: The Fittstown has a substantial megafauna although it does not include as many identifiable species as the Haragan. Excluding pelmatozoans, most of which cannot be identified, the brachiopods comprise the major part of the fauna. Trilobites are next in abundance, although most specimens are fragmentary. I have collected a few other fossils, such as Bryozoa, but outside of the above mentioned groups it is a small fauna. No arenaceous Foraminifera have been seen in the acetic acid residues (only a few acetic acid tests have been made).

Reeds (1911, p. 265-266) recorded about two dozen species from the Bois d'Arc formation, which included both the Cravatt and Fittstown divisions. Maxwell (1936, p. 97-98) gave a faunal list for his Bois d' Arc formation which was restricted to beds roughly equal to the Fittstown member of this report. He recorded 44 species which included 29 brachiopods, four gastropods, one cephalopod, four trilobites, one bryozoan and four corals. I suspect that some of these fossils came from Cravatt strata as certain of these groups, such as the corals, are extremely rare in the Fittstown lithofacies. No Bois d'Arc fossils were recorded in my *Catalog of Hunton Fossils,* and to my knowledge the only fossils which have been described are the articulate brachiopods (Amsden 1958B).

The Fittstown fauna is Helderbergian in age and similar to that of the Cravatt and Haragan (Amsden 1958B, p. 20, fig. 4). The combined Bois d'Arc-Haragan fauna is closely related to that of the New Scotland of New York; for other correlatives see HARAGAN FORMATION, *Fossils and age.*

FRISCO FORMATION

These strata were included by Reeds (1911) in his original description of the Bois d'Arc formation, but in 1926 he recognized them as a distinct formation, the Frisco limestone, named for the town of Frisco in Pontotoc County (panel I). The Hunton is not exposed in the viciniy of this town and Reeds did not indicate a type section so in 1957 (p. 47) I designated the exposures along Bois d'Arc Creek (NE¼ sec. 11, T. 2 N., R 6 E.) as the tyDe section; this is my stratigraphic section P11 which is described in the APPENDIX, and which is located on the geologic map, plate A, panel II. There are also fine exposures in the vicinity of Coal Creek (P 9, pl. VIII, fig. 2). The stratigraphy and paleontology of this formation were made the subject of a University of Oklahoma Master of Science thesis by William Ventress in 1958.

Frisco outcrops are confined to a small area in the northeastern part of the Arbuckle Mountain region (fig. 42). This formation has been mapped in detail on the Lawrence Uplift (pl. A, panel II) and in the vicinity of old Hunton townsite (pl. B, panel II).

Lithology: The Frisco is a fossiliferous calcarenite generally in beds to two or three feet, although locally, as in the upper part of section P11, it becomes massive with beds up to 10 feet in thickness. The bedding is somewhat irregular (plate VIII, fig 2; see also Amsden 1957, pl· III). It is commonly some shade of light gray or yellowish gray, but near the south end of the outcrop belt (T. 1 S., R 8 E.) it ranges from a a dusky yellow (5Y 6/4) to a pale greenish yellow (10Y 8/2), the greenish cast being in part produced by glauconite.

Chert is locally present in the Frisco. It is mostly a light-colored, vitreous type, commonly in small nodules and lenses. A few nodules of porous chert were found in the SE ¼ sec. 10, T. 2 N., R. 6 E., and Ventress observed some elongate bands of chert ranging up to 10 inches in thickness near Coal Creek (NW¼ sec. 22, T. 1 N., R. 7 E.) Some of the chert is in angular fragments, or aggregates of angular fragments which have a brecciated appearance. These brecciated cherts are present in other parts of the Hunton; I have seen good examples in the Cochrane member and in the Bois d' Arc formation. As a rule they have the outline of a typical nodule, but the chert is broken up into angular fragments. On some, however, the fragments are dissociated and strewn out in the plane of the bedding. Ventress (1958, p. 12), in his study of the Frisco, noted that at some localities angular fragments of chert were scattered through the rock. There are several reasons for believing this brecciated character is a depositional rather than a tectonic feature: (1) In none of the examples observed by me are they closely associated with faults or shear zones. (2) The associated rock shows no marked evidence of deformation. (3) where the fragments are disarticulated they seem to be distributed

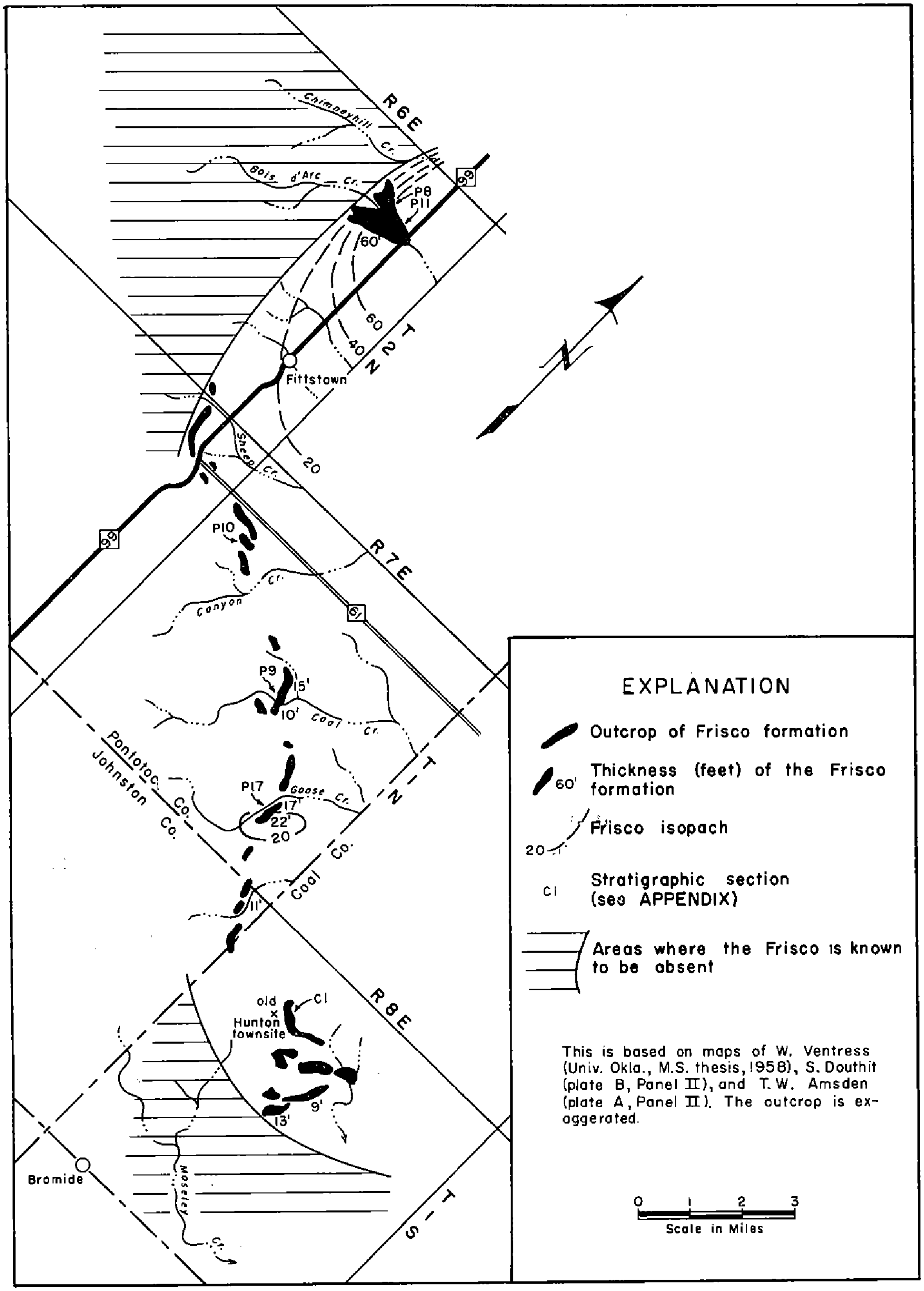


Figure 42. Outcrop and isopach map of the Frisco formation. The horizontally ruled parts indicate those areas where the Frisco is known to be absent and the Woodford rests directly on the Bois d'Arc formation. This is compiled from Ventress 1958 (pl.

in the plane of the bedding rather than transgressing bedding planes. (4) I have observed well-developed brecciated cherts in the Cochrane on the Lawrence uplift where tectonic deformation is at a minimum. It has been suggested that the brecciated texture could be produced by cracking at the time the chert was formed (possibly due to shrinkage associated with dessication) and that where the fragments are dissociated it was owing to waves or currents acting on the fractured chert. This hypothesis, of course, assumes that the chert is a primary feature of the rock, formed by precipitation or by penecontemporaneous replacement at the time the associated sediments were laid down (See HUNTON GROUP, *Hunton chert*).

Chert beds and spherical "concretions" appear on or near the Woodford-Frisco contact in some areas. These are discussed in the section on the WOODFORD FORMATION.

One of the more distinctive features of the Frisco is the way it weathers. Bedding surfaces exposed at the surface almost everywhere develop a pitted or "honey comb" structure. On a dip slope, where one bed is exposed over a considerable area, these holes become rather large and have some resemblance to "pot holes" (fig. 1, pl. VIII). This "honey-comb" or "pot holed" structure is widely developed in the Frisco and is useful in distinguishing this formation from the Fittstown calcarenites.

The frequency distribution of 8 HCl insoluble residues is shown on figure 43. These range up to 5 percent, but the average is only 1.7 percent and 5 of the 8 specimens had less than one percent. Ventress made 19 insoluble residue tests and these show a range from a fraction of a percent up to 5.2 percent, most falling between 0.7 and 1.7 percent. The Frisco calcarenite (excluding chert) is thus a rather pure limestone with an insoluble content which rarely exceeds 2 percent. A considerable part of most washed residues is subangular to subrounded, clear quartz in the silt and fine sand size (only rarely exceeding 0.2 mm in diameter). Some of the grains, however, are in the form of small crystals (a few doubly terminated) and, rarely, crystal aggregates; these commonly show little or no evidence of abrasion and may represent secondary growth on detrital grains. Fragments of silicified fossils are generally present and locally may become abundant.

The residues from 3 specimens collected in the NE¼ NE¼ sec. 16, T. 1 S., R. 8 E., are composed in large part of silicified fossils, most of these being sponge spicules but including a few well preserved ostracods; these residues, which range up to 5 percent, have only a small percentage of detrital quartz but do contain a fair amount of glauconite. The Frisco glauconite is commonly lighter in color than most Hunton glauconite; some grains have a polylobate or fossil shape like that in the Cochrane member, but most is in the form of small, porous, granular aggregates. Some pyrite and limonite (?) is present in most residues.

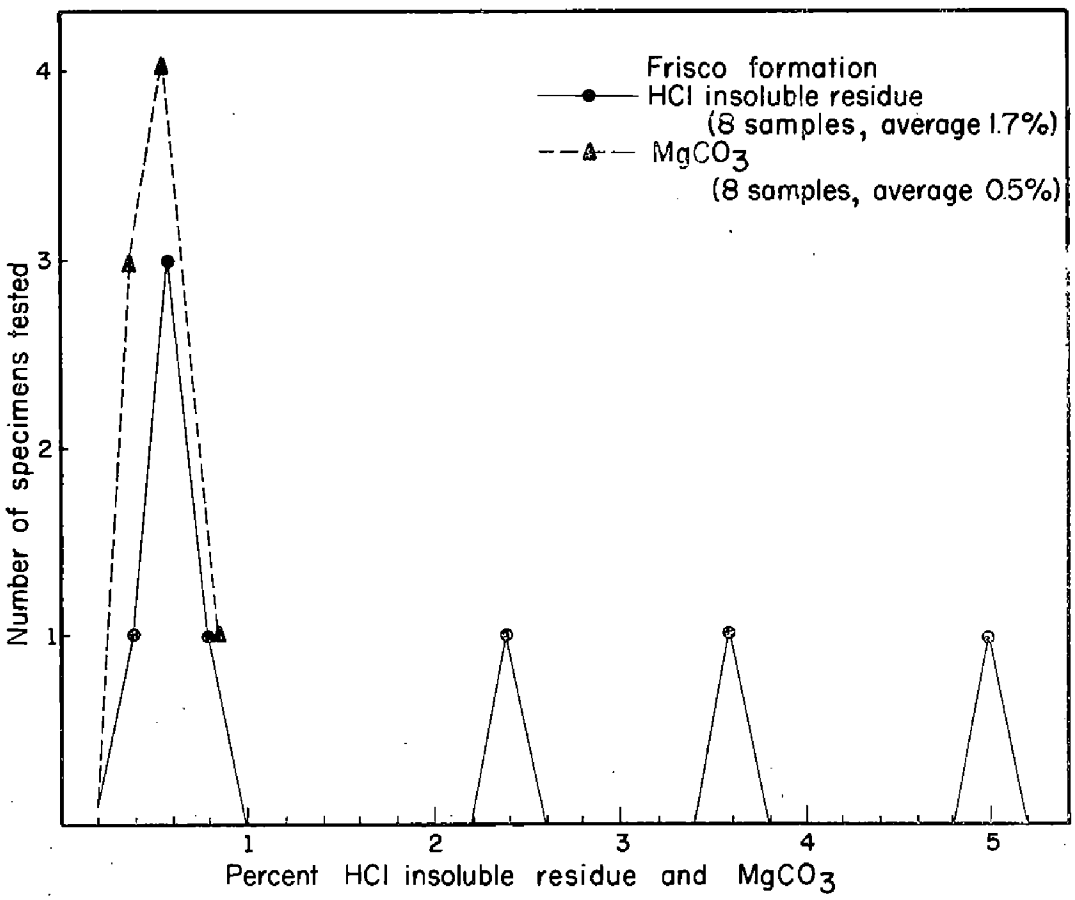


Figure 43. Frequency diagram showing the distribution of HCl insoluble residues and $MgCO_3$ in the Frisco formation. The data for this are given in the APPENDIX.

The Frisco has an extremely low magnesium content (fig. 43). All of the 8 specimens tested had less than 1 percent $MgCO_3$, and all contained over 96 percent $CaCO_3$ (the average being 98.6 percent). These analyses are, of course, determined on a chert free basis, but even so the Frisco is one of the purest limestones in the Hunton.

Several paralodion peels and one thin section have been prepared, and four of these are illustrated on figures 1 to 4, plate XIV. These show that the Frisco is predominantly a calcarenite, locally grading into calcirudite, which is composed in large part of fossil debris set in a matrix of clear, crystalline calcite. The amount of recognizable fossil material varies greatly. The specimen illustrated on plate XIV, figure 1, is mostly finely divided calcite, with only widely scattered fossils. This texture is, however, uncommon and most of the Frisco is composed of over 50 percent recognizable fossil material. It is difficult on some specimens to determine the precise proportion of clear calcite to organic material due to the effects of recrystallization. Almost all peels show some recrystallization, especially associated with pelmatozoan plates, and possibly this process has been extensive. Many clear calcite crystals show inclusions of granular bodies with irregular and indistinct outlines; commonly these bodies cannot be positively identified as organic, but some show the unmistakable porous texture of the echinoderm skeleton (see photomicrographs, pl. XIV, figs. 3, 4). It is therefore possible that a considerable part of the clear calcite in the Frisco originated as organic debris (particularly pelmatozoan plates) which was later converted to sparry calcite. In my opinion, however, most of the clear calcite is a primary feature, precipitated at the time of deposition. Much of it appears to resemble that which Bathurst (1959, p. 14-21) called granular cementation or rim cementation (compare figures 3, 4 of plate XIV to figure 1, number 2 in Bathurst). For a further discussion of this topic see under KEEL MEMBER, *Lithology;* BOIS D'ARC FORMATION; FITTSTOWN MEMBER, *Lithology.* Regardless of the importance of recrystallization the Frisco is predominantly a bioclastic rock.

Brachiopod and snail shells make up a considerable part of the Frisco fossil material, along with some bryozoans, corals and other groups. In most beds pelmatozoan debris is subordinate, and the Frisco in this report is quite different from the Fittstown member of the Bois d' Arc formation. The latter is predominantly a calcareous sand, largely pelmatozoan plates, with the clear calcite acting as a cement. The Frisco, in contrast, generally shows a greater proportion of clear calcite and nowhere appears to have as much pelmatozoan material. Possibly this indicates that the Frisco has undergone a more extensive alteration of its original texture; pelmatozoan plates appear to be more readily recrystallized than other fossil elements and it may be that originally the Frisco included a considerably greater amount of pelmatozoan debris which was later converted to clear, sparry calcite (see discussion above).

There is ample evidence of fragmentation and I estimate the breakage of fossils during deposition was more extensive in the Frisco than in the Fittstown. In its more characteristic lithologic expression, as in the lower beds along Bois d'Arc Creek, the Frisco is composed of a heterogeneous assortment of fossils, with brachiopod and snail shells up to three inches in diameter mixed with smaller fossils and fragments of fossils. The bivalved shells, such as the brachiopods, are almost all disarticulated, and the peels as well as the fossil collections from the Frisco in this area show considerable breakage. This debris, composed of broken and whole fossils of different sizes, is mixed together to produce a rock of variable textures which shows little evidence of size sorting. In some areas, however, the Frisco appears to have undergone rather extensive size sorting by current and/or wave action. Throughout much of the southern area of outcrop (fig. 24; T. 1 S., R. 8 E.) the texture is fine and relatively uniform; peels show that it is composed largely of ostracods, sponge spicules and fragments of larger fossils, few grains exceeding 0.5 mm in diameter (HCl residues of this rock are mostly silicified sponge spicules and ostracods, along with considerable glauconite; acetic acid residues have conodonts). This fine-grained rather uniform texture suggests that it represents the smaller fraction which was removed from a more heterogeneous assemblage by selective wave or current action.

The partial or complete silicification of fossils is fairly extensive in the southern outcrop areas (T. 1 S., R. 8 E.) but elsewhere is not common.

Environment of deposition: The Frisco formation, like the Fittstown member of the Bois d'Arc formation, is a bioclastic rock with the fossils set in a matrix of clear calcite. The acid insolubles are slightly lower in the Frisco calcarenites (about 2½ percent) athough this reduction may be in part due to the somewhat more extensive silicification of fossils in the Fittstown. In any event, the quantity of extra-basinal detritus is small in the limestones from both, although it should be kept in mind that the Fittstown includes marly partings and thin beds of marlstone, whereas these are absent from the Frisco. The Frisco differs primarily in its somewhat greater proportion of clear calcite to fossils, and in its somewhat greater proportion of broken to whole fossils. Furthermore, the Frisco in some areas appears to have undergone considerable size sorting, a feature which I have not observed in the Fittstown on a comparable scale.

The Frisco fauna, like that of the Fittstown, belongs largely to the vagrant and sessile benthos. The two faunas are alike in being dominated by the brachiopods, but aside from this they differ considerably. Snails are common in the Frisco and some reach a large size; a fair number of corals are present, including some colonial types, although there does not seem to be any reef development (Cloud 1952, p. 2128). Ostracods and sponge spicules are common in some areas; no calcareous algae have been observed. The peels of Frisco specimens from various places show some pelmatozoan plates but on none are they the dominant element and on many are relatively uncommon (see discussion above under *Lithologic*). The fragmentary nature of many of the fossils, combined with evidence of size sorting, suggests that this fauna is, at least in part, a thanatocoenose.

The foregoing faunal and lithologic characteristics point to an offshore environment similar to that of the Fittstown, although the water was probably somewhat more strongly agitated. The fragmentary nature of many of the fossils, combined with the evidence of size sorting, indicates considerable shifting of the fossil material by wave or current action. There is, however, no cross-bedding, channeling or other evidence which would point to deposition in the zone of strong wave action, as is present close to shore. In fact, the very small quantity of terrestrial detritus would seem to exclude a littoral or inner sublittoral environment. The Frisco would thus represent an offshore, outer sublittoral type of environment, in general similar to that of the Fittstown, although I would imagine the water was shallower and had a slightly greater turbulence.

The significance of clear calcite in connection with this problem is discussed in the chapter on the FITTSTOWN MEMBER, *En-*

vironment of deposition; for a discussion on chert see CRAVATT MEMBER, *Environment of deposition.*

Frisco-Bois d'Arc relationship: The Frisco formation rests on on the Fittstown, although locally this upper member of the Bois d'Arc formation is quite thin (P17). Both the Frisco and Fittstown are bioclastic calcarenites, but there are several lithologic characteristics which will serve to separate them. (1) The Frisco is consistently thicker bedded, the beds of the Fittstown rarely attaining a foot in thickness; compare figure 1, plate VII with figure 2, plate 2, plate VIII (see also Amsden 1957, pl. III). (2) The Frisco has almost no marly partings or beds of marlstone whereas these are common in the Fittstown. (3) The Frisco weathers to a distinctive "honey-comb" or "pot-holed" surface whereas the Fittstown weathers to a fairly smooth surface. These lithologic differences are accompanied by a marked change in the faunas, the Frisco carrying a Deerparkian fauna and the Fittstown a Helderbergian fauna. Some of the Frisco fossils are stratigraphically useful, even to the person without a detailed knowledge of the faunas. The Fittstown calcarenites commonly have a meager snail fauna, whereas these are generally abundant in the Frisco with some individuals reaching a diameter of three inches. Of even greater value is the Frisco coral *Trachypora* which has distinctive, finger-like branches (plate XVII); this coral is abundant in the lower part of the formation at most outcrops, and is useful since it is unlike any Bois d'Arc fossil. It is especially helpful in those areas where the upper Bois d'Arc and Frisco strata are so poorly exposed that it is difficult to determine the bedding and other physical characteristics.

I believe the Frisco is separated from the underlying Bois d'Arc by an erosional unconformity· The two faunas are distinct and the change from one to the other is abrupt and without any transitional zone. Such an abrupt faunal change points to a complete withdrawal of the Fittstown seas, followed at some later time by a return of the sea, this time with a Frisco fauna. The sharp lithologic change which accompanies these faunal changes furnishes supporting evidence for such an interpretation. There is only meager evidence for regional truncation of pre-Frisco strata, but this is hardly surprising since the Frisco has such a limited outcrop area. Even so, there is some evidence of pre-Frisco erosion in the thinning of the Bois d'Arc strata between sections P3 and P8; see section A-A,' plate C, panel III.

Frisco-Woodford relationship: See discussion under WOODFORD FORMATION.

Thickness and distribution: The outcrop area of the Frisco formation is limited to the northeastern part of the Arbuckle Mountain region. Its distribution in relation to the entire Hunton outcrop area is indicated on the Devonian isopach map, figure 28, and is shown in more detail on the isopach and outcrop map of figure 42; additional details on Frisco distribution may be found in the geologic maps, plates A and B, panel II. This formation attains a maximum thickness of 60 feet along Bois d'Arc Creek on the Lawrence uplift; it thins rapidly to the southeast and throughout the central and southern areas is generally less than 20 feet.

This report does not deal with the subsurface geology of the Hunton group; however, a few remarks might be added with respect to the Fricso. This formation is one of the easier of the Hunton units to recognize in surface exposures, but its distinction from the underlying Bois d'Arc is based on features such as bedding which are not apparent in subsurface data, and the Frisco is lithologically enough like the underlying Fittstown to make their separation extremely difficult in the subsurface. Faunal data is commonly unavailable in the subsurface; however, recently Huffman and myself (Amsden and Huffman 1958, p. 73-75, figs. 1-2) identified a Frisco brachiopod from a core out of the Kytle-Ray well which clearly establishes the presence of this formation in Pottawatomie County (Huffman 1958, p. 34) which suggests the Frisco may have a rather extensive subsurface distribution in central and eastern Oklahoma.

Fossils and age: The Frisco has a large megafauna, most species belonging to the sessile or vagrant benthos. Brachiopods are the dominant element, exceeding all other groups both in number of species and in number of individuals. There are also several species of snails along with some corals and bryozoans; ostracods and sponge spicules are locally common, and pelmatozoan plates and stems are present although I have not seen any complete calyces. Arenaceous Foraminifera are rare or absent in the HC1 insoluble residues. I have obtained a few conodonts out of acetic acid residues of Frisco specimens from the NE¼ NE¼ sec 16, T. 1 S., R. 8 E.

Reeds (1926, p. 10) listed 5 species from the Frisco formation (Schuchert, 1922, p. 669-670, recorded 17 species from strata in Sequoyah County which are presumed to be equivalent to the Frisco formation; see Huffman 1958, p. 34-35). Maxwell (1936, p. 104-105) recorded 58 species distributed as follows: five corals, eight Bryozoa, 32 brachiopods, one pelecypod, 10 gastropods, and two trilobites. The most recent work is that of Ventress (1958) who made a stratigraphic and faunal study of this formation in its type area. This author's collections (including fossils collected by me) were distributed as follows: four species of corals, 23 brachiopods, one pelecypod, six gastropods, one trilobite and two bryozoans. Ventress described and illustrated the brachiopods in detail and gave summary descriptions and illustrations of the corals and gastropods. Amsden and Huffman (1958, fig. 1) illustrated a Frisco brachiopod (*Rensselaeria* cf. *R. elongata*) from a well core (see above), and the common Frisco coral *Trachypora* sp. is illustrated on plate XVII, figures 1-4 of the present report (I am indebted to Dr. William Oliver, Jr. of the U. S. Geological Survey for information on this coral). No Frisco species is listed in my *Catalog of Hunton Fossils* (1956) and to my knowledge no species other than those mentioned above have been described.

The Frisco fauna is Deerparkian in age and closely related to that of the Oriskany sandstone in the eastern United States.

WOODFORD FORMATION

The stratigraphy of the Woodford is not a part of the present report and the formation has been studied only to the extent necessary to determine its relationship with the underlying Hunton group. It is predominantly a dark, fissile shale with thin beds of blocky siltstone and some chert. In most places the Woodford shale stands in marked lithologic contrast to the Hunton limestones and there is little difficulty in separating the two. There are, however, a few places where the Woodford strata, or at least post-Hunton strata, develop a carbonate facies and thus present some problems in recognition; this is discussed below under WOODFORD ? BROWN CARBONATE and the TURKEY CREEK INLIER.

The age of the Woodford has been in question for many years. The latest information based on the conodont studies of Hass (1956A, p. 1, 2, 21, 25; 1956B, p. 27-29; 1958, p. 767; Ham 1959, p. 75) indicates that most of the formation is Upper Devonian (Cassadaga stage) with only a thin zone of Early Mississippian at the top.

Pre-Woodford unconformity: Robert Maxwell (1958, p. 213) has made an extensive regional study of the post-Hunton pre-Woodford unconformity which covers approximately the southern ⅓ of Oklahoma. My investigation of this unconformity is confined to the outcrop area of the Hunton group in the Arbuckle Mountain region and Criner Hills.

The time interval separating the youngest Hunton strata (Frisco formation—Lower Devonian, Deerparkian) from the Woodford is considerable, covering all of the Middle Devonian and probably the early part of the Upper Devonian (pre-Cassadaga stage). During this time the Hunton strata were uplifted and subjected to considerable erosion; within the present outcrop area this erosion was extensive enough to locally strip away all of the Hunton and to allow the Woodford to rest directly upon the Ordovician. The Woodford may thus be in contact with any of the Hunton formations, although it is generally underlain by the Bois d'Arc formation. Two photographs of the Woodford-Bois d'Arc contact are shown on plate IX.

I have prepared several maps and geologic sections to bring out the nature and extent of this unconformity. The Woodford-Hunton relationship is shown on the two geologic maps of panel II; the map of the Lawrence Uplift (pl. A) is especially good to bring out the transgressive nature of this contact, the Woodford resting successively on the Frisco formation, Bois d'Arc formation, Haragan formation and finally on the Henryhouse formation. Four cross section views of this unconformity are shown on the stratigraphic sections of plate C, panel III. Finally, the pre-Woodford subcrop map (pl. A, panel III) delineates the strata upon which the Woodford rests; this is a paleogeologic map which shows the inferred surface distribution of stratigraphic units just prior to Woodford deposition.

The Hunton rocks were rather extensively truncated during this period of erosion. The maximum thickness of this group in the outcrop area is slightly over 400 feet and, from this maximum it ranges down to zero (fig. 7). It should, however, be kept in mind that this thickness variation is, in part, due to erosion that occurred during Hunton time (see *Distribution and thickness,* under HUNTON GROUP). Nevertheless a considerable part of Hunton truncation can be assigned to the post-Hunton pre-Woodford unconformity, and in a few places this is moderately abrupt. A good example of post-Hunton erosion is found on the Lawrence Uplift (geologic map, pl. A, panel II; see also stratigraphic section A-A', pl. C, panel III); within a distance of three miles the entire Devonian part of the Hunton, totaling about 150 feet, is removed (Frisco-Bois d'Arc-Haragan). A similar condition exists in the central part of the Arbuckle Mountain region, in the area extending from White Mound (M3) south to the Washita River (Ca5); here again the Devonian part of the Hunton, totaling some 250 feet, is removed in a distance of three and one-half miles (see stratigraphic scetion D-D', pl. C, panel III). The entire Hunton has been removed in the south-central part of the Arbuckle Mountain region (stratigraphic section C-C', pl. C, panel III; subcrop map, pl. A, panel III). On the other hand, this post-Hunton period of erosion does not appear to be so extensive if the entire outcrop area is considered. The Hunton group, which is a relatively thin stratigraphic unit within the area under consideration, is only locally removed, and throughout much of this area the Woodford remains in contact with the Bois d'Arc formation (pl. A, panel III).

It is interesting to consider the question of pre-Woodford structure. This is a difficult problem as there is no vertical control for the pre-Woodford surface; however, the pattern shown on the pre-Woodford subcrop map (pl. A, panel III) would seem to preclude much pre-Woodford folding. Undoubtedly there was some warping on the surface during uplift and subsidence, but this must have been on a moderate scale since throughout the outcrop region covering an area of about 50 miles by 60 miles the Woodford commonly rests on Hunton Helderbergian strata which at few places exceed a thickness of 250 feet.

There is no clearly defined relationship between the pattern shown on the pre-Woodford subcrop and total Hunton isopach maps (pl. A, panel III), and the present day structure of the Arbuckle Mountain region. The stratigraphic and structural pattern of this region is well defined by the geologic and structural map of Ham (1954). My investigation reveals a pre-Woodford thinning of the Hunton in the area south of Davis, along a northeast-southeast trending zone, and this could be construed as the forerunner of the present day Dougherty anticline, although both its position and trend are somewhat different. In any event, the pronounced northwest-southwest trend which is so marked on the structural map of Ham does not appear to have been developed in either pre-Woodford or pre-Devonian times (pls. A, B, panel III); also, none of the isopach maps of the various Hunton stratigraphic units shows any well-defined relationship to the structural trends developed in the latter part of the Paleozoic. Moreover, there is little or no similarity between the pattern shown on the pre-Woodford map (pl. B, panel III) and the pre-Devonian map (pl. A, panel III), nor do the areas of maximum thickness of Silurian strata (fig. 8) correspond with the areas of maximum thickness for the Hunton Devonian.* It should, however be emphasized that these remarks are based entirely on information obtained from a study of the outcrop area, and a regional study covering a considerably larger area might well bring out relationships and trends which are not apparent in a more restricted area. Maxwell has noted that "a study of the pre-Woodford distribution in southern Oklahoma, coupled with an isopachous map of the Hunton, reveals several structural trends that have persisted through the Pennsylvanian period of denudation" (Maxwell's article is to appear in the *Petroleum Geology of Southern Oklahoma,* Volume II, to be published by the American Association of Petroleum Geologists; this volume in press at the time the present manuscript was sent to the printer).

* In studying a total Hunton isopach map of this, or any, region it should be kept in mind that it is a composite made up of rocks of different ages. A comparison of the different isopach maps in this report will show that the areas of maximum thickness are not the same.

Woodford-Hunton contact: The Woodford-Hunton contact is exposed at a number of places in the Arbuckle region and Criner Hills. In places the Woodford shale rests directly on the Hunton with no basal conglomerate or chert present. An example of this may be seen in about the center of sec. 33, T. 3 N., R. 6 E., where the Woodford Bois d'Arc contact is exposed for 100 feet or so (illustrated, pl. IX); there is no clearly defined structural discordance between the two units, although the geologic map in this area (pl. A, panel II) shows Woodford "truncating" various Hunton formations. A thin bed of conglomerate ranging up to three or four inches in thickness may be present at the base of the Woodford. There is a one- to two-inch bed of conglomerate between the Fittstown calcarenites and typical Woodford shale at section P3 on the Lawrence Uplift (pl. A, panel II; APPENDIX). This conglomerate is composed of subangular to subrounded pebbles up to an inch in diameter (in general the smaller fragments are more angular, the larger ones subrounded); some chert fragments are present along with considerable glauconite. A similar conglomerate may be seen near Goose Creek (SW¼ SE¼ NE¼ sec. 26, T. 1 N., R. 7 E.; see discussion below) where the Woodford rests on Frisco, and at section Ca2 near Tulip Creek (NE¼ SE¼ sec. 25, T. 2 S., R. 1 E.) where the Woodford rests on the basal part of the Cravatt member. This conglomerate is undoubtedly a basal phase of the Woodford as I have never observed such a bed within any part of the Hunton; it is invariably underlain by typical Hunton and overlain by typical Woodford shale.

Chert is somewhat erratically associated with the Woodford-Hunton contact. On the Hunton outcrop belt extending from the Lawrence Uplift south to old Hunton townsite (which is the outcrop belt of the Frisco formation; fig. 42) loose blocks of chert are common in the vicinity of the Woodford-Hunton contact, and in places this chert may be observed in situ between typical Hunton and typical Woodford. Ventress (1958, p. 18) noted exposures of chert at the folowing places: NW¼ SE¼ SE¼ sec. 16, T. 1 S., R. 8 E., SW¼ SE¼ NE¼ sec. 16, T. 1 S., R. 8 E., NW¼ NW¼ sec. 15, T. 1 S., R. 8 E., NW¼ SW¼ SW¼ sec. 10, T. 1 S., R. 8 E.,; SW¼ NW¼ NE¼ sec. 8, T. 1 S., 8 E.; SW¼ NE¼ SE¼ sec. 1, T. 1 S., R. 7 E. (the location of most of these is shown on the geologic map, pl. B, panel II). Ross Maxwell (1936) assigned this chert to the Frisco, believing that a two- to five-foot bed of light-colored chert marked the top of this formation. It is, however, the opinion of both myself and Ventress (1958, p. 18-19) that it is a part of the Woodford and has no relation with the Hunton. Chert is known to be present in the Frisco, mostly in the form of small nodules and lenses (FRISCO FORMATION, *Lithology*), but there is good evidence for assigning the chert associated with the contact to the Woodford. For example, in the vicinity of Goose Creek (SW¼ SE¼ NE¼ sec. 26, T. 1 N., R. 7 E.; near section P17; fig 42) the Frisco-Woodford contact is exposed and shows the following sequence: Frisco calcarenite overlain by a one-inch bed of conglomerate like that described above, followed by a three-inch bed of chert similar in all respects except thickness to those mentioned above; directly above the chert is typical Woodford shale (Ventress 1858, p. 18). Another excellent exposure showing the relation of chert to contact may be seen in the NW¼ SE¼ sec. 1, T. 1 S., R. 7 E.; at this locality I have observed large, subspherical chert "concretions" embedded in the basal few feet of the Woodford shale; the shale wraps around and encloses these concretions (which range up to a couple of feet in diameter). Futhermore, chert is present in the basal part of the Woodford in areas where the Frisco is absent. A bed of Woodford chert is present just above the Hunton contact on Haragan Creek in the vicinity of White Mound (section M3; fig. 54, APPENDIX). The basal two to three feet of the Woodford formation at section M5, west of Price's Falls (fig. 52, APPENDIX) consists of brown, fractured chert with considerable carbonate (16 percent $CaCO_3$; APPENDIX); this particular outcrop is believed to be of significance in the interpretation of the Oil Creek outcrops and is therefore discussed at greater length below (WOODFORD? BROWN CARBONATE). The foregoing data are sufficient to show that chert in the form of beds or lenses, or "concretions" is present in the basal part of the Woodford at a number of different places.

Figure 1. Contact of the Woodford shale with the Cravatt member of the Bois d'Arc formation. Arrow points to geologic pick stuck in the contact. About the center of sec. 33, T. 3 N., R. 6 E., Pontotoc County.

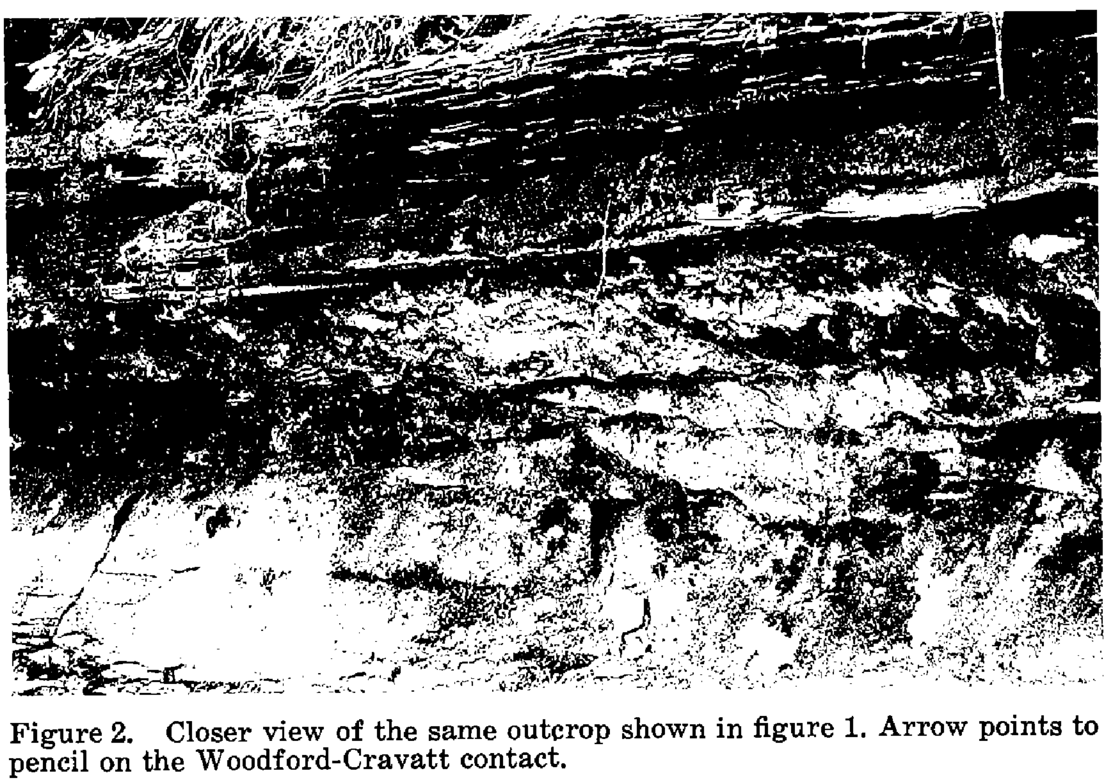


Figure 2. Closer view of the same outcrop shown in figure 1. Arrow points to pencil on the Woodford-Cravatt contact.

WOODFORD? BROWN CARBONATE

This formation is well exposed near Oil Creek in the western part of Johnston County (figs. 44, 46). It is mostly a brown-weathering, cherty carbonate, in part highly dolomitic, with a maximum thickness of about 25 feet; this unit is overlain by Woodford shale and underlain by Sylvan shale. These exposures have been known for a number of years and have generally been assigned to the Hunton group. Maxwell (1936, p. 57) referred the strata in this area to the Cochrane member of the Chimneyhill formation, and Ham (1954) included them in the Hunton group on the Arbuckle Mountain map (the Hunton outcrop belt was extended from sec. 10, T. 3 S., R. 3 E. in a southeasterly direction and joined with the outcrops in question). In my opinion, however, these rocks are not a part of the Hunton group. I suspect they represent a lower member or facies of the Woodford, although they could be a pre-Woodford sequence; whatever their relationship may be with the overlying beds they appear to be almost certainly post-Hunton in age. Before discussing the evidence bearing on this problem, a brief outline will be given of the geologic and geographic setting.

The geographic distribution and geologic relationships are shown in figure 44. The Woodford? brown carbonate is present in the NE¼ sec. 20, the SW¼ sec. 17, and the eastern half of sec. 18. In this area it is underlain by typical Sylvan shale and overlain by typical Woodford shale; there is no question about these stratigraphic relations as there are several outcrops with complete exposures across the upper part of the Sylvan, brown carbonate and lower part of the Woodford shale. I could not find any outcrops in this stratigraphic position from sec. 18 northwest to Highway 18. West of the highway the Hunton ridge reappears and in sec. 4 I have described two stratigraphic sections (Ca3, Ca4) which are lithologically and faunally typical in every respect for Hunton strata (in both sections the Henryhouse is directly overlain by Woodford; see APPENDIX). I have not observed any of the Woodford? brown carbonate in the eastern part of sec. 20 (east of J18) or in the western part of sec. 21; however, Maxwell records it in sec. 21, and Ham shows the "Hunton" outcrops extending into this section so it may be present in sec. 21. Apparently there is no

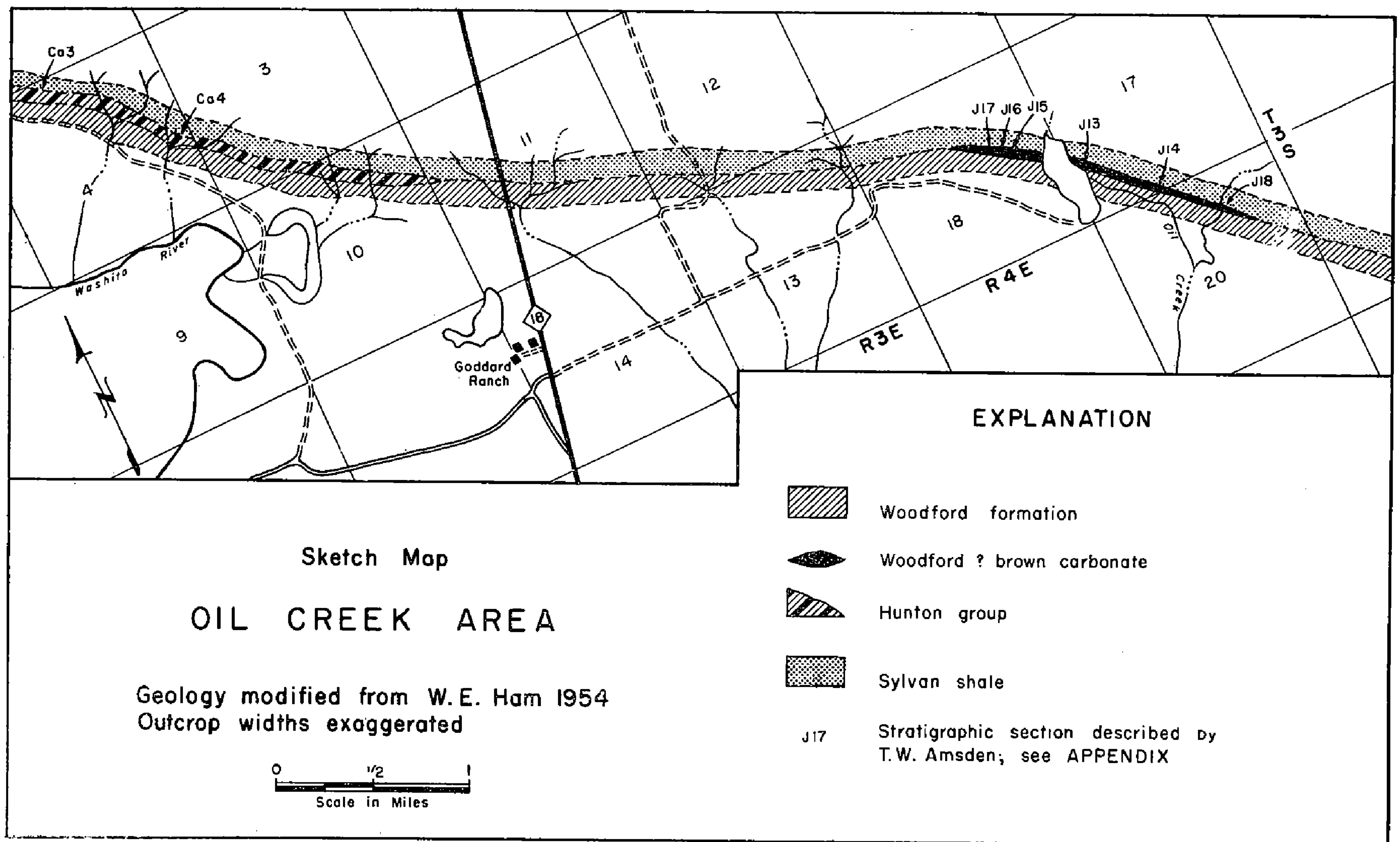


Figure 44. Map of the Oil Creek area showing the known surface distribution of the Woodford? brown carbonate.

Woodford? brown carbonate or Hunton present from this area west to sec. 6, T. 4 S., R. 5 E. Near Ravia, on the eastern edge of sec. 5, T. 4 S., R. 5 E. I have described stratigraphic section J12 (fig. 46) which is normal in all respects for the Hunton group (see APPENDIX). This distribution pattern shows that while the Woodford? brown carbonate occupies the stratigraphic position of the Hunton strata, it is separated geographically from unquestioned Hunton by a considerable distance (figs. 44, 46).

Lithology: This rock is predominantly a brown-weathering (5YR 5/6 to 5YR 4/4), glauconitic carbonate with varying amounts of chert. Excluding chert (in so far as possible) it has a relatively low insoluble content, most specimens testing less than 15 percent insoluble residues (fig. 45). Locally some beds yield as much as 70 percent, but the residues from these are largely spongy silica which may be secondarily introduced. The amount of $MgCO_3$ is

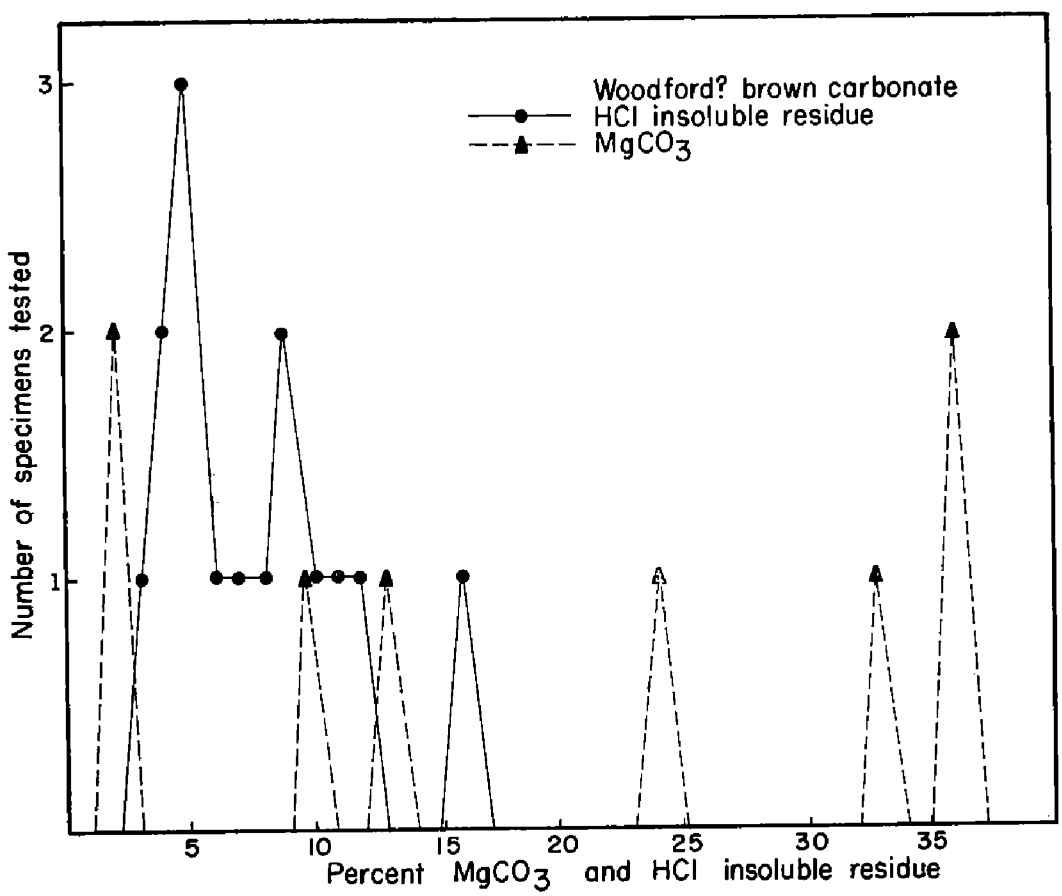


Figure 45. Frequency diagram showing the range of the HCl insoluble residues and $MgCO_3$ in the Woodford? brown carbonate of the Oil Creek area. One residue of 71 percent from J16-G is omitted. The data for this are given in the APPENDIX.

highly variable; eight specimens tested range from about 2 percent up to almost 37 percent (fig. 45): the $CaCO_3$ content of these same specimens ranges from 53 percent up to 87 percent (see sections J13 to J18, CHEMICAL ANALYSES, APPENDIX).

Chert is common in most of the exposures which I examined. None was observed at sections J13 or J17 although the residues do contain some spongy silica. All of the other sections described have considerable chert, in places making a substantial part of the total rock. It is mostly a vitreous type in nodules and lenses along with some beds of almost solid chert up to a foot in thickness. Parts of this rock have a distinctly brecciated texture and some of the chert bodies are so fractured that they appear to consist of aggregates of angular pieces. In places these angular fragments are separated and the rock is made up of chert fragments set in a matrix of brown carbonate; locally the carbonate is also brecciated and consists of angular pieces of carbonate up to an inch or so in diameter set in a carbonate matrix. I do not believe this is a tectonic breccia resulting from structural deformation as the overlying Woodford shows no evidence of such deformation. Cherts with a brecciated texture are not uncommon in various parts of the Hunton and are probably a primary feature produced during deposition (see FRISCO FORMATION, *Lithology*). All evidence points to a local source for the fragments.

Irregular cavities are common in parts of this rock. Most of these are small and do not exceed a few millimeters in diameter, but a few have a maximum diameter of as much as half an inch; they may be lined with crystals (dolomite?). Much of the Woodford? brown carbonate is stained or impregnated with a black carbonaceous substance. This material is stiffly viscous and may partly or completely fill some of the cavities.

The insoluble residues were made from specimens which appeared to be free of chert; nevertheless, most residues show considerable light-colored spongy silica which probably represents some form of chert (or incipient chert). There are also minor amounts of crystalline aggregates of clear quartz, and some of the detrital grains mentioned below appear to show secondary growth. Glauconite is abundant in most samples, and on some it makes up most of the residue. Much of this has a dark green color, although there is considerable color variation, even ranging into a pale green. The glauconite grains have several different shapes; some have a polylobate form similar to that which is common in the Hunton (pl. XVII, fig. 6), or glauconite may serve as the filling or replacement of fossils (fig. 5 of pl, XVII). A considerable part is in small aggregates which suggest crystal aggregates. Several of the residues have glauconite grains which are rounded and appear to have been abraded by movement. In addition to glauconite, many residues have a substantial amount of a dark-brown to brown spongy material that looks like some iron mineral, possibly limonite. Detrital grains are present in all of the HC1 residues examined, although the quantity is variable. Samples which have been washed to remove the clay include both silt and sand size detritus; the finer grains are subangular to subrounded whereas most of the sand grains (which range up to 2 mm) are well rounded and frosted. The quantity of detrital material is variable, although it always appears to be subordinate to the other elements such as glauconite and spongy silica. On the whole the quantity of land-derived detritus is small and probably in no case exceeds 2 or 3 percent of the total rock. However, the presence of rounded and frosted sand grains is believed to be significant as this type of detritus is absent from most residues of undoubted Hunton rocks.

I have prepared some paralodion peels, but as these are not entirely satisfactory they have been supplemented by thin sections, six of which are illustrated on plate XV. This rock has, in general, a fine texture. The more dolomitic parts, such as the specimen illustrated on figure 3 of plate XV (36 percent $MgCO_3$) have a rather uniform texture consisting almost entirely of rhombic crystals up to 0.3 mm. Those beds with a low dolomite content are somewhat finer grained, consisting largely of finely divided $CaCO_3$; the two specimens illustrated in figures 2, 5 of plate XV are a good example of this (2.4 and 1.7 percent $MgCO_3$). Glauconite is present in both the dolomitic and non-dolomitic parts. Fossils are present in the Woodford brown carbonate (see below), but the thin sections and peels show that even the parts with a low $MgCO_3$ content have little fossil debris; at no place do fossils contribute any significant part to the rock, a fact of importance in determining the relationships (see below). I have collected a few questionable representatives of the brachiopods and pelmatozoans, but none of these is even generically identifiable. A few fragmentary conodonts have been recovered from the acetic acid residues (J18-D); no arenaceous Foraminifera have been found in either the HCl or acetic acid residues.

Relationship of the Woodford? brown carbonate: The primary question I am here concerned in respect to the Woodford? brown carbonate centers around its relationship with the Hunton group. Is it Hunton or post-Hunton in age? In the past most investigators (Maxwell 1936; Ham 1954) have placed it in the Hunton, assigning it to the Cochrane on the basis of its stratigraphic position and glauconite content; since it does not have too much resemblance to the Cochrane, aside from the fact that both are glauconitic carbonates, it is assumed to have been considerably altered by dolomitization associated with the Woodford unconformity. It is, however, my opinion that these strata are post-Hunton in age, but before discussing the evidence for and against such an interpretation it might be well to summarize its geologic position. The Woodford? brown carbonate crops out for about a mile and a half in the vicinity of Oil Creek (fig. 44) and is well enough exposed within this area to make it appear reasonably certain that it extends throughout as a continuous unit. It is everywhere a sequence which shows no evidence of any break in deposition, and therefore appears to form a single stratigraphic unit of closely related beds.

In considering the evidence bearing on stratigraphic relationships, it should be kept in mind that if this rock represents any part of the Hunton it must be the Cochrane member as this is the only unit with which it has any lithologic affinities. Favoring such a correlation is its geologic position, overlain by Woodford and underlain by Sylvan, and directly on strike with known Chimneyhill outcrops (fig. 46; Ca3 and Ca4 both include typical Cochrane strata). The absence of any oolite in the Oil Creek area could be explained as the result of pre-Cochrane erosion (see pl. C, panel III), and the absence of younger Hunton as due to post- Hunton pre-Woodword erosion. The Woodford? brown carbonate thus appear to be in the correct stratigraphic position for Chimneyhill, although it should be noted that I have not checked the thickness of the Sylvan shale and the brown carbonate could occupy a considerably lower stratigraphic position than do the Hunton beds at either Ca3-Ca4 or J12 (that is, erosion prior to the deposition of the Woodford? brown carbonate may have removed some of the Sylvan shale; see discussion below). Finally, the gross lithologic features of the Woodford? brown carbonate are similar to those of the Cochrane; both are glauconitic carbonates with chert.

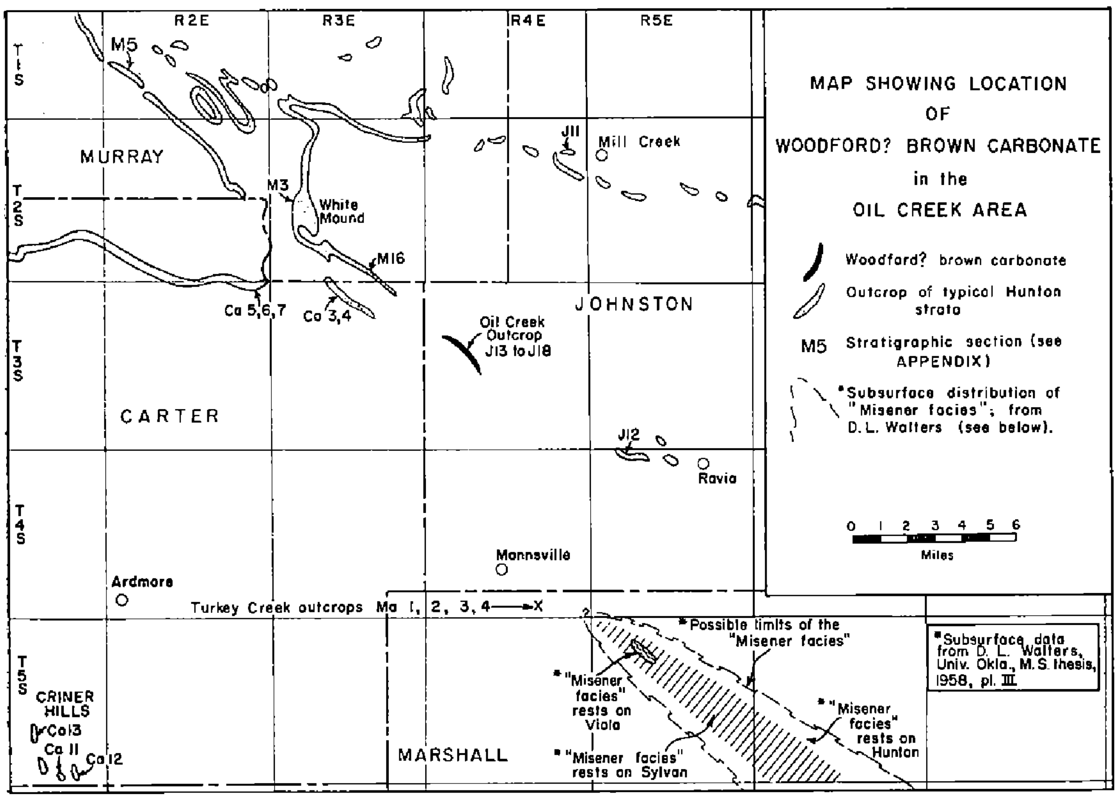


Figure 46. Map showing the general geographic and geologic setting of the Woodford? brown carbonate in the Oil Creek area. This also shows the approximate subsurface distribution of the "Misener facies", and the location of the Turkey Creek inlier.

A substantial body of evidence can be marshalled against a correlation with the Cochrane (or any part of the Hunton). First, the relationship observed in the field suggests that the beds in question grade upwards into typical Woodford shale, and thus represent a basal member or facies of that formation. For example, on sections J15 and J16 (APPENDIX) the lower three or four feet of the Woodford is a highly glauconitic and dolomitic siltstone which appears to bridge the gap between the underlying glauconitic carbonate and the overlying Woodford shale. It should also be noted that there are lenses of silty dolomite interbedded with undoubted Woodford shale (J18), and that both the brown carbonate and the Woodford include considerable carbonaceous material. This evidence is, of course, not overwhelming, but it is suggestive of Woodford rather than Cochrane affinities, especially when combined with the information given below.

The Cochrane member is described in the first part of this report (COCHRANE MEMBER, *Lithology*), but a brief recapitulation of its salient features might be helpful before comparing it with the Woodford? brown carbonate. Throughout its outcrop area the Cochrane is a light-colored, bioclastic limestone which is made up in large part of fossil debris (pl. XII, figs. 5, 6); none of the thin sections, or peels which I have studied shows less than 50 percent recognizable fossil material. Its acid insolubles range up to about 6 percent (fig. 13) and glauconite makes up most of the residue; the percentage of detrital material is small and appears to be almost exclusively silt size (and smaller), subangular, clear quartz. The $MgCO_3$ content is low, all specimens tested having less than 2 percent (fig. 14). Chert is erratically developed, being absent in many areas; where present it is confined to small nodules which are invariably a subordinate part of the total rock. The Woodford? brown carbonate has a very different type of lithology. It is a brown-weathering carbonate, ranging from a limestone to a dolomite. Chert is generally conspicuous, being present in the form of nodules and beds, and on some sections it makes up a substantial part of the formation. There is far more silica (including both vitreous chert and spongy silica) present in the Woodford? brown carbonate than in the Cochrane member. The insoluble residues (excluding chert) range up to about 15 percent and are composed in large part of glauconite and spongy silica. Detrital grains are common and, of special interest, is the presence of well-rounded and frosted sand grains, a type of detritus which is almost unknown in any part of the Hunton group. The character of the glauconite is also significant. A considerable part has a polylobate or fossil shape similar to that which is so common in the Cochrane; however, there is a considerable part which is different from the characteristic Hunton glauconite, being in the form of small angular aggregates: Finally, there is considerable evidence of abrasion in the Woodford? brown carbonate glauconites. A much greater difference is apparent in the carbonate portion of the rock. The Woodford? brown carbonate is composed of finely divided calcium carbonate which grades into crystalline dolomite; fossils are only sparingly present and at no place does it have a bioclastic texture even faintly like that of the Cochrane. It can be postulated that dolomitization has obscured an original bioclastic texture, an explanation which is applicable to the strongly dolomitic parts (pl. XV, fig. 3), but which will not account for the texture of those parts with a low $MgCO_3$ content (pl. XV, figs. 2, 5). These remarks are equally applicable to secondary silicification of the rock. There are beds in the Woodford? brown carbonate, such as J18-D(3) and J13-B(1) which have an analysis similar to that of the Cochrane except for a slightly higher insoluble content; however, these beds have a quite different texture from that of the Cochrane as may be seen by comparing the illustrations on plate XII, figures 5 and 6, with those on plate V, figures 2 and 5. The foregoing information would seem to rule out a Hunton relationship, especially when it is recalled that there are outcrops of typical Hunton rocks less than three miles away. This does not, of course, prove that it is a part of the Woodford formation, although the nature of the contact cited above, plus the information given below is suggestive of a Woodford relationship.

The strong concentration of chert in the Woodford? brown carbonate is quite unlike any undoubted Hunton rocks. On the other hand, beds of chert are known to be present in the basal part of the Woodford at a number of different places (WOODFORD FORMATION, *Woodford-Hunton contract*). Of particular interest is the presence of a bed of fractured chert and carbonate at section M5 near Price's Falls (fig. 52, APPENDIX). At this locality the Hunton consists of the Chimneyhill, Henryhouse and Haragan formations, all in a characteristic lithologic and faunal expression. Overlying the Hunton strata is the Woodford formation with a two- to three-foot bed of fractured chert at its base; this chert is unusual in that it includes over 20 percent carbonate (16.3 percent $CaCO_3$ and 6.3 percent $MgCO_3$). This bed, which appears to be quite localized in its development, weathers to a brown color and has a lithologic resemblance to the Woodford? brown carbonate, although I did not observe any glauconite or detrital grains in the residues. Whatever its relationship with the Oil Creek outcrops may ultimately prove to be, it is significant in demonstrating that at least locally the Woodford cherts have a substantial carbonate content.

This report is primarily based on a surface study, but a few comments will be appended on the subsurface rocks of Marshall County, just south of the Arbuckle region, as these furnish some information which has a bearing on the present problem. In this area an oil-bearing cherty carbonate underlies the typical Woodford shale. These strata have been called the basal Woodford carbonate by Robert Maxwell (1958) and the Misener (?) by Walters (1958, p. 14). According to Walters this rock consists of an "off-white, to tan, glauconitic arenaceous, cherty, locally calcareous dolomite", which ranges in thickness from zero to 115 feet. The exact distribution of this unit in the subsurface has not been determined, but Walters (1958, pl. I) has outlined its approximate position and I have incorporated this information on figure 46. There appears to be some uncertainty concerning its stratigraphic relations, but both Maxwell and Walters treat it as a basal part or facies of the Woodford formation. It is separated from the underlying strata by an unconformity so that it may rest on the Hunton, or the Sylvan, or even locally on the Viola (Robert Maxwell 1958; Walters 1958, pl. I) Walters (1958, p. 14-15) correlated the "Misener" with the Oil Creek outcrops (Woodford? brown carbonate), and while I have not studied any samples or cores of this rock the lithologic and stratigraphic data available to me suggest such a relationship. According to this interpretation, the Woodford? brown carbonate is only the thin edge of a stratigraphic unit which has a much thicker and more extensive development in the subsurface to the south of the outcrop area (see also Ham 1959, p. 75).

The outcrops exposed on Turkey Creek, which are described below, may represent another surface expression of this unit; these strata are of special interest because they carry a substantial megafauna which is clearly not Hunton. This carbonate-siltstone sequences does not have much lithologic resemblance to the Woodford? brown carbonate; however, Walters' description of the subsurface "Misener" shows that this unit, at least, encompasses considerable lithologic variation. Actually, at the present time there is substantial evidence to show that the three stratigraphic units, Woodford? brown carbonate, "Misener" and Turkey Creek carbonate siltstone sequence, are post-Hunton in age, but not much evidence for relating them to each other. The only diagnostic megafossils known are from the Turkey Creek strata, and it seems highly unlikely that any will be obtained in the future from either the Woodford? brown carbonate or the "Misener" beds. If any paleontological evidence is to be brought to bear on the relationship of these units it will almost certainly have to come from the microfaunas or microfloras.

It is interesting to compare the geographic distribution of these three units with the pre-Woodford erosion surface. According to the information now available, they seem to have their best development in those areas where the Hunton (or older strata) have been thinned or removed by post-Hunton pre-Woodford erosion (compare the distribution shown on figure 46 to the pre-Woodford subcrop map, plate A, panel III).

The thickness of the Sylvan underlying the Woodford? brown carbonate is not known and this unit may occupy a lower stratigraphic position than is indicated on section C-C[1], plate C, panel III; in preparing this illustration the Woodford? brown carbonate-Sylvan contact was arbitrarily placed on the datum plane, but the Sylvan may be thinner here than in other parts of the Arbuckle region.

TURKEY CREEK INLIER

The strata to be discussed in this section are a part of a small inlier of Paleozoic rocks which is completely surrounded by the Cretaceous. These beds crop out for about a mile and a half along Turkey Creek in the eastern part of sec. 34 and the western part of sec. 35, T. 4 S., R. 4 E., Marshall County (panel I; figs. 46, 47). The strata in question, which were first described by Tomlinson in 1926 (p. 138-143), occupy a stratigraphic position above the Sylvan shale and below typical Woodford shale. They are thus in the general stratigraphic position of the Hunton (but see below) and have commonly been referred to this group (Tomlinson 1926; Tomlinson, Hendricks and Engleman 1952). In my opinion, however, the lithologic character and stratigraphic relationship do not indicate a Hunton correlative, and recently I have obtained fossils from the basal part which seem clearly to rule out a Hunton relationship. These strata, which will be named and more fully described in a later publication, are here informally designated the *carbonate-siltstone sequence*. Before discussing the lithologic character and evidence bearing on relationships, a brief outline of the geologic setting will be given.

A geologic map of the Turkey Creek area is shown on figure 47. This map is essentially the same as that of Tomlinson, Hendricks, Engleman and Parker which was published in the Ardmore Geological Society Guide Book for April 25, 26, 1952. I have spent several days in this area and am in basic agreement with the distribution of outcrops and structure as presented by these authors. The only difference of opinion concerns the age of the beds occupying the interval between the Sylvan shale and the typical Woodford shale. The Paleozoic strata exposed on this inlier begin with the the Viola limestone, possibly including some "Fernvale" near the top, overlain by a thin section of Sylvan shale (see below under *Lithology*), and followed by the beds in question; that is, the *carbonate-siltstone sequence* of this report or the Hunton group of Tomlinson and others. Above these rocks is typical Woodford shale and then the Sycamore. There are three outcrops of the *carbonate-siltstone sequence* shown in figure 47, but two of these (Ma3, Ma4) are small and expose only a few feet of strata; however, the third, Ma2, gives a complete exposure of 55 feet of beds lying between the Sylvan (?) and the Cretaceous. The Woodford shale is not exposed here in contact with the beds under discussion, but there is a good outcrop of typical shale in a small tributary a short distance south of M2 (fig. 47).

Lithology: The best section is at Ma2 (APPENDIX) where 55 feet of strata referred to the *carbonate-siltstone sequence* is ex-

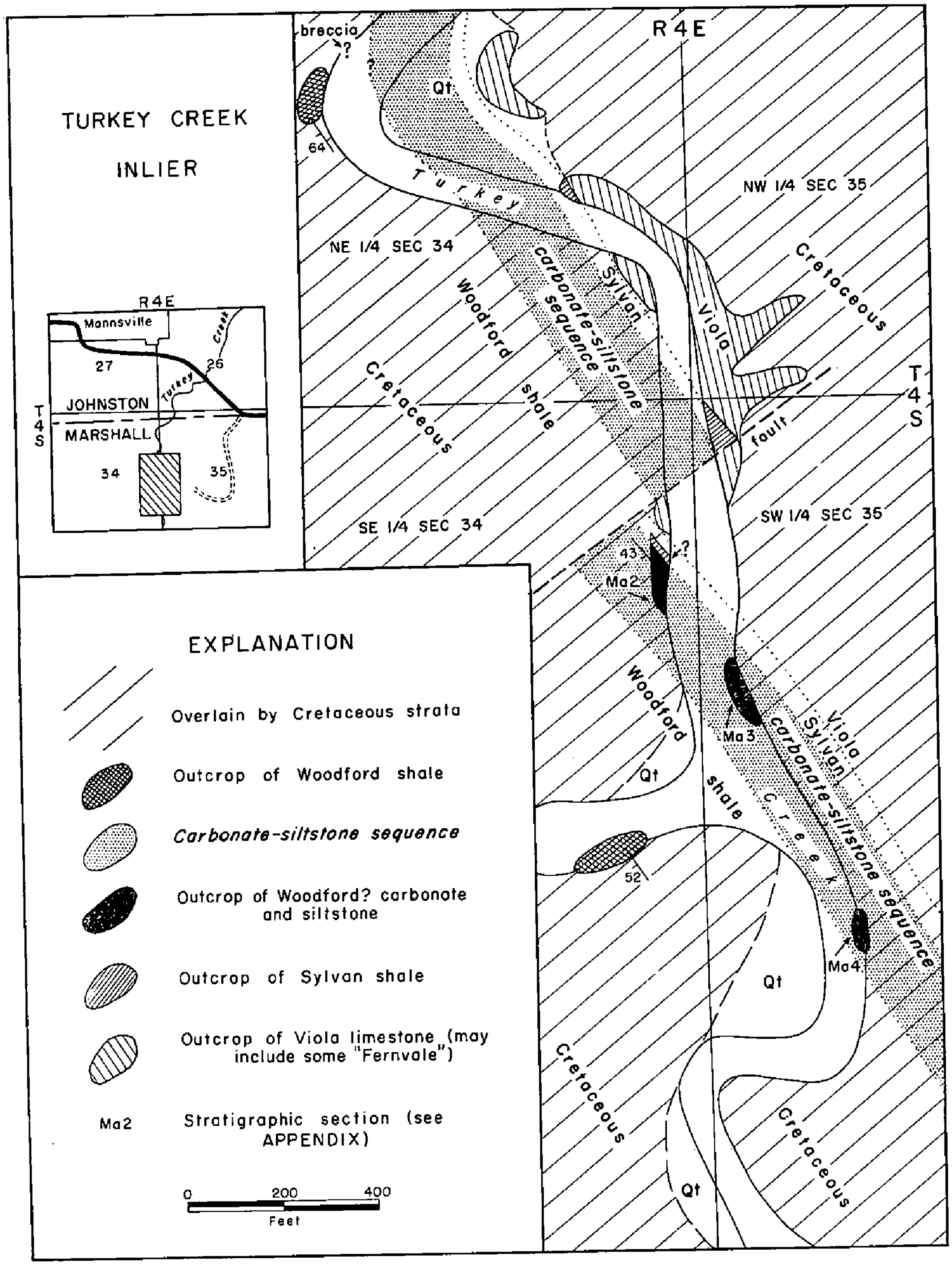


Figure 47. Geologic map of the Turkey Creek inlier south of Mannsville, Oklahoma. (after Tomlinson, Hendricks, Engleman and Parker 1952). The location of this area is shown in figure 46 and on panel I.

posed between the Sylvan and the Cretaceous. This thickness is not too significant as appreciable erosion may have occurred prior to the deposition of the Cretaceous. The strata at section Ma2 rest on six feet of yellowish-gray, strongly calcareous claystone that is referred with question to the Sylvan, although differing from the typical green shale or clay of that formation. Two analyses of this rock give acid insolubles of 37 and 59 percent, indicating that at least locally it grades into an argillaceous limestone (APPENDIX, CHEMICAL ANALYSES). This is a rather high carbonate content for the Sylvan although lenses of argillaceous limestone are known to be interbedded with characteristic green clay; a lens of this kind is present about 25 feet below the top of the Sylvan at J17, near Oil Creek, and a photomicrograph of this rock appears on plate XVI, figure 6 (a thin section of the Turkey Creek Sylvan (?) is illustrated on figure 5 of this same plate). A 20-foot (stratigraphic) covered interval is present between the base of the calcareous claystone and the highest exposure of Ordovician limetone (Viola or "Fernvale"). Assuming this to be a normal undeformed sequence, and the geologic mapping in this area indicates that it is (fig. 47), there is only 26 feet of Sylvan present, including all of the yellowish-gray calcareous claystone in this formation. This covered interval is known to include some undoubted Sylvan, because dark, graptolitic shales are exposed just above the Ordovician limestones on the east side of Turkey Creek (fig. 47; Decker, 1935B, p. 618, states that the lower part of the Sylvan is a dark shale), but the uppermost, yellowish-gray beds may be a part of the *carbonate-siltstone sequence*.

The beds of section Ma2 fal linto three distinct lithologic units (excluding the questionable Sylvan strata discussed above). a lower, bioclastic limestone, a middle dolomitic silestone, and an upper cherty siltstone and carbonate. The last two units grade into one another and appear to be closely related lithologically and genetically, but the lower one has distinctly different lithology and its upper and lower contacts are sharply defined. This lower unit (Ma2-A, B, C) consists of five feet of evenly bedded, highly fossiliferous and glauconitic calcarenite. The acid insolubles range from 5 to 10 percent and the residues are mostly glauconite and light-colored, spongy silica, some of which serves as the partial replacement for fossils; the amount of terrigenous detritus is small and is mostly in the silt and finer size, but locally there are well-rounded and frosted sand size grains. The $MgCO_3$ content is low, analyses of three different specimens ranging from 0.4 to 1.4 percent (APPENDIX, CHEMICAL ANALYSIS). Several paralodion peels and one thin section show a rock rich in fossil material with most parts having well over 50 percent recognizable organic material; pelmatozoan plates are common along with the shells of snails and other organisms. These fossils, which are set in a matrix of clear, crystalline calcite, show some breakage and possibly some recrystallization (fig. 4, pl. XVI). Dr. J. L. Wilson made a collection of megafossils from these strata, which he has kindly loaned to me. In addition I have obtained fossils from here (including some condonts from acetic acid residues), and with these two collections combined there is a fairly representative group. In the future I plan to present a detailed study of this fauna and will therefore give only a brief discussion of it in this report. This fauna includes snails, trilobites, brachiopods and corals. The most conspicuous fossils are large phacopid trilobites, some of which are quite well preserved. Snails and brachiopods are also common, the latter group comprising several different species.

The middle unit (Ma2-D) consists of 29 feet of a brown-weathering, dolomitic siltstone in beds to three or four inches and with some minor cross-bedding. It is composed in large part of subangular to angular quartz detritus, along with considerable mica and glauconite; the grains range up to 0.60 mm, averaging about 0.40 mm (a thin section is illustrated on plate XVI, fig. 3). About 30 percent of this rock is carbonate, of which 12 to 13 percent is $MgCO_3$ (two analyses given in the APPENDIX, CHEMICAL ANALYSES). I have not seen any fossils in this rock, either at the outcrop or in the thin sections.

The upper unit (Ma2-F) is 20 feet thick and composed of light-colored, dolomitic chert and siltstone. In its lower part it is a dolomitic and cherty siltstone having about 35 percent carbonate of which 8 percent is $MgCO_3$ (APPENDIX, CHEMICAL

ANALYSES). This lower part is similar in texture and composition to the underlying siltstone (Ma2-D; this unit has a little chert in its upper few feet) from which it is separated by a one-foot bed of vitreous chert. The upper part of Ma2-F appears to grade into a cherty carbonate although all parts seem to have considerable silt. One specimen from the upper 10 feet (Ma2-F (2)) analyzed over 60 percent carbonate, 18 percent being $MgCO_3$. Two thin sections from the upper and lower parts of this interval are illustrated in figures 1, 2, plate XVI; note the similarity between the photomicrograph of figure 2, from the lower part of Ma2-F, and the photomicrograph of figure 3, from the lower part of D. The stratigraphic and lithologic evidence points to a close genetic relationship between the strata composing units Ma2-D and Ma2-F. No fossils were observed in unit Ma2-F, either at the outcrop or in the thin sections.

The cherty siltstones and carbonates of Ma2-F are directly overlain by Cretaceous strata from which they are separated by angular unconformity. I have not observed typical Woodford shale in contact with the strata in question, but there is an excellent exposure of this shale in a small tributary a short distance south of Ma2 (fig. 47), and it would appear certain that this rock occupies a stratigraphic position immediately above the *carbonate-siltstone sequence* (excluding, of course, the Cretaceous strata).

The exposure at Ma3 (fig. 47) consists of a single, large outcrop of brown-weathering, siltstone in beds to three or four inches and showing some subdued cross-bedding. The rock is almost certainly the same as the dolomitic siltstone of Ma2-D; both rocks look alike and appear to be on strike with one another. One thin section was cut from a rock specimen of Ma3 and this shows a texture and composition almost identical to that of Ma2-D; it is composed largely of angular to subangular, silt size quartz detritus along with some mica and glauconite. No fossils were observed at the outcrop and no organic debris was seen in the thin section.

Section Ma4 consists of a small outcrop of silty and agrillaceous dolomite with much chert. The chert is pale-gray to white and has a porcellaneous texture; the rest of the rock is a fine-grained carbonate with considerable silt size (and smaller) quartz detritus; locally it may grade into a dolomitic siltstone. Analyses of two rock specimens (APPENDIX, CHEMICAL ANALYSES) give a total carbonate of 29 and 57 percent, of which 22 and 23 percent is $MaCO_3$. This rock resembles the upper part of Ma2-F, with which it is presumably correlative.

Relationship of the Turkey Creek strata: These strata have commonly been correlated with the Hunton group. They occupy the general stratigraphic position of the Hunton group, being overlain by typical Woodford shale and underlain by the Sylvan formation (the latter is, however, quite thin). In a general way the stratigraphic sequence does suggest Hunton: section Ma2 consists of bioclastic calcarenite, overlain by a fine-grained clastic rock which grades upward into cherty strata, a sequence whose gross lithologic features are somewhat silimar to the Chimneyhill marlstone (Henryhouse and/or Haragan)—Bois d'Arc succession.

In my opinion these strata are unrelated to the Hunton group. In the first place the lithologic similarity between the Turkey Creek beds and the Hunton is quite superficial and a careful field study, aided by thin section and chemical analyses, shows that these rocks are unlike any of the undoubted Hunton strata of the Arbuckle region or Criner Hills. A dominant part of the rock at Ma2 is a dolomitic siltstone which consists largely of silt size, subangular quartz detritus with considerable mica and glauconite; its insolubles range from 65 to 70 percent and the $MaCO_3$ from 8 to 12 percent. Even excluding the $MgCO_3$, which may have been secondarily introduced, the composition of this rock is quite unlike either the Henryhouse or Haragan marlstones, whose insolubles rarely exceed 30 percent (fig. 20). Moreover, the Turkey Creek siltstone either lacks fossils completely, or they are extremely rare, whereas fossils are a common feature of the Hunton marlstones. The same disparity exists between the upper cherty strata (Ma2-F, Ma4) and the Bois d'Arc formation. The latter consists of fossiliferous marlstone and bioclastic calcarenites with chert nodules; the insoluble content (excluding chert) ranges from around 20 percent down to less than 5 percent (fig. 36). This is most unlike the unfossiliferous cherty and dolomitic siltstone and carbonate of Turkey Creek whose insolubles range from 40 to 70 percent. Compare the photomicrographs of Ma2-D and Ma2-F illustrated on figures 1-3 of plate XVI with those of the Henryhouse, Haragan and Cravatt shown on plate XIII and the upper, bioclastic calcarenites of the Fittstown on figures 5, 6, plate XIV. If these Turkey Creek beds are correlative with the Hunton they must represent a marked facies change. Undoubted Hunton strata are present to the northeast (J12), to the north and northwest (Ca3, Ca4, Ca5, Ca6, Ca7), and to the southwest (Ca11, Ca12, Ca13) as shown in figure 46. Throughout this area the Hunton marlstones show absolutely no tendency to grade into a rock like the dolomitic siltstone exposed on Turkey Creek.

The lower glauconite limestone of Ma2 (units A, B, C) has the closest resemblance of any Turkey Creek strata to a Hunton formation. This is an evenly bedded, highly glauconitic, bioclastic limestone; the insolubles range from 5 to 10 percent and the $MgCO_3$ is less than 1.5 percent. It thus has some lithologic resemblance to the bioclastic limestones of the Clarita and Cochrane members of the Chimneyhill formation. The even-bedded character is similar to the Clarita (pl. III), but I have never observed that member with a glauconitic content evenly remotely like that of the Turkey Creek rock. Its glauconite content is actually greater than that in most Cochrane outcrops; however, its most marked lithologic departure from that member lies in its bedding characteristics, the Cochrane being irregularly and obscurely bedded (pl. II), whereas the limestones of Ma2 have an even and well-defined bedding. These are the only fossiliferous strata which I have observed on Ma2, Ma3, and Ma4. D. K. Greger (Tomlinson 1926, p. 141) reported Henryhouse fossils from a Turkey Creek limestone which is almost certainly the same as the one under discussion. As noted above, I have a fairly large collection of megafossils (as well as some conodonts) from this calcarenite and none of these fossils is similar to Henryhouse forms; in fact, this collection with its many phacopid trilobites is almost surely post-Silurian. Furthermore, none of the brachiopod or trilobite species is conspecific with those from the Haragan-Bois d'Arc or Frisco formations and it is probably a post-Deeparkian fauna. I plan to describe this fauna later in detail and at that time will discuss its age at greater length. In the present report my principal concern is to demonstrate that the Turkey Creek strata* are not properly included within the Hunton group.

The relationship of these strata to the Woodford formation is uncertain. Its stratigraphic position within 26 feet of the Viola (possibly including some "Fernvale" at the top) is suggestive of the Woodford, as that formation is known to rest on Viola or even older beds (Tarr 1955, fig. 4). In this connection it is interesting and perhaps significant to note the proximity of the Turkey Creek inlier to the "Misener facies" of the subsurface, a stratigraphic unit which locally rests on beds as old as Viola. In the preceding chapter I commented on the distribution of the Turkey Creek beds, "Misener facies" and Woodford? brown carbonate with respect to the pre-Woodford erosion surface. All three of these units are located where the Hunton (or older strata) have been thinned or removed by post-Hunton pre-Woodford erosion. This relationship could, of course, be entirely fortuitous, or it could be that additional subsurface information will show that the distribution of these strata has nothing to do with the underlying surface. In any event the problem cannot be properly investigated until such time as these strata have been accurately dated with respect to one another.

GEOLOGIC HISTORY

This section contains a summary of the events, depositional and erosional, which took place during Hunton time. The evidence supporting this historical outline is given in the first part of the report and will not be here repeated. It is perhaps unnecessary to add that the observations herein given are almost entirely inferential, and even those statements which are unqualified represent interpretations drawn from various field and laboratory data.

Hunton deposition was initiated with the advance of the sea in early Chimneyhill time. I have very little information on the pre-Hunton surface; the Sylvan shale has not been studied in

* It should be noted that whereas the siltstone-cherty siltstone strata (Ma2-D, Ma2-F) are certainly younger than the underlying bioclastic calcarenite (Ma2-A, B, C), they are not necessarily related to it. These bioclastic calcarenites are lithologically quite distinct from the beds above, or below; however, their general stratigraphic position with respect to the beds above, and to the underlying Sylvan and Viola (see below) suggest a relationship with the overlying strata.

detail and I have seen only one really fine exposure of the Hunton-Sylvan contact, this being the one illustrated on plate I.

The Keel and Ideal Quarry members appear to represent shallow water deposits, and in this respect differ from all of the other Hunton units. Later Hunton strata were, for the most part, laid down in an offshore environment out of the zone of effective wave action. The Ideal Quarry member of the Chimneyhill formation is a bioclastic limestone which appears to represent a normal marine deposit; the presence of calcareous algae points to a deposition in water shallow enough to be within the zone of effective light penetration. Deposition continued without interruption from the Ideal Quarry to the Keel although the environment changed markedly, the waters becoming shallower and strongly charged with calcium; marine life was much restricted and oolites formed in great abundance.

The deposition of the Keel oolites was followed by a period of emergence. Erosion that accompanied this uplift was not extensive, but was enough to remove locally the Keel-Ideal Quarry strata, plus an undetermined amount of Sylvan shale. When the sea returned the environment of deposition was quite different. The Cochrane beds consist of glauconitic, bioclastic calcarenites which appear to be the product of deposition in an offshore environment that was deep enough to screen out all but the strongest waves. Oolites are absent and the salinity appears to have returned to that normal for Paleozoic continental seas. The amount of extrabasinal detritus is low and almost exclusively in the silt-clay size range. The sea must have teemed with invertebrate life, judging from the fossil-rich debris making up the rock. These fossils, like most of those from the later Hunton deposits, belong largely to the sessile and vagrant benthos. There is no tendency towards the development of reefs in the Cochrane, or in any part of the Hunton for that matter. This member is the most widely distributed of the Chimneyhill units and undoubtedly covered the entire area at the close of Cochrane deposition. It was followed by a period of emergence and erosion during which time it was irregularly thinned by erosion. There appears to have been little or no folding accompanying this uplift and the amount of strata removed was certainly not great, being only locally enough to completely remove the Cochrane.

The Clarita strata appear to represent a deposit of the outer sublittoral zone, in water deep enough to screen out most wave action. The site of deposition must have been well removed from shore as land-derived clastics are, for the most part, not abundant and almost exclusively in the silt and finer sizes. The seas were inhabited by a large invertebrate fauna and much of the rock is made up of the hard parts of these organisms. Crinoid colonies flourished and in places the disintegration of their skeletons produced a crinoid sand. Other benthonic groups such as the brachiopods, trilobites and arenaceous Foraminifera were common. Corals appear to have been poorly represented and calcareous algae entirely absent, possibly because the water was too deep. At the close of Clarita deposition the seas were withdrawn and the sediments exposed to erosion. The faunal and stratigraphic evidence for post-Clarita pre-Henryhouse emergence is convincing, but here again the amount of erosion was slight and only locally did it completely remove this member. All of the Hunton periods of emergence appear to represent changes in sea level that were accompanied by little or no folding. Moreover, the land surface in every case must have been low because even during the longest periods of emergence, such as the one at the close of the Hunton, erosion did not produce much relief or remove excessive quantities of sediments. Certainly the post-Clarita pre-Cochrane period of erosion produced only the slightest relief.

With the start of Henryhouse deposition there was a change in the character of the sediments. The quantity of land-derived clastics increased sharply, being more than twice that of the Clarita sediments, although the grain size remained about the same. I might digress briefly to note that the terrigenous (insoluble) clastics present throughout the Hunton are almost entirely in the silt-clay size range; the coarsest fraction consists largely of subangular, clear quartz grains which fall near the upper limit of the silt category, but which only rarely range into a fine sand. Returning to the Henryhouse, the increase in clastics was accompanied by a decrease in the quantity of fossil material. These changes may be in part related, the flood of extra-basinal detritus "diluting" the fossil debris, but it is not the sole cause as the decrease in fossils appears to be considerably greater than the increase in clastics. Despite these changes in the character of the sediments the environment of deposition does not appear to have changed greatly from that of the Chimneyhill. The Henryhouse strata give every evidence of being deposited in quiet water, quite probably near the outer margin of the sublittoral zone; however, the water must have been somewhat more turbid and the bottom muddier than during Chimneyhill times. Certainly the Henryhouse strata, like those of the Clarita and Cochrane, were laid in non-turbulent waters. Possibly the increased terrigenous clastics are related to some change in the source area, such as increased uplift; or they may have resulted from the removal of some barrier between the source area and the site of deposition. Since the increase in quantity is not accompanied by any change in grain size or composition the latter explanation may be the most reasonable. Actually, almost nothing is known about the source of the Hunton land-derived clastics as there is no marked lithofacies pattern or trend that will give a clue to the nature or position of the area furnishing this material. Excluding the Keel-Ideal Quarry beds (which have almost no insoluble clastics), all of the Hunton strata appear to represent offshore deposits which were far enough removed from land to effectively screen out all but the finest material. Neither the Henryhouse nor the Haragan, which are the Hunton units with the greatest amount of terrestrial clastics, show any well marked trends. There is a suggestion that the quantity of terrigenous material in the Henryhouse increases to the southeast (fig. 21), but the evidence for this is far from conclusive.

The Henryhouse seas were inhabited by a large and varied invertebrate fauna. Over 100 species are represented by fossils and this is undoubtedly only a small part of the original biota. The fossils are mostly benthonic types, the brachiopods being the dominant group. Corals are present and locally may be abundant both in numbers of individuals and numbers of species, but there is no tendency towards any kind of reef formation. I have not observed any stromatoporoids or calcareous algae.

Henryhouse deposition was followed by a period of emergence and erosion. There is no sedimentary record between the Henryhouse (early Upper Silurian) and the Haragan (Lower Devonian), and if any strata were laid down during this period they were completely removed by post-Henryhouse pre-Haragan erosion. The only record of events during this long period of time is in the rather extensive truncation of Silurian strata. Here, as in other Hunton periods of emergence and erosion, the topographic relief developed appears to have been subdued and the "rate" of truncation modest. Nevertheless, the amount of erosion was sufficient to remove the Silurian (which has a maximum thickness of 300 feet in the outcrop area) completely and to allow the Lower Devonian strata to rest upon the Sylvan shale.

The sea returned to this area in the early part of the Devonian period. The fauna inhabiting this sea was similar in its general composition to that of the Henryhouse, benthonic types predominating in both, but the generic and specific suites were quite different. The sediments deposited during Haragan times were much like those of the Henryhouse and the environment must have been similar at both times. This unfortunate set of circumstances has caused great trouble to stratigraphers, because in those areas where the Haragan rests on the Henryhouse the Silurian-Devonian boundary can only be located by means of the fossils. Of course in those places where the Devonian rests on the Chimneyhill bioclastic limestones the contact is easily located by lithologic as well as faunal characteristics.

All evidence indicates the Helderbergian strata (Haragan-Bois d'Arc formations) were deposited in the same sea with no interruption in sedimentation. These strata do, however, involve some interesting facies changes, both faunal as well as lithologic. Deposition began in most areas with the marls of the Haragan; the lithologic character of this rock points to deposition in relatively quiet, offshore waters. The quantity of terrigenous material introduced into the basin of deposition was reduced slightly over that of the Henryhouse, but the waters must have been turbid and the bottom muddy. With the passage of time there was a tendency for the amount of extra-basinal detritus to be reduced, in many places quite drastically (Fittstown member). This was almost everywhere accompanied by an increase in the amount or organic material so that the bottom was generally carpeted by a lime sand composed mostly of shells and other skeletal debris. The waters appear to become shallower and this organic material was subjected to movement by modest current and wave action resulting in the disarticulation of valves and some breakage. These areas of lime sand deposition shifted from place to place with the passage of time, thus producing an intimate mixing of the different lithologic types. On the whole the seas of later Helderbergian times received much less terrigenous material than at the start, although the silica content of the water seems to have increased, producing small chert bodies. These changes in environment were accompanied by some changes in the faunas. Benthonic types such as the brachiopods and trilobites continue to be an important part of the fauna, but the corals, bryozoans and snails were much restricted. One of the most marked changes, however, was in the development of the pelmatozoans. Great colonies of crinoids must have covered large areas, and as the individuals died their skeletons disintegrated to form a sand; in many places the Fittstown member is composed in large part of pelmatozoan plates with just enough clear calcite to bind them together.

Bois d'Arc deposition was followed by a period of emergence. Undoubtedly some erosion took place at this time, but it is not possible to determine accurately how much as the overlying Frisco formation has a limited outcrop area. Throughout much of the Arbuckle Mountain region and Criner Hills the Bois d'Arc or older Hunton formations are directly overlain by Woodford shale, and in these places it is impossible to distinguish between post-Bois d'Arc pre-Frisco erosion and post-Frisco pre-Woodford erosion.

The last known Hunton submergence occurred during Deerparkian time when the Frisco strata were deposited. These beds have a low insoluble content and must have been laid down in an environment where terrigenous material was rather effectively screened out; the water was clear and the bottom largely calcareous sand. This sea was probably somewhat shallower than that of the Bois d'Arc, and there appears to have been a fair amount of shifting and reworking of the bottom sediments; it was, however some distance from shore and well out of the zone of strongly turbulent water.

The Frisco seas were inhabited by a large invertebrate fauna, dominated by the sessile and benthonic types. Brachiopods and snails constitute the major part of the fauna along with some trilobites and bryozoans. Corals, which were rare in the clear seas of the later Bois d'Arc, became fairly common in the Frisco. Some of these, like *Trachypora,* appear to have built fairly large colonies, but there is no evidence of reef structures. No calcareous algae have been observed.

Frisco deposition concludes the Hunton stratigraphic record, at least in so far as the outcrop area is concerned. In most places the Hunton beds are directly overlain by the Woodford shale, but locally there is evidence suggesting deposition in the time interval between these two units. The strata exposed on Oil Creek and Turkey Creek (discussed in the previous sections) are certainly post-Hunton in age, but it is uncertain whether they represent an early phase of Woodford deposition, or are a pre-Woodford deposit. Excluding these beds, there was a long period of time covering all of the Middle Devonian in which the area appears to have been emergent. Erosion accompanying this emergence stripped away parts of the Hunton, locally cutting through to the Sylvan. This is one of the best known Paleozoic unconformities in this general region, but it should be noted that within the Hunton outcrop area its effect is only slightly more pronounced than is that of the Silurian-Devonian unconformity; post-Hunton pre-Woodford erosion can be credited with the removal of more than 400 feet of Hunton strata whereas the Silurian-Devonian erosion removed at least 300 feet of strata in the same area. The unconformity at the base of the Woodford is, of course, more easily studied due to the distinctive lithologic character of the Woodford shale as contrasted with pre-Woodford strata.

The emergence which followed Hunton deposition appears to have been accompanied by little or no folding within the area under study. Furthermore, this period of erosion, like the earlier ones within Hunton time, does not seem to have produced marked topographic relief. The "rate" of truncation is not marked and throughout much of the Hunton outcrop area the Woodford rests on Helderbergian strata which at few places exceed 300 feet in thickness.

PLATE X

Figures 1-3 Ideal Quarry member (Chimneyhill formation).

1. Thin section (x 18) showing the concentrically banded coating on the rock and fossil fragments; this coating is probably an algal deposit. Compare to the coating of the Keel oolites, plate X, figs. 4, 5, 6. and plate XI, figs. 2, 3. Stratigraphic section M12A-A, Price's Falls, Murray County, Okla. (Analysis gives in the APPENDIX, CHEMICAL ANALYSES).

2. Thin section (x 18) showing the same type of coating as figure 1; the core of the body in the upper left quadrant is a pelmatozoan plate. Stratigraphic section C1-A, near old Hunton townsite, Coal County, Okla.

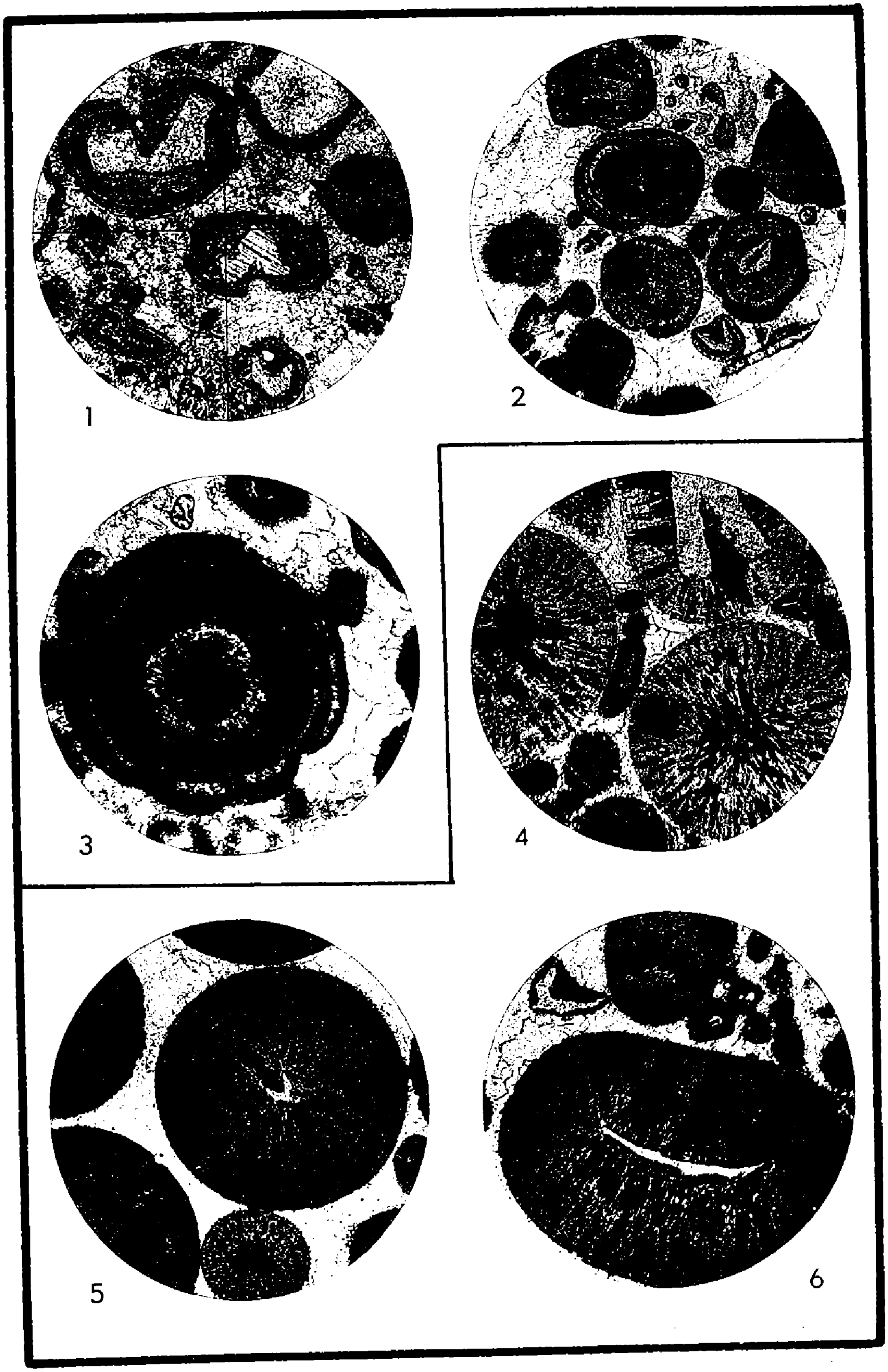
3. Enlarged view (x 31) from the same thin section as that shown in figure 2. The clear areas are crystalline calcite.

Figures 4-6. Keel member (Chimneyhill formation).

4. Thin section (x 31) showing oolites with a pronounced radial structure. Note that the oolite partly visible near the top of the picture conforms in shape to its core (pelmatozoan plate). The smaller bodies, which lack the radial structure, have the granular texture so common in Keel oolites (pl. XI, fig. 6). This rock is composed of over 99% $CaCO_3$ (see APPENDIX, CHEMICAL ANALYSES). Stratigraphic section M12A-B, Price's Falls, Murray County, Okla.

5. Thin section (x 18) showing oolities with a weaker radial structure than those of figure 4. Note the nearly perfect circular cross section of the center oolite. This specimen with 1.3% HCl insoluble residue. Lawrence Quarry, NE¼ NE¼ sec. 36, T. 3 N., R. 5 E., Pontotoc County, Okla. (see pl. A, panel II).

6. Thin section (x 31) showing an oolite whose shape is controlled by the shape of its core. Note that the smaller bodies show little evidence of radial structure. This is from a specimen collected by W. E. Ham, Lawrence Quarry; same locality as figure 5.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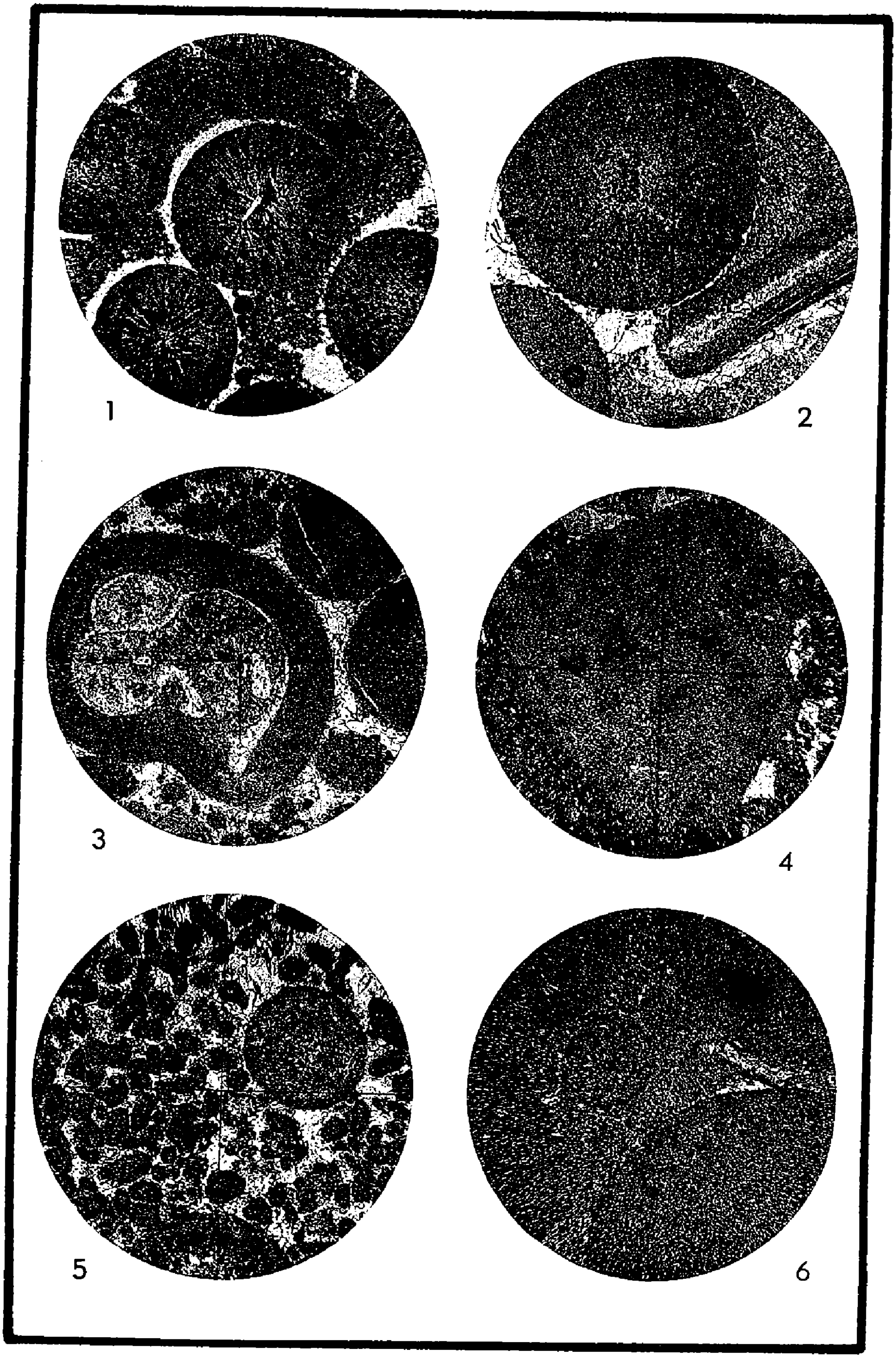
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PLATE XI

Figures 1-6. Keel member (Chimneyhill formation).

1. Thin section (x 18) showing the two kinds of matrix which enclose the oolites: (1) crystalline calcite (clear areas), and (2) very fine, evenly granular calcite. Note that on the central oolite the inner concentric layers are markedly elliptical in outline, the outer ones more nearly a perfect circle. Lawrence Quarry; same thin section as that illustrated on plate X, fig. 6.

2. Paralodion peel (x 18). The matrix (excluding clear calcite), oolite and material coating the elongate body all have a similar granular texture. Clear areas are crystalline calcite. Lawrence Quarry, NE¼ NE¼ sec. 36, T. 3 N., R. 5 E., Pontotoc County, Okla.

3. Paralodion peel (x 18) showing a coated fossil; note that this coating has a granular texture like that of the oolites. Clear areas are crystalline calcite. Stratigraphic section M12A-B, Price's Falls, Murray County, Oklahoma, Okla. Analyses given in the APPENDIX, CHEMICAL ANALYSES.

4. Paralodion peel (x 18) of the limestone breccia facies of the middle laminated part of the Keel. The pebble, which largely fills the field, has a granular texture similar to that found in much of the Keel oolite and matrix. The larger, dark areas are blemishes in the peel, but the smaller ones appear to be mostly insoluble clastic grains. Stratigraphic section J1-C, about 1½ miles southeast of Wapanucka, Johnston Co., Okla. Analysis given in the APPENDIX, CHEMICAL ANALYSES.

5. Paralodion peel (x 18) showing a brecciated facies of the Keel oolite. Note the granular texture of the irregular fragments. Stratigraphic section Call-B, Criner Hills, Carter Co., Okla.

6. Paralodion peel (x 31) showing remarkable similarity in texture of the matrix and oolites. Note the small, indistinct oolite just to the left of the center. Lawrence quarry, NE¼ NE¼ sec. 36, T. 3 N., R. 5 E., Pontotoc County, Okla.

PLATE XII

Figures 1-3. Clarita member (Chimneyhill formation).

1. Thin section (x 18) of a shell rich facies of the Clarita; the dark matrix is mostly finely divided carbonate with some clay and silt size insoluble debris. Specimen collected by W. E. Ham from near old Hunton townsite, SW¼ SW¼ sec. 8, T. 1 S., R. 8 E., Coal County, Okla. (pl. B, panel II).

2. Thin section (x 31) showing the typical bioclastic limestone of the Clarita. Note the pelmatozoan texture of the larger fragments. Specimen collected by W. E. Ham, Delaney quarry NE¼ NE¼ sec. 30, T. 3 N., R. 6 E., Pontotoc County, Okla. (pl. A, panel II).

3. Paralodion peel (x 31) of a specimen from the coarse-grained facies of the Clarita. Most of the matrix engulfing the fossils is clear, crystalline calcite. Stratigraphic section P1-E, near Chimneyhill Creek, Pontotoc County, Okla. Analysis given in the APPENDIX, CHEMICAL ANALYSIS

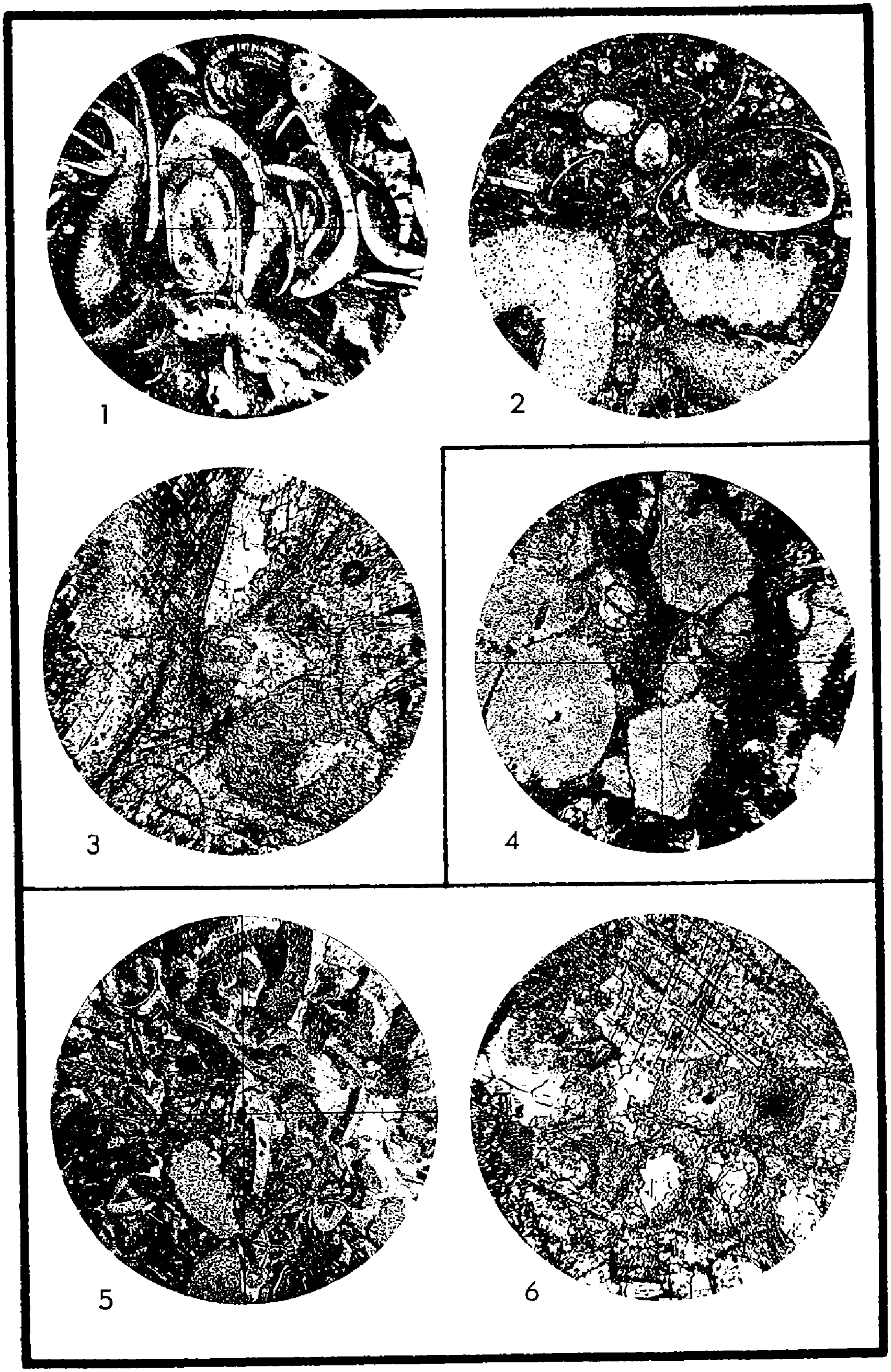
Figure 4. Henryhouse formation.

4. Paralodion peel (x 18) of an unusually fossiliferous bed in the upper part of the Henryhouse. Much of this fossil material consists of pelmatozoan debris; the dark matrix is finely divided carbonate with silt and clay size insolubles. Compare this texture with that of the typical Henryhouse marlstone shown on figures 1, 2, plate XIII. Stratigraphic section P1-S, near Chimneyhill Creek, Pontotoc County, Okla. Anaylsis given in the APPENDIX, CHEMICAL ANALYSES.

Figures 5-6. Cochrane member (Chimneyhill formation).

5. Thin section (x 18) of a limestone composed in large part of fossil debris. The clear areas are crystalline calcite; the dark spots are glauconite. Most of the fossil debris consists of pelmatozoan plates. Specimen collected by W. E. Ham from the Lawrence uplift, NW¼ NW¼ SW¼ sec. 29, T. 3 N., R. 6 E., Pontotoc County, Okla.

6. Paralodion peel (x 31) of a specimen from the very coarse-grained facies of the Cochrane. The clear areas are crystalline calcite. Stratigraphic section Ca12-C, northwest of Overbrook in the Criner Hills, Carter Co., Okla. Analysis given in the APPENDIX, CHEMICAL ANALYSES.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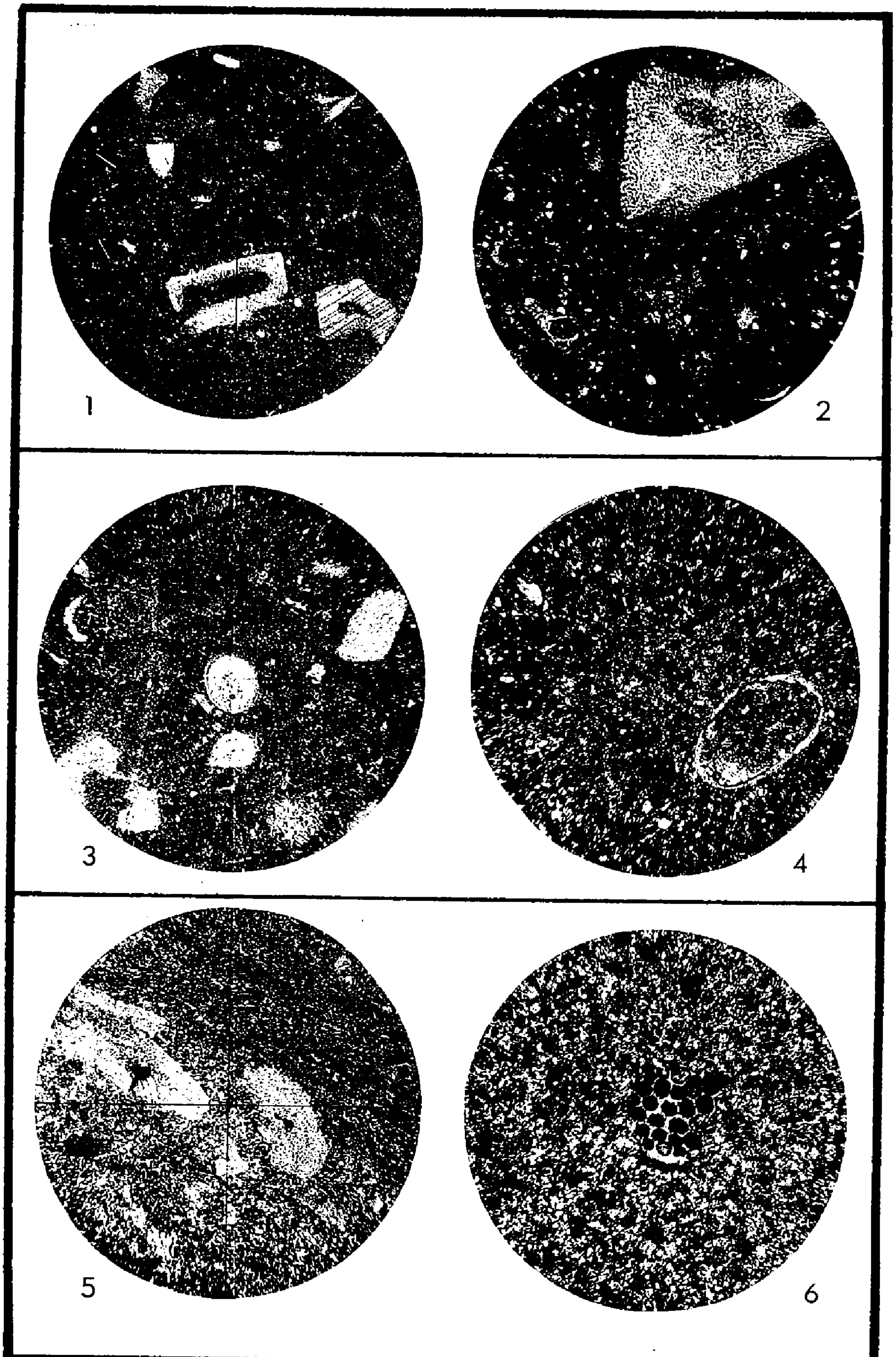
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PLATE XIII

Figures 1-2. Henryhouse formation.

1. Thin section (x 18) of typical Henryhouse marlstone. Most of the larger fossil fragments are pelmatozoan plates; the dark matrix is composed largely of finely divided carbonate, and silt-clay size insoluble debris. Compare to the more fossiliferous Henryhouse shown in plate XII, fig. 4. Specimen collected by W. E. Ham, Henryhouse Creek, SW¼ SE¼ sec. 30, T. 2 S., R. 1 E., Carter County, Okla. (my section Cal).

2. Thin section (x 31) of a red bed in the Henryhouse marlstones. The large fragment near the top is a pelmatozoan plate. Figures 1 and 2 show the characteristic marlstone lithology consisting of finely divided carbonate and insoluble debris with scattered fossils; note the similarity between this and the Haragan marlstone shown in figures 3, 4. Specimen collected by W. E. Ham, same locality as figure 1.

Figures 3-4. Haragan formation.

3. Paralodion peel (x 18) of Haragan marlstone. The fossil material is set in a matrix composed largely of silt and clay size carbonate and insoluble debris. Stratigraphic section Ml-I, Vines dome, Murray County, Okla. Approximately 12% insolubles; analysis given in the APPENDIX, CHEMICAL ANALYSES.

4. Paralodion peel (x 31) of Haragan marlstone. This particular rock has only widely scattered fossils. Stratigraphic section Ml-J, Vines dome, Murray County, Okla. Approximately 17% insolubles; analysis given in the APPENDIX, CHEMICAL ANALYSES.

Figures 5-6. Cravatt member (Bois d'Arc formation).

5. Paralodion peel (x 18) of a fossiliferous Cravatt marlstone. The larger fragments are pelmatozoan plates. Stratigraphic section Cal-U(2), Henryhouse Creek, Carter County, Okla. Approximately 15% insolubles; analysis given in the APPENDIX, CHEMICAL ANALYSIS.

6. Paralodion peel (x 31) of Cravatt marlstone with widely scattered fossil material. Stratigraphic section Ml-O(1), Vines dome, Murray County, Okla. Approximately 10% insolubles; analysis given in the APPENDIX, CHEMICAL ANALYSES.

PLATE XIV

Figures 1-4. Frisco formation.

1. Paralodion peel (x 18) of an unusually fine-grained facies of the Frisco having only scattered fossil fragments. This specimen came from an outcrop about 1,000 feet south of Bois d'Arc Creek, NE¼ SE¼ sec. 10, T. 2 N., R. 6 E., Pontotoc County, Okla. Approximately 3% insolubles; analysis given in the APPENDIX, CHEMICAL ANALYSES.

2. Paralodion peel (x 18) of a typical Frisco calcarenite showing fossil debris set in a matrix of clear calcite. Stratigraphic section P8-H, Bois d'Arc Creek, Pontotoc County, Okla. Less than 1% insolubles; analysis of this rock is given in the APPENDIX, CHEMICAL ANALYSES.

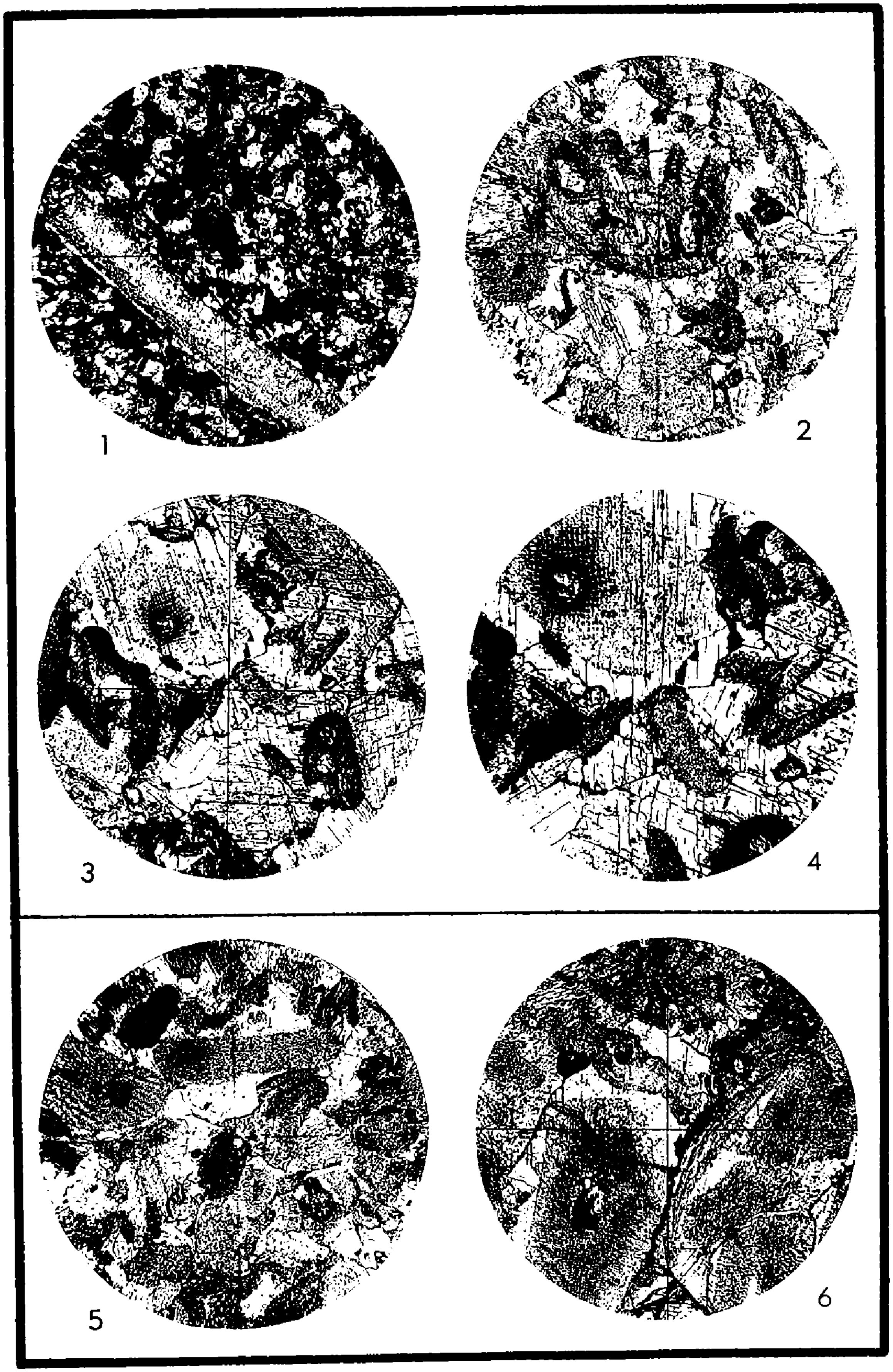
3. Paralodion peel (x 18) of a fossiliferous calcarenite. Note that the pelmatozoan plate in the upper left quadrant, which is completely enclosed in clear calcite, has indistinct boundaries and the same cleavage as the enclosing calcite Stratigraphic section P8-H (see figure 2).

4. Enlarged view (x 31) of the paralodion peel shown in figure 3.

Figures 5-6. Fittstown member (Bois d'Arc formation).

5. Paralodion peel (x 18) of a fossil-rich calcarenite bed in the Bois d'Arc formation; pelmatozoan plates make up a large part of the fossil material.
Stratigraphic section P2-B (APPENDIX; this specimen is from a calcarenite bed low in the Bois d'Arc formation; it is interbedded with much cherty marlstone and is therefore referred to the Cravatt, but the lithology is typical for the Fittstown).

6. Paralodion peel (x 18) of a fossiliferous calcarenite consisting mainly of pelmatozoan debris set in a matrix of clear calcite. Stratigraphic section C1-Q, near old Hunton townsite, Coal County, Okla. Approximately 2% insolubles; analyses given in the APPENDIX, CHEMICAL ANALYSES.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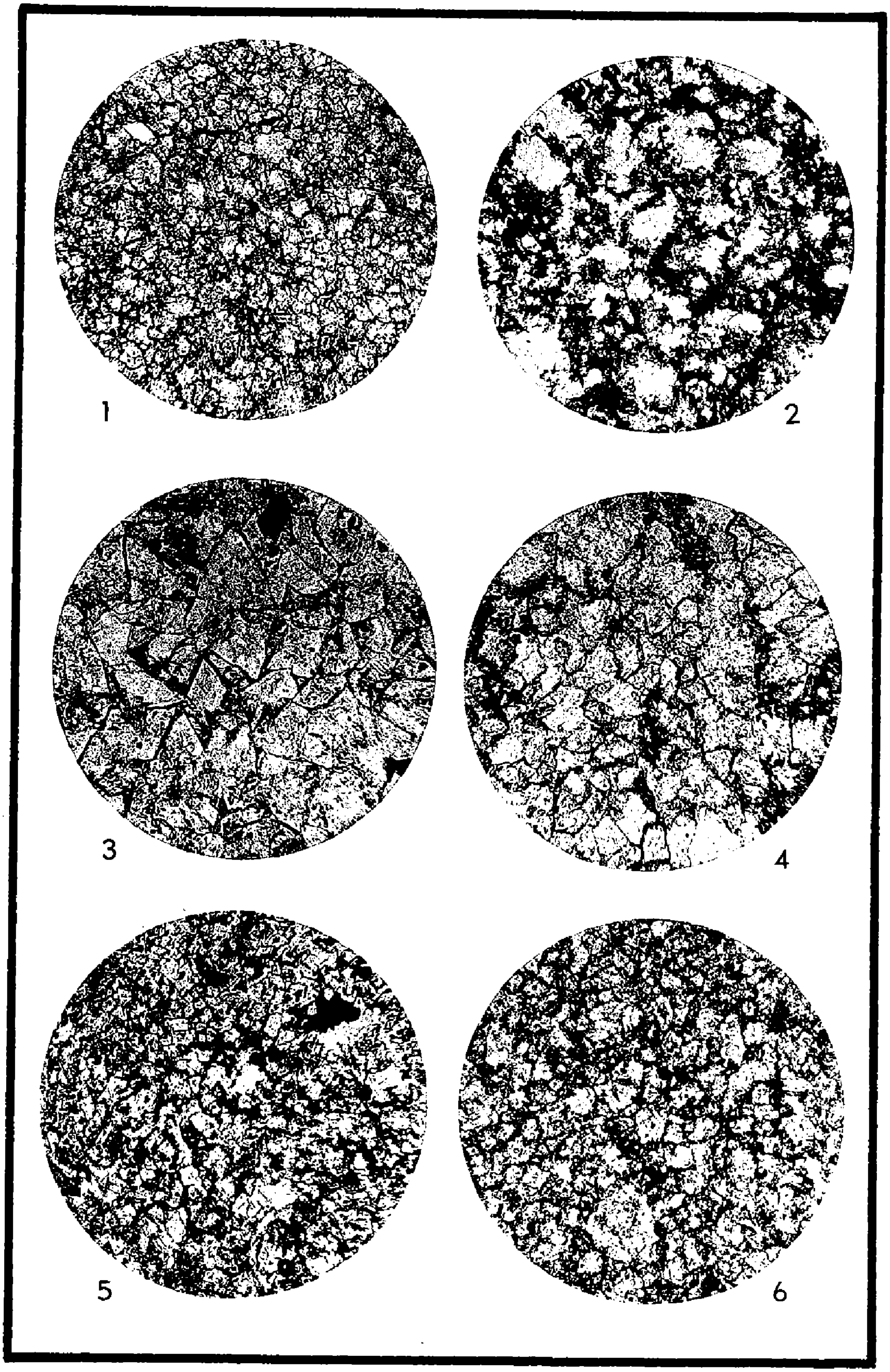
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PLATE XV

Figures 1-6. Woodford? brown carbonate. This stratigraphic unit is exposed in the vicinity of Oil Creek, Johnston County; the stratigraphy is described in the APPENDIX, STRATIGRAPHIC SECTIONS and chemical analyses are given in the section, CHEMICAL ANALYSES.

1. Thin sections (x 47) of unit J18-D(1), near Oil Creek, Johnston County, Okla. (fig. 44). HCl insoluble residue - 9.1%, $CaCO_3$ - 53.8% $MgCO_3$ - 33.3%.

2. Thin section (x 78) of unit J18-D (3), near Oil Creek, Johnston County, Okla. (fig. 44). HCl insoluble residue - 16.7%, $CaCO_3$ - 79.5%, $MgCO_3$ - 2.4%.

3. Thin section (x 78) of unit J18-E(2), near Oil Creek, Johnston County, Okla. (fig. 44). HCl insoluble residue - 4.5%, $CaCO_3$ - 56.4%, $MgCO_3$ - 36.6%.

4. Thin section (x 47) of a specimen collected by W. E. Ham, NE¼ NE¼ SE¼ sec. 18, T. 3 S., R. 4 E., near Oil Creek, Johnston County, Okla. (near my section J15; see fig. 44).

5. Thin section (x 47) of unit J13-B(1), near Oil Creek, Johnston County, Okla. (fig. 44). HCl insoluble residue - 9.5%, $CaCO_3$ 87.1%, $MgCO_3$ - 1.7%.

6. Thin section (x 78) of unit J13-B(2), near Oil Creek, Johnston County, Okla. (fig. 44). HCl insoluble residue - 9.9%, $CaCO_3$ 80.1%, $MgCO_3$ - 9.7%.

Compare the illustrations on this plate to the photomicrographs of the Clarita and Cochrane members of the Chimneyhill formations shown on plate XII.

PLATE XVI

Figures 1-4. *Carbonate-siltstone sequence*, Turkey Creek, Marshall County (fig. 47). These strata are described in the APPENDIX, STRATIGRAPHIC SECTIONS, and analyses are given in the section on CHEMICAL ANALYSES.

1. Thin section (x 78) of unit Ma2-F(2a), Turkey Creek, Marshall County (fig. 47). HCl insoluble residue - 61.6%, $CaCO_3$ - 26%, $MgCO_3$ - 11.5%.

2. Thin section (x 78) of unit Ma2-F(1), Turkey Creek, Marshall County (fig. 47). HCl insoluble residue - 66.8%, $CaCO_3$ - 21.5% - $MgCO_3$ - 8.1%.

3. Thin section (x 78) of unit Ma2-D(1), Turkey Creek, Marshall County (fig. 47). HCl insoluble residue - 67.1%, $CaCO_3$ - 18.2%, $MgCO_3$ - 13.2%.

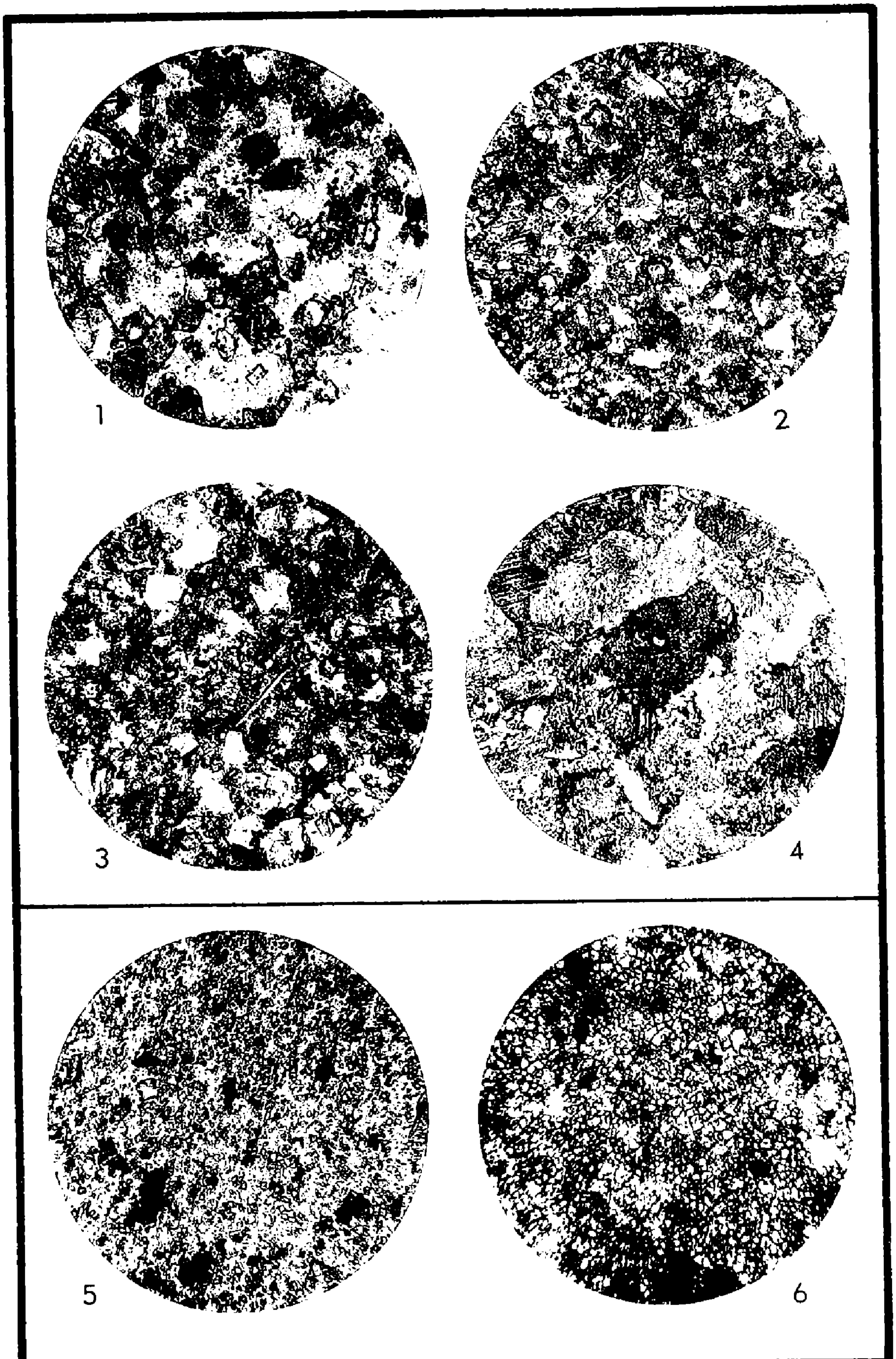
4. Thin section (x 18) of unit Ma2-A, Turkey Creek, Marshall County (fig. 47). HCl insoluble residue - 10.1%, $CaCO_3$ - 87.8%, $MgCO_3$ - 0.6%.

Compare to the Hunton photomicrographs shown on plates XII, XIII, XIV.

Figures 5-6. Sylvan formation.

5. Thin section (x 78) of unit Ma2-Y, Turkey Creek, Marshall County (fig. 47). This is a thin section of a bed which is referred with question to the Sylvan; see discussion in the section, TURKEY CREEK INLIER, *Lithology*. HCl insoluble residue - 59.6%, $CaCO_3$ - 37.7%, $MgCO_3$ - 0.7%. The dark grains in this photomicrograph are probably limonite or hematite; the light colored discrete grains are mostly calcite.

6. Thin section (x 78) of a Sylvan specimen from section J17, near Oil Creek, Marshall County (fig. 44). This represents undoubted Sylvan, being a lens of argillaceous limestone that is interbedded with typical Sylvan shale; it lies 25 feet (stratigraphically) below the Woodford? brown carbonate. HCl insoluble residue - 19%. The dark grains are probably limonite, light, discrete grains carbonate.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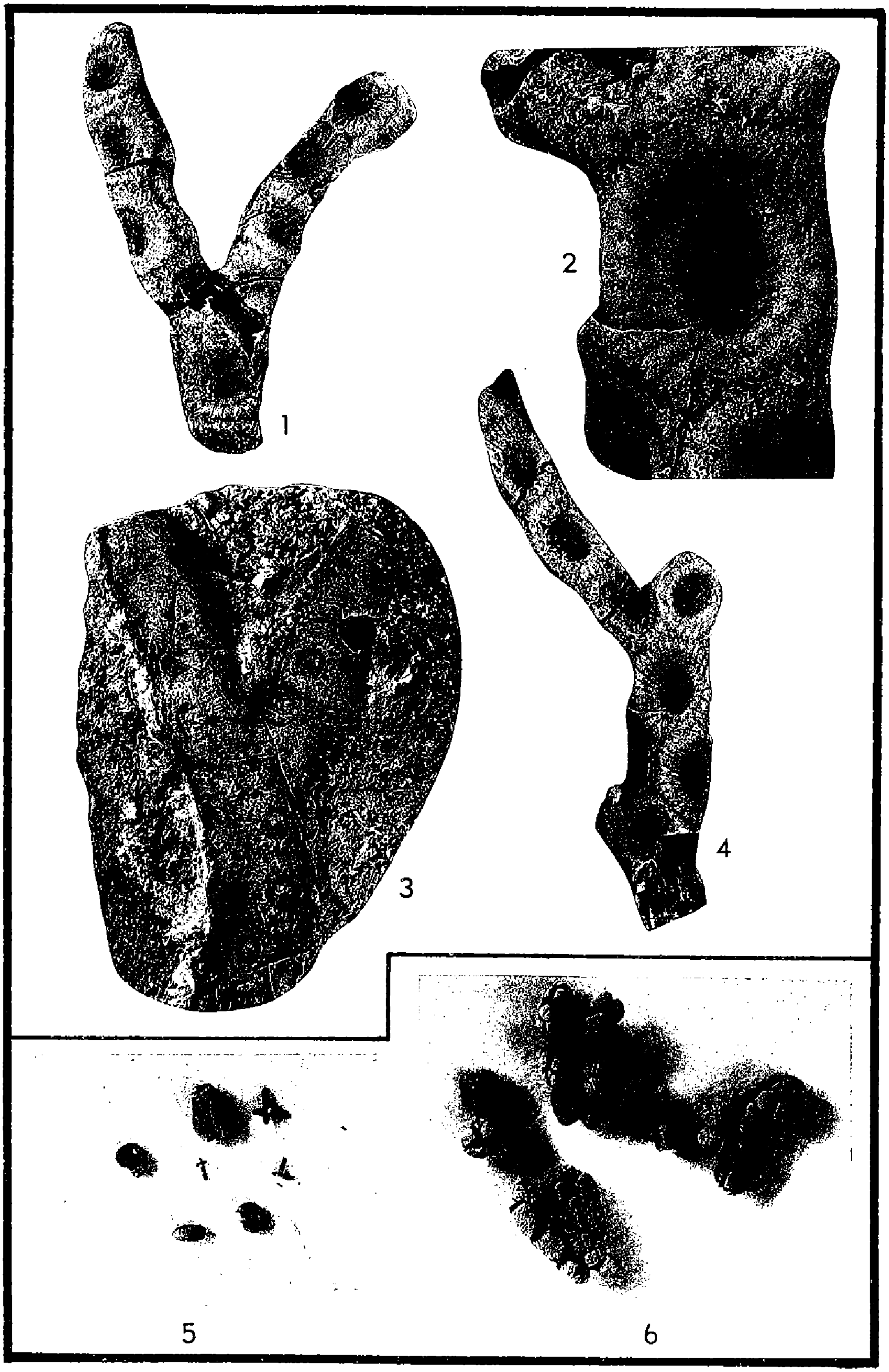
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PLATE XVII

Figures 1-4. *Trachypora* sp. from the Frisco formation.

1. Fragment of a corallum (x 1) ; O. U. Catalog No. 3120.

2. Enlarged view (x 3) of the specimen shown in figure 4; O. U. Catalog No. 3121.

3. Portion of an abraded corallum (x 1) and matrix; O. U. Catalog No. 3122.

4. Part of a corallum (x 1) ; this is the specimen shown in figure 2.

All of these specimens are from the lower 2 or 3 feet of the Frisco formation on Bois d'Arc Creek; SW¼ NW¼ sec. 11, T. 2 N., R. 6 E., Pontotoc County, Okla. (my section P8-H; see panel II, pl. A).

Figures 5-6. Glauconite from the Cochrane member (Chimneyhill formation).

5. Fossils preserved in glauconite (x 10) ; most are steinkerns, but the sponge spicules may represent replacement. Cochrane member, E½ SW¼ sec. 18, T. 2 S., R. 8 E., Johnston County, Okla. (my section J6-C).

6. Glauconite with the polylobate shape that is so common in the Cochrane member (x 10). Cochrane member, NW¼ sec. 8, T. 1 S., R. 8 E., Coal County, Okla. (my section C1-C; see panel II, pl. A).

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APPENDIX

The APPENDIX is divided into two parts: (1) STRATIGRAPHIC SECTIONS, which includes a description of all measured and described sections p. 181-286), and (2) CHEMICAL ANALYSES, which includes a tabulation of all chemical data (p. 287-297).

STRATIGRAPHIC SECTIONS

Seventy-seven partial or complete Hunton stratigraphic sections are described on the following pages. All of these were made by me, either alone or in a few cases with William Ventress (P11, P17) and Styron Douthit (C2). These sections cover the major outcrop belts in the Arbuckle Mountain region and Criner Hills, including the inlier on Turkey Creek. All fossil and lithologic specimens used in my investigation of the Hunton were taken from these sections and are identified according to the section (e. g. P1, J6) and stratigraphic position (e. g. P1-A, 6J-B) ; see below.

The descriptions and illustrations are grouped into *Stratigraphic sections* and *Collections*. The latter cover fossil collections made from strata which were not described in detail; the formation (or member) is cited and the stratigraphic position within the formation noted, but no further lithologic details are given. There are only a few of these and most of the information is presented in the form of detailed stratigraphic sections. However, in order to save some space I have abbreviated the descriptions of some sections. Those marked with an asterisk (*) have been shortened to include only a summary description of each formation and member, and the individual stratigraphic units recognized in making the original description (and fossil collections) are listed only by number and position (see section A1 for an example). A complete description is given for all other stratigraphic sections (see P1 for an example).

The stratigraphic sections are designated by a letter and a number (e. g. J6) ; the letter designates the county (e. g. J for Johnston County) and the number distinguishes the different sections measured in that county. Under each section the different stratigraphic divisions recognized in describing and collecting are given a letter. For example, C2-A encompasses six feet of calcarenites assigned to the Cochrane member (in section C2) and C2-J the upper five feet of the Haragan marlstone.

The geographic location is given in the introductory remarks which accompany each stratigraphic section. For quick reference the approximate geographic position of each section is indicated on the small scale map, figure 48; a more exact location is given in the map, panel 1, in the back of this report. Further geographic and geologic details for all sections located on the Lawrence Uplift, and on the old Hunton townsite belt are given in the geologic maps, plates A and B, panel II. This report also includes several maps giving further information for certain selected small areas (figs. 42, 44, 46, 47, 51, 52). A number of the stratigraphic sections are illustrated in the cross sections which appear on plate C, panel III.

Rock descriptions: This is not primarily a petrographic study; however, I have tried to supplement the field descriptions with additional details obtained from a laboratory investigation of rock specimens. The principal techniques used in this part of the study are outlined below.

1. Chemical analyses. These are discussed and tabulated in the chapter on CHEMICAL ANALYSES.

2. Thin sections and paralodion peels. A number of thin sections and many paralodion peels were made. Peels are especially useful as relatively large areas can be prepared quickly. They were made by polishing a surface of the rock with number 400 grit, and then etching it in a 5 percent solution of HC*l* for 15 to 30 seconds. The time varies slightly, depending largely upon the percentage of $CaCO_3$, but most Hunton rocks will yield satisfactory results in 20 to 25 seconds. After rinsing and drying the paralodion liquid was added and allowed to dry (the solution described by Koenig, 1954, p. 78, gives excellent results). Air bubbles can be kept to a minimum if the speci-

men is thoroughly dried before adding the liquid; if dried on a hot plate it should be allowed to reach approximate room temperature before coating. Most Hunton rocks yield fine peels which in some cases are superior to thin sections of conventional thickness. However, certain lithologic types (i. e. Ideal Quarry member) did not give satisfactory results and it was then necessary to rely entirely on thin sections. The peels and thin sections were studied mostly by means of a binocular miscroscope at magnifications up to 112 diameters. This examination, when combined with the data from chemical analyses, will yield a substantial amount of information on the lithologic characteristics of the rock.

3. HC1 insoluble residues. The percentage of residue was calcuated for a number of Hunton rock specimens, most of this being done in the Chemical Laboratories of the Oklahoma Geological Survey (see CHEMICAL ANALYSES). I also made an examination of many residues representing all of the Hunton stratigraphic units in order to determine the texture, composition and other information which might have a bearing on origin. Samples to be studied in this way were first crushed (not pulverized), and then digested in dilute, warm HC1, and the residues thoroughly washed. Washing removes the fines, but this is necessary as the clay fraction is too small to be studied by the means available to me, and only serves to obscure the silt size and larger particules. The washed residues were examined under a binocular microscope; no investigation was made of the heavy mineral suite.

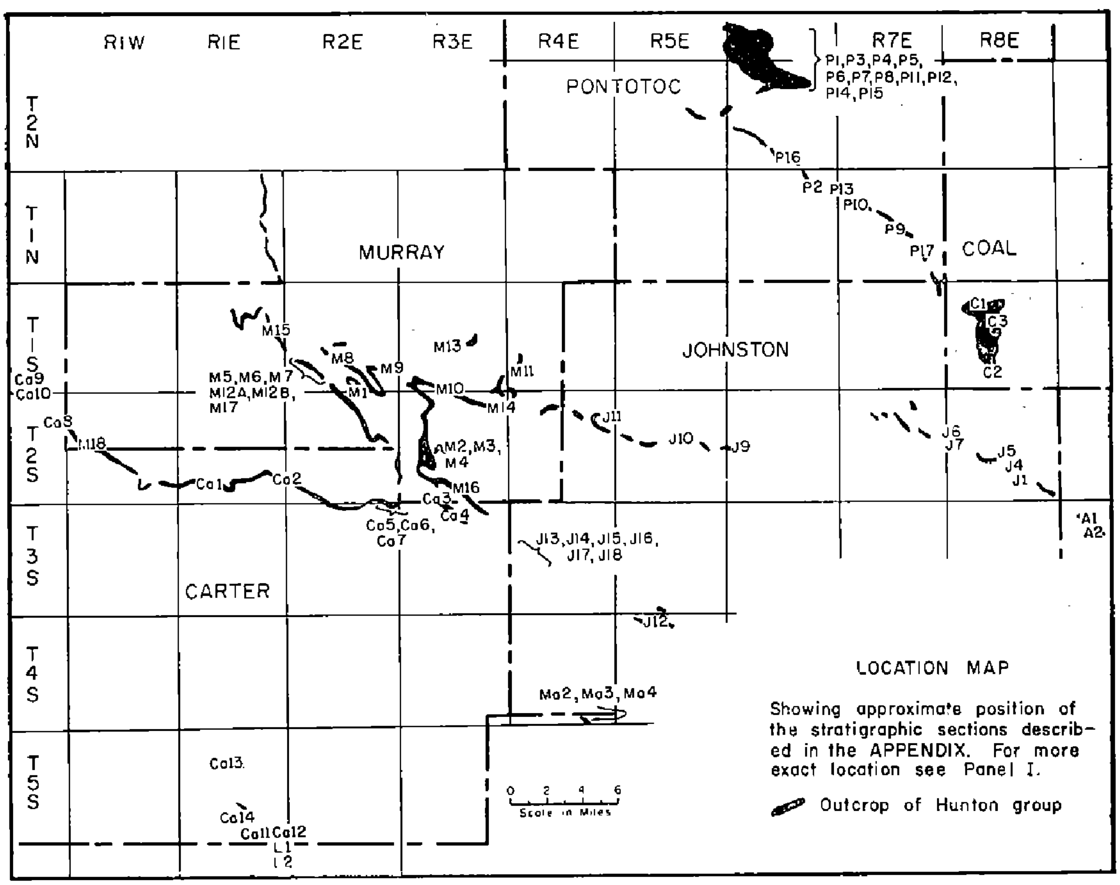

Figure 48. Index map showing the approximate geographic location of the stratigraphic sections described in the APPENDIX. For a more detailed location see panel I.

A number of specimens from the various Hunton stratigraphic units were digested in dilute, warm, acetic acid, and the residues examined for conodonts, inarticulate brachiopods and arenaceous Foraminifera. The latter are also preserved in the HCl residues.

The limestones of the Hunton show considerable lithologic variation when studied by the methods outlined above, and this diversity in texture and composition presents a real problem with respect to rock classification. There is need for a more elaborate limestone terminology than has customarily been used in the past, and recently several attempts have been made to develop such a system. I have, however, tried to keep my lithologic terminology as simple as possible since this study is primarily biostratigraphic rather than petrologic. Most of the rock names are used as defined by Pettijohn although there are one or two which require additional explanation. The name marlstone has been applied for many years to the earthly limestones of the middle Hunton, especially the Haragan and Henryhouse, and I have continued to use it in spite of the fact it does not precisely agree with the standard definition (Pettijohn 1957, p. 369-410). The Hunton marlstones are fine grained, impure limestones with scattered fossils. The fossils, which almost always make up less than 25 percent of the rock, are set in a matrix of finely divided carbonate and insoluble material (see photomicrographs on plate XIII). The insoluble residues, which are almost exclusively in the silt-clay size, range from about 7 percent up to almost 50 percent, the average falling between 16 and 20 percent. The more impure parts fall within the conventional definition (35% to 65% insolubles) of a marlstone (although including silt as well as clay), but in the lower ranges it grades into an argillaceous (and silty) calcilutite and I have sometimes used this name for those marlstones with less than 15 percent insolubles.

I have applied the term bioclastic to those Hunton limestones which are composed of more than 50 percent fossil material; if predominantly sand size they are called bioclastic calcarenites, and if predominantly silt-clay size bioclastic calcilutites. Almost invariably these rocks are low in acid insolubles, generally less than 6 percent. This terminology is not entirely adequate. For example, the name bioclastic calcarentie carries no connotation (as defined above) as to the matrix, which may be clear, crystalline calcite (sparry calcite of Folk, 1959), or finely divided carbonate ("lime mud"; microcrystalline calcite of Folk 1959). Actually, most of the Hunton bioclastic calcarenites have a matrix of clear, crystalline calcite, and most of the bioclastic calcilutites have a matrix of finely divided carbonate, but there are some exceptions. I have therefore tried to describe the lithologic characteristics and variations as fully as possible in the sections on *Lithology* which accompany each formation and member.

The color terms used in this report are taken from the *Rock Color Chart* prepared by Goddard and authors under the auspices of the National Research Council and distributed by the Geological Society of America. Color has not proved to be especially significant in the recognition of the different Hunton formations and members.

Two types of chert are recognized; (1) a solid, vitreous chert with a conchoidal fracture, and (2) a spongy weathering type which I call tripolitic chert. This second type, where relatively fresh and unweathered, consists of a mixture of carbonate and silica which is not readily distinguished from the surrounding limestone: when exposed to weathering at the surface the carbonate is leached out, producing a spongy texture with a brown color that is easily seen (pl. VI, fig. 2). The relationship of these two cherts is discussed under CRAVATT MEMBER, *Lithology*. Both kinds commonly make small lenses or irregular nodules (pl. VI, fig. 1); the vitreous type may form small angular fragments, or aggregates of fragments, which have a brecciated appearance.

The term glauconite has been used in both a morphologic and a mineralogic sense (Burst 1958, p. 310), the latter now commonly defined by X-ray methods. In this report it is used as a morphologic term to cover those dark to bright-green pellets, variable in shape, but generally having either a polylobate outline, or the shape of some fossil (pl, XVII, figs. 5, 6). This mineral is most common in the Cochrane and is further discussed in the chapter on that member.

Fossil collections: All of the fossils used in my study of the Hunton were taken from the sections described on the following pages. Most of the collections from the marlstones (i.e. Henryhouse, Haragan and part of the Cravatt) were collected loose on the surface, although always on outcrops whose stratigraphic position had been carefully determined. Collections made in this way may be contaminated by specimens washed down from the overlying beds; however, repeated field checks indicate that the fossils have moved surprisingly little. I have made a number of sections across the Henryhouse-Haragan contact, and the Henryhouse collections obtained from these sections show almost no admixture of Haragan fossils with the possible exception of a thin zone near the contact (at most only a few feet). Care should be exercised in the case of silicified steinkerns; almost all of these (excluding silicified corals) are out of the Bois d'Arc formation and they may move a considerable distance down the slope. Practically all of the fossils obtained from the Chimneyhill, Fittstown and Frisco were collected in place by breaking the specimens out of the rock; all collections made in situ are so indicated. Fossils which have been identified to genera or species are listed under their proper section and horizon. The range of Haragan-Bois d'Arc brachiopod species on section C1 is illustrated in figure 49.

STRATIGRAPHIC SECTION A1*

Southeast of Wapanucka

Section described by T. W. Amsden, Oct. 11, 1956. About 4 miles southeast of Wapanucka, NW¼ NW¼ sec. 9, T. 3 S., R. 9 E., Atoka County, Okla. Strike of beds 295 degrees (magnetic), dipping 70 degrees to the northeast.
Covered (much shale float probably representing the WOODFORD FORMATION)

HUNTON GROUP (total 64 feet)

BOIS D'ARC FORMATION (total 52 feet)

CRAVATT MEMBER: Yellowish-gray (locally mottled with red) argillaceous calcilutite with many nodules of chert; chert brown-weathering, partly tripolitic, partly vitreous. Almost entirely a calcilutite texture, little or no calcarentie. Beds from 2 to 8 inches.
A1-C .... 50 feet
A1-B (covered) .... 2 feet

CHIMNEYHILL FORMATION (total 12 feet)

COCHRANE MEMBER: Gray, glauconitic limestone with nodules and lenses of vitreous chert. Bedding irregular, commonly obscure. No evidence of Clarita or Keel in this belt (see SECTION A2).
A2-A. .... 12 feet
Covered (probably SYLVAN FORMATION)

STRATIGRAPHIC SECTION A2

Southeast of Wapanucka

Section described by T. W. Amsden, Oct. 11, 1956. About 4 miles southeast of Wapanucka, Atoka County; SE¼ NW¼ sec. 9, T. 3 S., R. 9 E. Strike of beds approximately 295 degrees (mag.), dipping 65 to 70 degrees to the NE.
Covered (shale float: probably WOODFORD FORMATION)

HUNTON GROUP (total 62 feet)

BOIS D'ARC FORMATION (total 47 feet)

CRAVATT MEMBER (total 47 feet)

C. *Lithology*: Yellowish-gray (5Y 8/1) mottled .... 45 ft.
with red, argillaceous calcilutite with many nodules of chert. Chert fossiliferous, mostly brown-weathering, porous; some vitreous chert. Rock almost entirely calcilutite, only a bed or two of calcarenite. Bedding 2 to 8 in.

An analysis of this rock is given in the section of CHEMICAL ANALYSES.

Remarks: Three specimens tested for HCl insoluble residues: 7.6%, 17.5% and 21%.

Upper contact of C covered, but the float indicates it is near the Woodford; the lower contact rests directly upon Cochrane, or upon the breccia of unit B. No Haragan, Henryhouse or Clarita present.

Fossils: Small fauna of typical Haragan-Bois d'Arc species collected: *Levenea subcarinata pumilis, Coelospira virginia, Atrypina hami, Nucleospira ventricosa, Rhynchospirina maxwelli, Sphaerirhynchia lindenensis, Costellirostra singularis*, phacopid trilobite.

B. *Lithology*: Limestone breccia; irregular fragments............................0 to 2 ft. set in a red argillaceous matrix; peels show the fragments range from microscopic size up to about 2 inches in diameter; mostly fossil-rich calcarenites. Both matrix and fragments glauconitic.

Remarks: This is a local phase, absent in most places. It appears to represent pieces of Cochrane incorporated into the basal Bois d' Arc beds.

No Clarita observed in any part of this belt of Hunton.

CHIMNEYHILL FORMATION (total 15 feet; no Clarita or Keel present)

COCHRANE MEMBER (total 15 feet)

A. *Lithology*: Gray (N8), fine- to medium-grained,......................................15 ft. calcarenite with rounded grains of glauconite. Amount of glauconite variable, ranging from a trace up to an estimated 3 or 4%. Minor pink fragments present, probably some are pelmatozoan plates. Bedding obscure. Some chert nodules present.

An analysis of this rock given in the section on CHEMICAL ANALYSES.

Remarks: No Keel observed in this belt of Hunton. In this area there is much float of a brown-weathering, iron-rich carbonate with many silicified pelmatozoan fragments. Superficially it resemblees the Ideal Quarry member, but shows no trace of oolites, is richly glauconitic and has some chert; it is probably an iron-rich facies of the Cochrane.

Covered (probably SYLVAN SHALE)

STRATIGRAPHIC SECTION C1

Near old Hunton townsite

Described and collected by T. W. Amsden, Oct. 12, 13, 14, 1955. All of this section lies in the NW¼ sec. 8, T. 1 S., R. 8 E., Pontotoc County, Okla.; this is a short distance north of old Hunton townsite (see panel I). Base of section (Ideal Quarry member) near the west edge of sec. 8, approximately 1,700 feet south of the NW section corner; the section extends slightly south of east through the woods and into the open area, crossing a dirt road and a small creek (upper part of F, Clarita member, exposed in this creek); it then extends almost due east along a fence line to the top of the ridge (Bois d'Arc formation, unit P), thence down the dip slope to the Frisco formation, approximately 1,000 feet east of the ridge top. The location of this section is shown on the geologic map, plate B, panel II.

The strike of the beds on the Keel and Cochrane members ranges from 110 to 130 degrees (magnetic), dipping about 10 degrees to the east; on the east; on the Clarita, Haragan and Bois d'Arc beds the strike is 165 degrees (magnetic), dipping 7 to 10 degrees to the east.

A summary of part of this section is given in Amsden 1958A (p. 26), and Amsden 1958B (p. 29). Analyses of rock samples from C1 are given in the section on CHEMICAL ANALYSES.

This is the type locality for the Hunton group (Amsden 1957, p. 3). The group is well exposed here except for a hundred-foot covered interval (C1-G) between the Clarita member and the lowest Haragan exposure. The total Hunton thickness at C1 is about 400 feet. The thickness up to and includ-

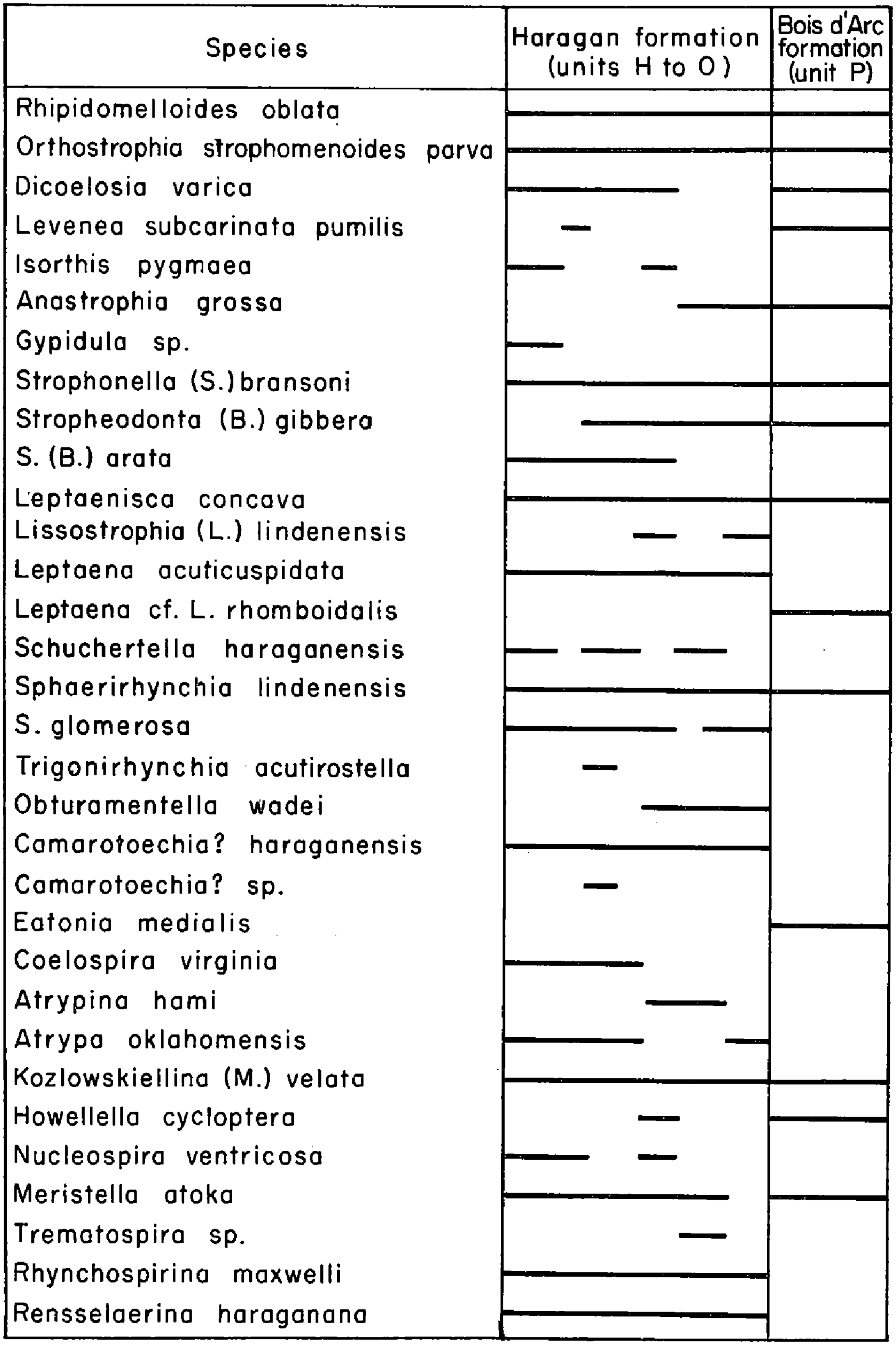

Figure 49. Chart showing the distribution of brachiopod species collected from the Haragan and Bois d'Arc formations at C1.

ing unit Q is 386 feet, a figure which is believed to be reasonably accurate although the covered interval between P and Q was measured on the dip slope and could be off as much as 10 or 15 feet either way; the covered interval above Q represents a small stratigraphic interval, and since the Frisco in this area has a known thickness of 9 to 10 feet (fig. 42) the Hunton must total approximately 400 feet.

The Haragan-Bois d'Arc strata are richly fossiliferous, brachiopods being especially abundant. The range of brachiopod species collected from C1 is shown in figure 49.

HUNTON GROUP (total thickness approximately 400 feet; see discussion above)

FRISCO FORMATION (9 to 10 feet)

Lithology: Yellowish-gray fine calcarenite; megafossils rare, but ostracods and sponge spicules locally abundant. Beds 18 inches to 2 feet in thickness, weathering with a "pot-holed" surface. HCl insoluble residues range from 3 to 6%, washed residues consisting largely of silicified fossil fragments. Thickness 9 to 10 feet.

BOIS D'ARC FORMATION (total approximately 85 feet)

Covered (see discussion above)..

FITTSTOWN MEMBER

Q. *Lithology*: Yellowish-gray (5Y 7/2 to 5Y 8/1)........................3 feet
medium- to coarse-grained fossiliferous calcarenite. HCl insoluble residue 1.8% (one specimen); residues mostly silicified fossil fragments with some clear, silt-size quartz fragments. Peel shows this rock is composed largely of fossil material, mostly pelmatozoan fragments with pieces of brachiopods and other fossils. Some evidence of recrystallization. $MgCO_3$ 2.1%.

Remarks: This is typical Fittstown lithology but since it is covered above and below the thickness of this lithofacies cannot be determined.

Fossils: Helderbergian fauna collected in situ consisting of a few snails, trilobites and the following brachiopods: *Platyorthis angusta*, *Leptostrophia beckii tennesseensis*, *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *Costellirostra singularis*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Meristella atoka*, *Rensselaerina haraganana*.

FITTSTOWN and/or CRAVATT MEMBER

Covered .... 27 feet

Remarks: Measured along the east slope of the Bois d'Arc ridge. The slope distance taped is 950 feet and since it approaches a dip slope it is difficult to determine the stratigraphic interval with any degree of precision; probably accurate within 10 or 15 feet.

CRAVATT MEMBER (55 feet excluding all of the covered interval above)

P. *Lithology*: Yellowish-gray to greenish-yellow........................55 feet
(5Y 7/2 to 5Y 8/2) argillaceous calcilutite or marlstone with nodules and lenses of brown-weathering porous chert. Two HCl insoluble residues calculated, 19.5% and 8.5% (chert free samples); washed residules mostly silt-size clear quartz with some mica; also fragments of silicified fossils (no completely silicified specimens observed and much is believed to be an incomplete surface silicification). The average grain size of the calcilutite, excluding larger fossil fragments, is well below 1/16 mm. $MgCO_3$, 2.4%.

Remarks: P was measured in the scarp face extending to the top of the ridge. It is largely exposed, only a few patches of cover. Except for the presence of chert it is lithologically like the underlying beds (Note: chert is present in unit L, below; see discussion under L).

Fossils: A fairly large Helderbergian fauna collected including the following brachiopods: *Orthostrophia strophomenoides parva*, *Levenea subcarinata pumilis*, *Rhipidomelloides oblata*, *Dicoelosia varica*, *Anastrophia grossa*, *Strophonella (S.) bransoni*, *Stropheodonta gibbera*, *Leptaenisca concava*, *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *Eatonia medialis*, *Kozlowskiellina (M.) velata*, *Howellella cycloptera*, *Meristella atoka*.

HARAGAN FORMATION (total 228 feet including all of the covered interval at the base)

O. *Lithology*: Partly covered. Yellowish-gray to..................................14 feet
greenish-yellow (5Y 8/1 to 10Y 8/2) fossiliferous marlstone. One specimen tested for HCl insoluble residues, 14%; washed residues largely silt-size, clear, subangular quartz fragments. Bedding nodular, up to 3 or 4 inches in thickness.
Remarks: Separated from the overlying P because of the absence of chert. Similar to the underlying N from it was separated largely for fossil collecting.
Fossils: *Rhipidomelloides oblata*, *Orthostrophia strophomenoides parva*, *Anastrophia grossa*, *Strophonella (S.) bransoni*, *Stropheodonta (B.) gibbera*, *Lissostrophia (L.) lindenensis*, *Leptaenisca concava*, *Leptaena acuticuspidata*, *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Obturamentella wadei*, *Camarotoechia? haraganensis*, *Atrypa oklahomensis*, *Kozlowskiellina (M.) velata*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

N. *Lithology*: Yellowish-gray (5Y 7/2) fossiliferous..............................30 feet
marlstone. Bedding nodular, up to 3 or 4 inches in thickness. HCl insoluble residue, 17%; washed residues mostly silt-size, clear subangular quartz fragments; few questionable arenaceous Foraminifera. One peel prepared; rock composed largely of finely divided carbonate (and quartz), well below 1/16 mm in diameter, plus scattered fossil material of larger size. Fossils only poorly oriented, many appearing to be at random.
Remarks: Units N, O and P make the upper scarp face, above the bench formed on M. N is similar to the beds above and below from which it was separated mainly for collecting.
Fossils: Include the following brachiopods:
Rhipidomelloides oblata, *Orthostrophia strophomenoides parva*, *Anastrophia grossa*, *Strophonella (S.) bransoni*, *Stropheodonta (B.) gibbera*, *Leptaenisca concava*, *Leptaena acutiplicata*, *Schuchertella haraganensis*, *Sphaerirhynchia lindenensis*, *Obturamentella wadei*, *Camarotoechia? haraganensis*, *Atrypina hami*, *Atrypa oklahomensis*, *Kozlowkiellina (M.) velata*, *Meristella atoka*, *Trematospira* sp., *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

M. *Lithology*: Mostly covered. One or two small..................................14 feet
ledges of marlstone like beds above.
Remarks: Unit M forms the bench between the upper and lower scarps.
Fossils: A rather large fauna collected loose on this bench, consisting of corals, trilobites, gastropods and the following brachiopods: *Rhipidomelloides oblata*, *Dicoelosia varica*, *Orthostrophia strophomenoides parva*, *Isorthis pygmaea*, *Anastrophia grossa*, *Strophonella (S.) bransoni*, *Stropheodonta (B.) gibbera*, *S. (B.) arata*, *Lissostrophia (L.) lindenensis*, *Leptaenisca concava*, *Leptaena acutiscuspidata*, *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Obturamentella wadei*, *Camarotoechia? haraganensis*, *C.?* sp., *Atrypina hami*, *Atrypa oklahomensis*, *Kozlowskiellina (M.) velata*, *Howellella cycloptera*, *Nucleospira ventricosa*, *Meristella atoka*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

L. *Lithology*: Yellowish-gray (5Y 8/1 to 10Y 8/2)..................................9 feet
fossiliferous marlstone with nodules and small lenses of brown-weathering, porous, chert. Beds range up to 5 or 6 inches in thickness.

Remarks: This unit is lithologically like P above, the chert in both being the same, porous tripolitic type. The marlstone of L is like that of the beds immediately above and below, from which it is separated only by having chert nodules. Since the base of the Bois d'Arc formation is defined on the presence of chert, unit L could be made the base of this formation. This was not done because L is thin and when traced leterally to the south lenses out and disappers (see map, panel II). Therefore L is placed in the Haragan and the Bois d'Arc base is placed at the base of P, the lowest chert of any appreciable thickness. Unit L makes the lip of a topographic bench.

Fossils: The following brachiopods collected: *Rhipidomelloides oblata*, *Dicoelosia varica*, *Orthostrophia strophomenoides parva*, *Strophonella* (*S.*) *bransoni*, *Stropheodonta* (*B.*) *gibbera*, *S.* (*B.*) *arata*, *Leptaenisca concava*, *Leptaena acuticuspidata*, *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Camarotoechia? haraganensis*, *Coelospira virginia*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Meristella atoka*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

K. *Lithology*: Yelowish-gray fossiliferous..21 feet marlstone. Grain-size, excluding larger fossils, well below 1/16 mm. Washed HCl residues largely silt-size, clear, subangular quartz. Acetic acid residues with many fossils; mostly pelmatozoan fragments with some brachiopods and ostracods.

Fossils: Highly fossiliferous; brachiopods predominant (as throughout the Haragan), trilobites, corals and Bryozoa also common. Brachiopods collected: *Rhipidomelloides oblata*, *Dicoelosia varica*, *Orthostrophia strophomenoides parva*, *Strophonella* (*S.*) *bransoni* *Stropheodonta* (*B.*) *gibbera*, *S.* (*B.*) *arata* *Leptaenisca*, *Chonetes* sp., *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Trigonirhynchia acutisulcata*, *Camarotoechia? haraganensis*, *Coelospira virginia*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Meristella atoka*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*. The Strophomenacea are especially common in unit K, this being one of the best collecting localities I have observed for these brachiopods.

J. *Lithology*: Yellowish-gray (5Y 8/1 to 10Y 8/2)..13 feet fossiliferous marlstone. Bedding nodular, up to 2 or 3 inches in thickness.

Remarks: Interval partly covered, separated from the beds above and below for collecting only.

Fossils: A few trilobites, gastropods, corals and the following brachiopods collected: *Rhipidomelloides oblata*, *Levenea subcarinata pumilis*, *Dicoelosia varica*, *Orthostrophia strophomenoides parva*, *Strophonella* (*S.*) *bransoni*, *Stropheodonta* (*B.*) *arata*, *Leptaenisca concava*, *Leptaena acuticuspidata*, *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Camarotoechia? haraganensis*, *Coelospira virginia*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Nucleospira ventricosa*, *Meristella atoka*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

I. *Lithology*: Covered..18 feet

H. *Lithology*: Partly covered. Outcrops of..8 feet yellowish-gray (5Y 7/2 to 10Y 8/2), fossiliferous marlstone. Two HCl insoluble residues calculated, 19%, 5%. One peel shows the rock to be composed of finely divided silt-size carbonate particles, plus clay- and silt-size insolubles; fossils scattered through this matrix, showing little evidence of orientation. $MgCO_3$ content low, less than 2%.

Remarks: Unit H is the lowest exposure of marlstone in the vicinity of section C1: the interval between here and the Clarita exposure in the creek is entirely covered; see geologic map, panel II. H is lithologically like the strata above from which it was separated for collecting: it forms the base of the Hunton scarp, units H, I, J, K, and L forming the lower scarp, and N, O and P the upper scarp.

Fossils: A fairly large fauna collected loose on the surface, including some trilobites, corals, Bryozoa and the following brachiopods: *Rhipidomelloides oblata, Dicoelosia varica, Orthostrophia strophomenoides parva, Isorthis pygmaea, Gypidula* sp., *Strophonella (S.) bransoni, Stropheodonta (B.) arata, Leptaenisca concava, Leptaena acuticuspidata, Schuchertella haraganensis, Sphaerirhynchia glomerosa, S. lindenensis, Camarotoechia? haraganensis, Coelospira virginia, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Nucleospira ventricosa, Meristella atoka, Rhynchospirina maxwelli, Rensselaerina haraganana.*

G *Lithology*: Covered..101 feet
Remarks: This covered interval occupies the open fields between the creek exposures and those at the foot of the Hunton ridge; see map, panel II. It is almost certainly all marlstone and is here assigned to the Haragan although the lower few feet could be Henryhouse as this formation is present at the south end of this belt (C1). If there is Henryhouse it is probably only a few feet thick.

CHIMNEYHILL FORMATION (total 73 feet)
CLARITA MEMBER (total 40 feet)

F. *Lithology*: Fossiliferous calcilutite and..36 feet
interbedded calcarenite with many scattered pink (orange-pink, 10YR 7/4) pelmatozoan plates. The background color of this rock ranges from an orange-pink (10R 8/2) to a yellowish-orange (10YR 8/6). Evenly bedded, beds up to a foot in thickness. HCl insoluble residue about 2%; washed residues mostly clear, subangular silt-size quartz fragments with some mica; arenaceous Foraminifera common in the residues; minor glauconite. Acetic acid residues with much pelmatozoan material, plus inarticulate brachiopods and conodonts. $MgCO_3$ content low, less than 1%. Two peels and one thin-section show this rock to be composed of well over 60% fossil debris, being a bioclastic calcilutite ranging into a bioclastic calcarenite; trilobite fragments are especially common.
Remarks: Unit well exposed in creek bed and on dip slope to the east. This is the type locality of the Clarita member (Amsden 1957, p. 19). Not all of the pink plates are clearly organic, but peels and thin sections show that many have the porous texture that is so characteristic of the Echinodermata (mostly crinoids).
Fossils: Rock richly fossiliferous but it is difficult to break out satisfactory specimens. A small fauna collected in situ from the lower 2 feet; this consists of some trilobites, snails and a few straight cephalopods; also a number of free specimens of a small brachiopod, *Lissatrypoidea?* sp.

Acetic acid residues carry a substantial microfauna of arenaceous Foraminifera, conodonts and inarticulate brachiopods.

E. *Lithology*: Fossiliferous calcilutite with many..3 feet
scattered pink pelmatozoan plates. Weathered color of rock grayish-orange (10YR 6/6), fresh surface yellowish-orange (10YR 8/6). Bedding even, up to 3 or 4 inches in thickness. Washed HCl residues largely clear, subangular, silt-size quartz fragments with some mica and glauconite; arenaceous Foraminifera abundant. Acetic acid residues with many conodonts, Foraminifera, ostracods and brachiopods.
Remarks: Unit differs from that above in its thinner bedding, more yellowish color and absence of calcarenite texture.
Fossils: The upper 6 inches of E is a trilobite coquina; the specimens are all disarticulated and only isolated pygidia and cranidia collected; probably a species of *Bumastus*. Acetic residues have a prolific microfauna (see above).

D. *Lithology*: Covered..1 foot
Remarks: This probably represents the basal, more argillaceous part of the Clarita.

COCHRANE MEMBER (total 19 feet)

C. *Lithology*: Gray (N7 to N8) to pale-orange,..19 feet (10YR 8/2) ranging into a pale-olive (10YR 6/2), calcarenite with many scattered grains of glauconite. Pelmatozoan plates are common and some have a distinct orange-pink color. Bedding irregular, commonly obscure, up to 6 or 8 inches. Two HC*l* insoluble residues, 1% and 3½%; washed residues mostly dark-green, rounded nodules of glauconite up to one mm or so in diameter; some of the glauconite in the form of steinkerns, filling ostracod and gastropod shells; some in the shape of sponges spicles, possibly representing replacement; HC1 residues also show some fragments of silicified fossils and a little clear, subangular silt-size quartz; no Foraminifera observed. Two peels made; these show a richly fossiliferous calcarenite, well over 60% of the rock being fossil material; many pelmatozoan plates. $MgCO_3$ content less than 2%.
Remarks: Rock carries some pink pelmatozoan plates like the Clarita, but differs in (1) abundant glauconite, and (2) irregular, thicker bedding. There is a small fault in this area but the section was measured so as to avoid this; however, there is some distortion in the beds and the thickness may be off a few feet.
Fossils: Rock highly fossiliferous, but it is difficult to extract satisfactory specimens. A small collection of trilobites, corals and straight cephalopods made, most fragmentary. Conodonts recovered from the acetic acid residues.

KEEL MEMBER (total 11 feet)

B. *Lithology*: Light-gray (N7) oolitic and pisolitic....................................11 feet limestone. Most of the oolites are less than a millimeter in diameter, but some range up to 3 mm. Two HC*l* insoluble residues prepared, 1% and 2½%; washed residues mostly a brown, earthy mineral, probably limonite; also some silicified fossil fragments. Peels show that the oolites are packed fairly close together (not all in contact)and embedded in a clear calcite ($MgCO_3$ content less than 1%); many of the oolites have a core commonly a recognizable fossil fragment; scattered through this rock are fossil fragments, commonly pelmatozoan plates, and all of these have at least a thin coating which resembles the oolitic material; as this coating gets thicker the outline of the fossil becomes obsecure and it assumes a spherical shape.
Remarks: Base of B not exposed so the thickness is not exact; however, the exposed beds probably represent nearly the complete thickness.
Fossils: None collected.

IDEAL QUARRY MEMBER (probable thickness, 3 to 4 feet)

A. *Lithology*: Yellowish-brown (10YR 5/4) to... light-brown (5YR 5/6) fossiliferous calcarenite; partly oolitic. Two HC1 residues made, 2% and 1½%; washed residues mostly fragments of silicified fossils. Acetic acid residues composed in large part of pelmatozoan plates, and this, plus the peel, shows the rock is dominantly fossil material, most of which is pelmatozoan debris. There is some glauconite but it is a small amount.
Remarks: Rock not exposed in place in the vicinity of section C1; however, many large blocks present at the base of the low bench formed by the outcrop of the Keel member and these indicate a thickness of 3 or 4 feet.
Fossils: Rock a bioclastic calarenite but matrix such that no specimens can be broken out.

Covered (probably SYLVAN SHALE)

STRATIGRAPHIC SECTION C2*

Northeast of Bromide

Section described and collected by T. W. Amsden and Styron Douthit, April, 17, 1957. Located at the south end of the outcrop belt that includes old Hunton townsite, about 1 mile northeast of Bromide; SW¼ NW¼ sec. 33, T. 1 S., R. 8 E., Coal County, Oklahoma (see pl. B, panel II).

Section covers that part of the Hunton from the base of the Chimneyhill up to the lower part of the Cravatt. Upper part of Bois d'Arc formation not described, but this formation is known to be directly in contact with the Woodford shale, there being no Frisco present in this area (see pl. B. panel II). No Keel or Ideal Quarry beds observed on this section but both members are known to be present in this general area. Clarita member present, but only 3 feet thick and unusually argillaceous; a short distance north of C1 this member is cut out under the Henryhouse unconformity, whereas a short distance to the south it thickens up to 10 feet or so and has the typical Clarita lithology (see pl. B, panel II, and section A-A, panel III). Past investigators have indicated that the Henryhouse was entirely absent in the Hunton belt extending from old Hunton townsite to Bromide (Reeds 1911, p. 261; Ham and Oakes 1944, p. 416-417), but on C1 there is approximately 9 feet of marlstone which carry a characteristic Henryhouse fauna; here, as in most other areas, there is no obvious physical evidence for an unconformity.

A summary of this section is given in Amsden 1958A, p. 26, 27; 1958B, p. 29). Analyses of rock samples given in section on CHEMICAL ANALYSES.

HUNTON GROUP

BOIS D'ARC FORMATION (upper part not measured: see above)

CRAVATT MEMBER: Yellowish gray, argillaceous calcilutite with many nodules of brown-weathering, porous chert. Two HC1 insoluble residues, 10.4%, and 7.4%. Lower part of member well exposed in the scarp face near the top of the Hunton ridge.

C2-K........40 feet (exposed to top of hill)

HARAGAN FORMATION: Yellowish gray, argillaceous calcilutite or marlstone, partly covered in the lower part; HC1 insoluble residues range from 8% to 15.8 %. This interval is fossiliferous and yields such characteristic Haragan fossils as *Levenea subcarinata pumilis, Orthostrophia strophomenoides parva, Meristella atoka*, and *Camarotoechia? haraganensis.*

	feet above base of formation
C2-J	56 to 61
I	39 to 56
H	24 to 39
G	4 to 24
F (partly covered)	0 to 4

HENRYHOUSE FORMATION: Yellowish-gray to grayish-yellow (5Y 7/2 to 5Y 8/4) marlstone; like beds above but somewhat more yellowish in color and with slightly higher clay content. Contact with overlying strata picked on a faunal basis, no physical evidence of an unconformity. HC1 insoluble residues range from 14.2% to 25%. A small but characteristic Henryhouse fauna collected including a few snails, horn corals and *Pleurodictyum* sp., one fragment of *Scyphocrinites* sp.; brachiopods as follows: *Dictyonella* sp., *Resserella brownsportensis, Rhipidomelloides henryhousensis, Merista* sp., *Coelospira saffordi*, and a number of specimens of *Lissatrypoidea concentrica.*

	feet above base of formation
C2-E	6 to 9 feet
D	0 to 6

CHIMNEYHILL FORMATION

CLARITA MEMBER: Yellowish-gray, argillaceous calcilutite; no pink pelmatozoan fragments observed HC1 insoluble residues range from 8.4% to 19.3% which is a higher insoluble content than normal for the Clarita; however, these beds can be traced laterally to the south a short distance where they grade into typical lithology (HC1 residues 3%); moreover, the acetic acid residues carry a prolific microfauna of arenaceous Foraminifera, conodonts, and inarticulate brachiopods which are characteristic for this member. The Clarita member disappears a short distance to the north of C1 (see discussion above and plate B. panel II).

feet above base of member

C1-C .... 2 to 4

C1-B (lower 1 foot covered) .... 0 to 2

COCHRANE MEMBER: Gray fossiliferous, glauconitic calcilutite and calcarenite with many nodules of virtreous, brown chert. Glauconite common, in rounded nodules up to 1 mm. Bedding irregular, up to 18 inches. Conodonts common in the acetic acid residues.

C1-A .... 6 feet

Covered (Keel and Ideal Quarry members known to be present in this area; see map, panel II).

COLLECTION C3

Southwest of Clarita

Collection made by T. W. Amsden and William Ventress, Feb. 28 1958. Collection made from the upper 2 inches of the Fittstown member, in a small gully, NE¼ NE¼ NE¼ sec. 16, T. 1 S., R. 8E., Coal County. The Frisco formation is exposed in place just above the Bois d'Arc (Amsden 1958B, p. 30).

FRISCO FORMATION: Gray to brownish-gray calcarenite in beds to a foot or so in thickness; weathering with a pitted or "pot-holed" surface. Megafossils rare.

BOIS D'ARC FORMATION

FITTSTOWN MEMBER: Gray, fossiliferous calcarenite with marlstone partings; beds to 5 or 6 inches. Collection C3 came from the upper 2 or 3 inches and included the following brachiopods: *Sphaerirhynchia lindenensis, Howellella cycloptera, Cyrtina dalmani? and Kozlowskiellina (M.) velata. Fossils* and matrix silicified.

STRATIGRAPHIC SECTIONS Ca1 and Ca1 (2)

Henryhouse Creek

Sections described and collected by T. W. Amsden. Nov. 15, 16, 17, 18, 1955. Both sections in the SE¼ sec. 30, T. 2 S., R. 1 E., Carter County, Okla. Chimneyhill formation measured in the bed of Henryhouse Creek where these limestones make a falls. Overlying strata measured in two sections: one of these, Ca1 (2), was measured in the bed of Henryhouse Creek, and the other, Ca1, on a glade exposure about 300 feet west of the creek. (The total marlstone section, Henryhouse-Haragan, measure 234 feet on the glade and 236 feet in the Creek bed). In the creek there are excellent exposures of relatively unweathered Hunton strata, but it is difficult to get fossils, whereas on the glade the rock is more deeply weathered, but yields more fossils. The creek exposures are especially important because they furnish a complete exposure across the Henryhouse-Haragan contact. Summary of these sections given in Amsden 1958A (p. 27) and 1958B (p. 30-31).

The strike of the beds ranges from 63 to 80 degrees (magnetic); dip varies from 22 to 28 degrees to the southeast.

Analyses of rock samples from these sections given in the section on CHEMICAL ANALYSES.

The distribution of $MgCO_3$ and HC1 insoluble residues is shown in figure 5.

SECTION Ca1 (2)
Bed of Henryhouse Creek

WOODFORD FORMATION (Shale exposed within 2 or 3 feet of the Hunton strata)

HUNTON GROUP (total 369 feet)

BOIS D'ARC FORMATION (total 91 feet)

FITTSTOWN MEMBER (total 18 feet)

V(2). *Lithology*: Gray, fossiliferous calcilutite .... 18 feet
and calcarenite with nodules of pale, bluish white vitreous chert. Three HC*l* insoluble residues, 3%, 3.3%, and 5.5%; most of the residue is light-colored silica, much of which appears to be partially silicified fossils. No microfossils observed in the HC*l* or acetic acid residues. Three peels made, showing the rock to be a bioclastic calcarenite and calcilutite; fossils set in a matrix of clear calcite ($MgCO_3$ content less than 1%); much of the fossil material consists of pelmatozoan plates; some evidence of recrystallization. Evenly bedded, beds up to a foot in thickness.
Remarks: Unit well exposed on the west side of Henryhouse Creek. It is exposed within two or three feet of the Woodford shale; no Frisco present.
Fossils: A moderate fauna collected in situ; this is a typical Helderbergian fauna. Large crinoid stems, commonly silicified, are numerous; also several pieces of dalmanitid and phacopid trilobites collected; brachiopods predominate, the following species collected: *Levenea subcarinata pumilis, Rhipidomelloides oblata, Strophеodonta (B.) gibbera, Leptaena* cf. *L. rhomboidalis, Sphaerirhynchia lindenensis, Camarotoechia?* sp., *Atrypa oklahomensis, Kozlowskiellina (M.) velata, Howellella cycloptera, Meristella atoka.*

CRAVATT MEMBER (total 73 feet including the transitional beds of U(2)

U(2). *Lithology*: Yellowish-gray (5Y 8/1) to pale .... 12 feet
orange (10YR 8/2) fossiliferous calcilutite and calcarenite with nodules and lenses of brown-weathering, vitreous to porous chert. Two HC*l* insoluble residues calculated, 15% and 18%; washed residues with much silt-sized quartz and some mica and glauconite; acetic residues with pelmatozoan plates, arenaceous Foraminifera rare. Peel shows the calcilutite lithology to be finely divided silt-size carbonate and detrital quartz with scattered fossils. Evenly bedded, beds to 1 foot.
Remarks: This interval well exposed in a scarp face on the west side of Henryhouse Creek. It is transitional between the cherty marlstones of S(2) and the more or less solid calcarenites of V(2); its reference to the Cravatt member is arbitrary.
Fossils: This rock is fossiliferous but no collection made due to the difficulty of collecting.

T(2). *Lithology*: Covered .... 21 feet
Remarks: There are a few scattered crops in this interval but these are below water level and not accessible.

S(2). *Lithology*: Grayish-yellow (5Y 8/4) to .... 40 feet
yellowish gray (5Y 7/2) argillaceous calcilutite (marlstone) with nodules of brown-weathering, vitreous to porous chert. Two HC*l* insoluble residues, 14% and 8.7%; washed residues with much finely divided, porous silica. The $MgCo_3$ content is up slightly from that of the overlying beds, being around 3%. Peel shows this rock to be finely divided (silt and smaller) carbonate and insolubles with scattered fossils. Beds up to 8 inches.
Remarks: Well exposed on the east side of Henryhouse Creek. Upper contact covered and lower contact placed at the lowest chert bed; other than chert S(2) is like R(2).

Fossils: Fossiliferous, brachiopods most common, some snails and trilobites. Fauna Helderbergian and includes the following brachiopods: *Orthostrophia strophomenoides parva, Rhipidomelloides oblata, Isorthis pygmaea, Schellwienella marcidula, Coelospira virginia, Kozlowskiellina (M.) velata, Meristella atoka.*

HARAGAN FORMATION (total 50 feet, including all of P(2))

R(2). *Lithology*: Yellowish-gray (5Y 7/2) to 5Y 8/4) .... 18 feet fossiliferous argillaceous and silty calcilutite or marlstone. Two HC*l* insoluble residues, 14% and 7%; washed residues mostly mica and a few arenaceous Foraminifera. Peel shows the rock to be finely divided carbonate and insoluble detritus with scattered fossils. 3.4% $MgCO_3$. Beds to 3 inches.

Remarks: Well exposed on the east side of Henryhouse Creek; upper contact marked by appearance of chert, lower contact gradational, largely arbitrary.

Fossils: This unit is fossiliferous and carries a typical Helderbergian fauna: *Discoelosia varica, Rhipidomelloides oblata?, Isorthis pygmaea, Levenea subcarinata pumilis, Atrypina hami, Camarotoechia? haraganensis, Meristella atoka, Favosites* cf. *F. conicus*

Q(2). Lithology: Greenish-yellow (10Y 8/2 to .... 19 feet 10Y 6/2) fossiliferous marlstone. Two HC*l* insoluble residues, 16% and 22%; washed residues mostly silt-size quartz with some mica, rare arenaceous Foraminifera. Acetic acid residues with a few pelmatozoan plates. One peel, show rock to be mostly finely divided carbonate and insoluble detritus (well below 1/16 mm) with numerous scattered fossils. Bedding up to 3 or 4 inches.

Remarks: Upper lower contacts gradational. Well exposed on east bank of Henryhouse Creek.

Fossils: Only a few fossils collected in situ: *Levenea* sp., *Rhipidomelloides* sp. and a conularid. The *Levenea* is a typical specimen representative of this genus and is certainly Haragan.

P(2). *Lithology*: Greenish-yellow (10Y 8/2 to .... 13 feet 10Y 6/2) fossiliferous marlstone. Two HC1 insoluble residues, 30% and 24%; washed residues largely silt-size clear, subangular quartz with some mica. Acetic acid and HC1 acid residues appear to be barren of fossils. Peel shows the rock to be finely divided carbonate and insoluble debris (well below 1/16 mm) with fossils scattered more or less at random. Bedding nodular, up to 3 inches.

Remarks: Haragan fossils collected from the upper part of P(2) and from Q(2), and Henryhouse fossils collected from the upper foot or so of O(2). Henryhouse-Haragan contact must therefore be located in the lower part of P(2), or at its base. These strata are completely exposed on the east bank of Henryhouse Creek so the contact must be visible, but there is no field evidence of any kind for a physical break. Moreover, none of the peels or insoluble residues gives any indication of a litholgic break.

Fossils: Two specimens of *Orthostrophia* sp., one *Rhipidomelloides* sp., and a *Leptaena* collected in situ 10 feet above the base. The orthostrophias are certainly Haragan and therefore the Haragan-Henryhouse contact must be below this point (and above O(2)).

HENRYHOUSE FORMATION (total 186 feet)

O(2). *Lithology*: Greenish-gray (19Y 6/2) .... 32 feet fossiliferous, marlstone. Three HC1 insoluble residues calculated, 9.7%, 15.5% and 20.5%; washed residues mostly silt-size quartz with some mica. No arenaceous Foraminifera observed in the HC1 or the acetic acid residues.

Remarks: Completely exposed on the east bank of the Creek. Henryhouse fossils collected in situ from the upper foot so all of O(2) is Silurian; see under P(2) for a discussion of the Henryhouse-Haragan contact.

Fossils: A dalmanitid pygidium and the following brachiopods collected from the upper foot of O(2): *Atrypa tennesseensis, Lissatrypoidea henryhousensis, Merista oklahomensis, Sieberella roemeri?*

N(2). *Lithology*: Mottled red (10R 5/4 to 10R 4/2) to yellowish-gray (5Y 7/2 to 10Y 8/2) marlstone. Two HC1 insoluble residues, 23.5% and 20%; washed residues silt size, quartz with some mica; no arenaceous Foraminfera observed in either the HC*l* or the acetic acid residues. Peel shows the rock to be largely finely-divided carbonate and insoluble debris (below 1/16 mm) with a few fossils. .....5 feet

Remarks: Exposed on the east bank of the creek; separated from O(2) because of its red color.

Fossils: Some fossils but no collection made here or in the underlying units. This part of the Henryhouse collected on the glade section, Ca1.

M(2). *Lithology*: Covered .....35 feet

L(2). *Lithology*: Partly covered. Scattered outcrops of mottled red and greenish-gray marlstone like K(2). Two HC1 insoluble residues, 23% and 19½%; washed residues like those from N(2) although they might be slightly finer. .....13 feet

Remarks: About 50% exposed on the east bank; separated from K(2) because it is partly covered.

K(2) *Lithology*: Mottled red (10R 5/4) to yellowish- or greenish-gray (5Y 7/2 to 10Y 5/4) marlstone. HC1 insoluble residues, 24% and 22.7%; washed residues largely silt-size, clear subangular quartz with some mica; no Foraminifera observed in the HC*l* or the acetic acid residues. Bedding nodular, up to 2 or 3 inches. Peels show a substantial amount of fossil material more or less randomly distributed through the finely-divided carbonate and insoluble debris. .....18 feet

Remarks: Completely exposed along the east bank. Separated from J(2) because of its red mottling.

Fossils: No collection made; see Ca1.

J(2). *Lithology*: Yellowish-gray to greenish-gray (5Y 7/2) marlstone. Two HC1 insoluble residues, 16% and 24%: washed residues like K(2); no acetic residues prepared. Bedding nodular, up to 3 inches. .....6 feet

Remarks: Completely exposed in the bed and on the east bank of Henryhouse Creek. It is essentially the same as the beds above and below; differs from K(2) in its lack of red color and from I(2) in being slightly thinner bedded.

Fossils: No collection made; see Ca1.

I(2). *Lithology*: Yellowish- to greenish-gray (5Y 7/2 to 10Y 6/2) marlstone. Three HC1 insoluble residues, 31½, 35% and 30%; washed residues mostly silt-size quartz with some mica; no Foraminifera observed in the HC1 or the acetic acid residues. Peels show a few fossils randomly distributed through a finely divided matrix (grain-size below 1/16 mm). .....8 feet

Remarks: Completely exposed in the bed and on the east bank of the creek.

Fossils: No colection made; see Ca1.

H(2). *Lithology*: Covered .....4 feet

G(2). *Lithology*: Yellowish-gray (5Y 6/4 to 5Y 7/2) marlstone. Three HC1 insoluble residues, 13.4%, 12% and 24%: washed residues mostly silt-size quartz and mica. No Foraminifera observed in either the acetic or HC*l* residues. Peel shows the rock to contain a few scattered fossils set in a finely divided matrix; grain size of the matrix well below 1/16 mm. Bedding nodular, up to 6 inches. .....3 feet

Remarks: Exposed on the east bank of Henryhouse Creek. This is the lowest exposure of Henryhouse on the creek, the interval between G(2) and the Chimneyhill being completely covered.
Fossils: No fossils collected. See Cal.

F(2). *Lithology*: Covered.......62 feet

CHIMNEYHILL FORMATION (42 feet exposed)
CLARITA MEMBER (total 13 feet)

E. *Lithology*: Yellowish-gray (5Y 7/2) to.......12 feet
pale-olive (10Y 6/2) bioclastic calcilutite with sparse, pink pelmatozoan plates; pelmatozoan plates some shade of orange-pink (5YR 8/4 to 5YR 7/2). Four HCl insoluble residues calculated, 3%, 3.8%, 4.5% and 11%; residues all in the silt and finer size; washed residues largely clear, subangular, silt-size quartz; arenaceous Foraminifera abundant. Acetic acid residues with many Foraminifera, conodonts, inarticulate brachiopods and a few pelmatozoan plates. Peels show this rock to be a bioclastic calcilutite (locally grading into a fine calcarenite), well over 50% of the rock being fossil debris; some of this fossil material is pelmatozoan plates, but also much trilobite and brachiopod material. Evenly bedded, beds up to a foot in thickness.
Remarks: This unit completely exposed in the bed of Henryhouse Creek. It can be traced to the west until it is in contact with the lowermost Henryhouse on the glade exposure, Cal. The uppermost beds of the Clarita have some resemblance to the lower Henryhouse (some pink pelmatozoan plates can be found in this formation), but lithologically the Clarita differs in: (1) higher fossil content, the Clarita being a bioclastic limestone whereas the Henryhouse is a marlstone with fossils scattered through it; (2) lower HCl insoluble residue content; the maximum Clarita is 11% and the average is much lower whereas the average Henryhouse insoluble content is around 20% (fig. 5); (3) the HC*l* and acetic acid insolubles of the Clarita yield a prolific microfauna whereas the Henryhouse residues carry only a sparse fauna. For a comparison of the Clarita and Cochrane members see below.
Fossils: This rock is too dense to break specimens out. A rich microgauna can be obtained from the acetic and HC*l* residues.

D. *Lithology*: Covered.......1 foot
Remarks: This probably represents the basal, more argillaceous part of the Clarita.

COCHRANE MEMBER (total 28 feet)

C. *Lithology*: Gray, bioclastic calcarenite with.......7 feet
scattered glauconite and pink pelmatazoan plates. The color, fresh surface, ranges from a light-gray (N7) to a pinkish-gray (5YR 8/1) or a yellowish-gray (5Y 8/1); the pelmatozoan plates are commonly some shade of orange-pink (5YR 8/4 to 5YR 7/2). Peels show this rock is composed of well over 50% fossil material; the grain-size is highly variable, the average estimated to be between 0.5 and 1 mm in diameter, but there are many larger fossils present; locally it grades into a bioclastic calcirudite. Three HC*l* insoluble residues, 1.2% 1.5%, and 2.5%; washed residues largely glauconite up to 2 mm in diameter; much of the glauconite is in rounded nodules, but some is present as the filling of fossil shells such as snails, ostracods and others; residues also contain some light spongy silica, probably in part fragments of silicified fossils; also some silt-size clear quartz. Acetic acid residues with much pelmatozoan material and conodonts. Bedding irregular, in beds up to 2 feet thick.

Remarks: Completely exposed in the bed of Henryhouse Creek. Resembles the Clarita in the presence of pink-pelmatozoan plates. It differs in (1) abundant glauconite, (2) thicker and more irregular bedding, (3) coarser texture, C being a calcarenite, (4) reduced insoluble content, this being especially apparent if the glauconite is removed (fig. 5).

Fossils: No satisfactory megafossils collected. Conodonts are present in the acetic residues.

B. *Lithology*: Gray, bioclastic calcarenite with..21 feet scattered grains of glauconite. Most of this rock composed of fossil material so the grain size is highly variable, but typically it is within the calcarenite range, locally grading into a calcirudlite. Two HC*l* insoluble residues prepared, 1% and 2%; much of the insoluble material is glauconite in rounded nodules, or as the filling (or perhaps replacement) of shells; a little silt-size, subangular to subrounded, clear quartz. No arenaceous Faraminifera observed in either the HC1 or the acetic residues, but the latter have conodonts. Peels show the rock to be dominantly fossil material, pelmatozoan plates being especially abundant. Beds to 2 feet.

Remarks: Completely exposed in the bed of Henryhouse Creek. B is lithologically like C except for the pink pelmatozoan plates; unit B contains abundant pelmatozoan plates but only rarely do these show a pink cast.

Fossils: Abundantly fossiliferous but it is difficult to break out satisfactory specimens. One small lens of more friable calcarenite was found 8 feet above the base and from this a small fauna was collected. This fauna consists of a number of brachiopods, a trilobite and a few snails. The brachiopods all appear to represent a single species; a preliminary check indicates it is a ***Triplesia*** that is similar to, perhaps identical with, *T. alata* Ulrich and Cooper from the Brassfield of Arkansas.

Acetic acid residues carry conodonts.

KEEL MEMBER (1 foot exposed)

A. *Lithology*: Yellowish-brown (10YR 5/4)..1 foot fossiliferous oolite. Two HC1 insoluble residues prepared, 2% and 2.5%; washed residues mostly a fine aggregate of limonite(?) or iron-stained clay; small amount of silt-size, clear quartz and glauconite. Peel shows this rock to be composed largely of oolites and fossil material; some of the oolites range up to a millimeter in diameter and are well formed, being almost circular in cross section; others are much more irregular in cross section, with some being conspicuously elongate; most show a central core, commonly a fossil fragment, and it is this feature that produces the irregularity in shape; where the fossil is elongate, and the "oolitic" coating thin, the oolite is elongate. As the coating gets thicker the shape becomes more and more nearly spherical; the matrix binding the fossils and oolites together appears to be clear calcite.

Remarks: Only a foot of this rock is exposed at the upper rim of the falls across Henryhouse Creek. This unit has the brown color of the Ideal Quarry member, but it has more oolitic material than is common in that member.

Fossils: No collection made. No conodonts or Foraminifera observed in the acetic or HC1 residues.

Covered.

STRATIGRAPHIC SECTION Cal

Henryhouse Creek (glate section; see p.)

BOIS D'ARC FORMATION (a completed section described under Cal(2))

CRAVATT MEMBER

X. *Lithology*: Yellowish-gray (5Y 8/4 to 5Y 7/2) .... fossiliferous marlstone with nodules of brown-weathering, porous chert. Peel shows this rock to be finely divided (below 1/16 mm) carbonate and insoluble debris with fossils fairly abundant, commonly oriented with their long dimension in the bedding plane. No acetic or HC1 residues prepared. Chert mostly tripolitic, rarely becoming vitreous. Bedding slightly nodular, up to 6 inches.
Remarks: This interval is about 80% exposed; it caps the Hunton ridge on the west side of the Creek; about 25 feet exposed in the scarp face, the rest of the formation being exposed on the dip slop; this was not measured on Cal as the same beds are almost completely exposed in the creek; see Cal(2). The base of X (base of the Bois d'Arc formation) is 234 feet above the top of the Chimneyhill formation; this same interval measures 236 feet in the Creek Cal(2).
Fossils: This unit is fossiliferous, carrying a typical Helderbergian fauna. The following brachiopods collected: *Levenea subcarinata pumilis, Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptaena* cf. *L. rhomboidalis, Camarotoechia? haraganensis, Kozlowskiellina (M.) velata, Meristella* sp. 2.

HARAGAN FORMATION (30 feet plus)

W. *Lithology*: Yellowish-gray (5Y 8/4 to 5Y 8/1) .... 30 feet
marlstone. One peel shows the typical marlstone lithology. the grain size of the matrix being well below 1/16 mm; fossils common, scattered through the matrix. No chert observed.
Remarks: About 50% of this interval is exposed. Differs from the overlying beds in its lack of chert; lacks the pink mottling of the underlying strata.
Fossils: A typical Haragan fauna collected from the surface, including such brachiopods as *Levenea subcarinata pumilis, Meristella atoka*, and *Phacops* sp. No Henryhouse fossils observed.

HARAGAN and/or HENRYHOUSE FORMATION

V. *Lithology*: Yellowish-gray, fossiliferous .... 21 feet
marlstone. Bedding nodular, up to 2 or 3 inches.
Remarks: Lithologically similar to the beds above and below, separated mainly for collecting. No fossils found in V; typical Henryhouse fauna collected from U and a typical Haragan fauna from W, the contact falling some place in between. The Haragan formation is much better defined on section Cal(2).

HENRYHOUSE FORMATION (total 183 feet, excluding V)

U. *Lithology*: Yellowish-gray (5Y 7/2 to 10Y 8/2) .... 35 feet
mottled with pink (10R 6/2 to 10YR 7/2) marlstone. Bedding to 2 or 3 inches.
Remarks: This interval similar to the beds above and below from which it was separated for collecting. This unit is excellent to show lateral color variation, the yellowish-gray beds grading laterally into shades of red and vice versa.
Fossils: A small fauna collected loose of the surface, all typical for the Henryhouse. Brachiopods predominate but there are a few trilobites, bryozoans, horn corals and crinoid fragments. The following brachiopods collected: *Atrypa tennesseensis?, Leptaena oklahomensis, Lissatrypoidea concentrica, Merista oklahomensis, Rhipidomelloides henryhousensis?, Sieberella roemeri?, Strophonella laxiplicata.*

T. *Lithology*: Greenish-gray to yellowish-gray marlstone mottled with red. Beds to 6 or 8 inches. ....24 feet
Remarks: Fairly well exposed, making a small ledge on the hill side, like the beds above and below, being separated primarily for collecting.
Fossils: Sparing fossiliferous, the following brachiopods being the only specimens collected: *Atrypa tennesseensis, Merista* sp., *Sieberella roemeri.*

S. *Lithology*: Partly covered. Scattered ledges of yellowish-gray marlstone. Lacks the red mottling of the beds above and below but is otherwise similar. ....12 feet
Remarks: About 60% exposed.
Fossils: Sparingly fossiliferous; one *Eophacops* sp., *Favosites* cf. *F. louisvillensis*, and a few horn corals collected, plus the following brachiopods: *Dicoelosia oklahomensis, Lissatrypoidea concentrica, Merista oklahomensis.*

R. *Lithology*: Mottled red and yellowish-gray marlstone. Beds to 4 inches. ....4 feet
Remarks: Completely exposed: separated from the strata above and below because it lacks the red color.
Fossils: No collection made.

Q. Lithology: Yellowish-gray, fossiliferous marlstone with faint red mottling. ....26 feet
Remarks: Dirt road crosses the lower part of this interval. Like the beds above and below except Q has much fainter red mottling.
Fossils: A fairly large Henryhouse fauna collected. Mostly brachiopods, but excellent specimens of *Calymene* sp. and *Eophacops* sp. found, plus several corals. Brachiopods as follows: *Atrypa tennesseensis, Dicoelosia oklahomensis, Leptaenisca irregularis, Leptaena oklahomensis, Lissatrypoidea concentrica, Merista oklamensis, Nanospira parvula, Resserella brownsportensis, Sieberella* sp.

P. *Lithology*: Red (10R 5/4) marlstone ....3 feet
Remarks: This bed separated because of its solid red color.
Fossils: No collection made.

O. *Lithology*: Yellowish-gray, fossiliferous marlstone. ....6 feet
Remarks: Like beds above and below except for its red color.
Fossils: A few horn corals and the following brachiopods collected: *Atrypa tennesseensis, Dictyonella* sp., *Nanospira parvula, Rhipidomelloides* sp., *Sieberella* sp.

N. *Lithology*: Mottled red (10R 5/4) and yellowish-gray (5Y 7/2) marlstone. ....2 feet
Fossils: No collection made.

M. *Lithology*: Partly covered. Few outcrops of yellowish-gray marlstone. One HC1 insoluble residue, 15.6%; $MgCO_3$ content low, less than 1%. ....28 feet
Remarks: About 70% of this interval is exposed. It lacks the red color of N; like L from which it was separated for collecting.
Fossils: A moderately large Henryhouse fauna collected; includes a few corals, bryozoans, trilobites (*Eophacops* sp.) and snails, plus the following brachiopods: *Atrypa tennesseensis, Dicoelosia oklahomensis, Isorthis arcuaria, Leptaena oklahomensis, Lissatrypoidea concentrica, Nanospira parvula, Nucleospira raritas, Resserella brownsportensis, Pseudodicoelosia oklahomensis, Strophonella laxiplicata, Sieberella* sp.

L. *Lithology*: Yellowish-gray marlstone. HC*l* insoluble residue, 32.5%; $MgCO_3$, 1.5%. ....13 feet
Fossils: No collection made.

K. *Lithology*: Yellowish-gray marlstone. HC*l* insoluble residue, 29.3%; $MgCO_3$, 1.6%. ....9 feet

Remarks: K is separated from L because it makes a small bench; from J because it lacks the red color.
Fossils: Small collection made; 4 specimens of horn corals, one fragment of a straight cephalopod and 8 specimens of *Lissatrypoidea concentrica*.

J. *Lithology*: Mottled red (10R 5/4) and yellowish-gray (5Y 7/2) marlstone. HC*l* insoluble residue, 30.7%; $MgCO_3$ 0.7%. ....1 foot
Fossils: No collection made.

L. *Lithology*: Yellowish-gray marlstone. HC*l* insoluble residue 49.3%; $MgCO_3$, 0.9%. ....5 feet
Remarks: The specimen tested for HC1 insoluble residues yielded an unusually high percent, 49.3%; however, this specimen, as well as all those from Ca1 are from a weathered glade exposure and may have undergone some leaching.
Fossils: One specimen of *Lissatrypoidea* collected.

H. *Lithology*: Red (10R 5/4) marlstone. HC*l* insoluble residue, 40.3%; $MgCO_3$, 0.7%. ....2 feet
Remarks: This is the lowest red bed observed on Ca1.
Fossils: None collected.

G. *Lithology*: Covered....5 feet

F. *Lithology*: Partly covered. Exposures of yellowish-gray marlstone, HC*l* insoluble residue, 36%; washed residues largely silt-size, clear, subangular quartz with some mica. No arenaceous Foraminifera or conodonts observed in the HC1 or acetic acid residues. Peel shows a finely-divided matrix (below 1/16 mm) with fossils scattered more or less at random. ....8 feet
Remarks: About 20 percent of this interval is covered, but its lower contact with the Chimneyhill is exposed. For a comparison of the Henryhouse-Clarita lithology see under Ca1(2)-E.

F. *Fossils*: Sparingly fossiliferous, but the few fossils collected appear to be typical Henryhouse species. Few horn corals and a fragment of a trilobite collected. Also the following brachiopods: *Coelospira saffordi*, *Merista* sp.

CHIMNEYHILL FORMATION

CLARITA MEMBER (see under Ca1(2)-E)

STRATIGRAPHIC SECTION Ca2*

Tulip Creek

Section described by T. W. Amsden, May 9, 1957. About 100 feet west of Tulip Creek, NW¼ SE¼ sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma. Strike of the beds about 110 degrees (magnetic), dipping 45 degrees to the SW. Analyses of the rock from this section given in the section on CHEMICAL ANALYSES. (See Amsden 1958A, p. 28).

WOODFORD FORMATION (basal 3 or 4 inches is a cherty conglomerate; above this is typical Woodford shale)

HUNTON GROUP (total 202 feet)

BOIS D'ARC FORMATION (total 2 feet)

CRAVATT MEMBER. Yellowish-gray, fossiliferous argillaceous calcilutite with nodules of brown-weathering, porous chert.
Ca2-Q....2 feet

HARAGAN FORMATION: Yellowish-gray fossiliferous marlstone in beds to 3 or 4 inches. The following fossils collected from units Ca2-O and Ca2-P: *Levenea subcarinata pumilis*, *Meristella atoka*, *Rhynchospirina maxwelli*, *Phacops* sp.

	feet above base of formation
Ca2-P	10 to 22
Ca2-O	0 to 10

HENRYHOUSE FORMATION: Yellowish-gray marlstone like above; few beds with a red mottling. The following fossils collected from units Ca2-J to N inclusive: *Anastrophia delicata, Atrypa tennesseensis, Coelospira saffordi, Delthyris kozlowskii, Dicoelosia oklahomensis, Isorthis arcuaria, Lissostrophia (L.) cooperi, Merista oklahomensis, Nanospira parvula, Resserella brownsportensis, Sieberella roemeri, Strophonella prolongata, Stropheodonta (Brachyprion) attenuata; Pleurodictyum tennesseensis*?, plus horn corals and a few Bryozoa; *Pisocrinus* sp. and a fragment of the cup of *Scyphocrinites.*

	feet above base of formation
Ca2-N	138 to 151
M	122 to 138
L	113 to 122
K	97 to 113
J	88 to 97
I	86 to 88
H	81 to 86
G	78 to 81
F (covered)	0 to 78

CHIMNEYHILL FORMATION (total thickness 26 feet)

CLARITA MEMBER: Gray to yellowish-gray, fossiliferous calcilutite with many pink pelmatozoan plates. Evenly bedded in beds to 6 inches. Acetic acid residues carry a large microfauna of arenaceous Foraminifera and conodonts. This member becomes somewhat argillaceous in the upper few feet.

	feet above base of formation
Ca2-E	6 to 10
Ca-D	1 to 6
Ca-C (covered)	0 to 1

COCHRANE MEMBER: Gray limestone with rounded nodules of glauconite. Most of this rock is a calcarenite texture, but a few beds of calcilutite are present. Glauconite content variable, common in some beds, rare in others. Stylolite seams marked with red. Bedding irregular, up to 3 feet in thickness.

Ca2-B .... 14 feet

IDEAL QUARRY MEMBER: Brown, fossiliferous calcarenite; somewhat argillaceous, with an insoluble content of about 10%. Peel shows this rock to be largely fossil debris, much being in the form of pelmatozoan plates; few oolites present. Mostly a calcarenite texture, but some calcilutite present. No Keel observed in this area.

Ca2-A .... 2 feet

Covered (probably SYLVAN SHALE)

STRATIGRAPHIC SECTION Ca3

Northeastern Carter County

Section described by T. W. Amsden, May 15, 1957. About 2 miles west of Oklahoma Highway 18, in northeastern Carter County, just south of the Murray County line; NE¼ NW¼ sec. 4, T. 3 S., R. 3 E. (fig. 44). The strike of the beds is 110 degrees (magnetic), dipping 70 degrees to the southeast.

Analysis of the rocks from this section given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION

(exposed in contact with the Henryhouse)

HUNTON GROUP (total 83 feet)

HENRYHOUSE FORMATION (total 63 feet)

H. *Lithology*: Yellowish-gray marlstone. One HCl .... 26 feet insoluble residue tested 22.6%. Beds to 4 inches, nodular. $MgCO_3$ content low, one sample testing about 1%.

Remarks: Completely exposed, including the upper Woodford contact. Typical Hunton marlstone and since Henryhouse fossils were collected from near the top it is all assigned to the Henryhouse.

Fossils: Six specimens of *Lissatrypoidea concentrica* were collected from this interval.

G. *Lithology*: Partly covered; scattered crops of....................................32 feet rocks like those above and below, except for higher dolomitic content; one specimen with 10.4% $MgCO_3$.

Remarks: Consists of typical Hunton marlstone and separated from the unit above and below only because it is partly covered. No fossil collected.

F. *Lithology*: Yellowish-gray marlstone..5 feet HC*l* insolubles high, one sample yielding 42.6%; the dolomite content is low, less than 1% $MgCO_3$.

Remarks: Typical marlstone with Henryhouse fossils.

Fossils: Several specimens of *Lissatrypoidea concentrica* collected from this interval.

CHIMNEYHILL FORMATION (total thickness 20 feet; all members present)

CLARITA MEMBER (total 12 feet)

E. *Lithology*: Highly fossiliferous calcilutite..5 feet with some argillaceous material dispersed through it. One rock specimen with 11.5% HC*l* residue. Evenly-bedded, in beds to 6 or 8 inches.

Remarks: Rock has a somewhat higher insoluble content and lacks the pink pelmatozoan plates of typical Clarita lithology. It has, however, the bedding character of this member, and the acetic acid residues yield the characteristic Clarita microfauna.

Fossils: Richly fossiliferous but no megafossils collected owing to the difficulty of breaking them out. The residues from acetic acid yield a large microfauna of conodonts, arenaceous Foraminifera and inarticulate brachiopods; appears to be a typical Clarita microfauna.

D. *Lithology*: Gray, highly fossiliferous calcilutite....................................6 feet with many pink pelmatozoan plates. Bedding even, up to 6 inches in thickness.

Remarks: Typical Clarita lithology. Argillaceous content reduced from that of E, one specimen with 3.2% HC*l* residues.

Fossils: None collected and no acetic residues prepared.

C. *Lithology*: Covered..1 foot

Remarks: Probably represents the lower, shaly portion of the Clarita.

COCHRANE MEMBER (total thickness 5 feet)

B. *Lithology*: Gray, glauconitic calcarenite with..5 feet nodules of gray to pinkish-gray, vitreous chert. Bedding irregular, obscure. HC*l* residue, 5.5%.

Remarks: Typical Cochrane lithology, including the presence of chert. Acetic acid residues yield Cochrane type conodonts.

Fossils: No megafossils collected. A few conodonts obtained from acetic acid residues.

KEEL AND IDEAL QUARRY MEMBERS (total 3 feet)

A. *Lithology*: Brown, crinoidal limestone with...3 feet some oolites present. Upper few inches lighter-colored and strongly oolitic. HC*l* insoluble residues, 3.4%.

Remarks: This unit represents the Keel and Ideal Quarry members undifferentiated. It has the color and composition of the Ideal Quarry, but has more oolites than is common in that member; the upper few inches becomes strongly oolitic and grades into typical Keel lithology.

Covered (soil appears to be weathered SYLVAN SHALE).

STRATIGRAPHIC SECTION Ca4

Northeastern Carter County

Section described by T. W. Amsden, May 15, 1957. About 1½ miles west of Oklahoma Highway 18, and ¼ mile north of the Washita River; NE¼ SE¼ sec. 4, T. 3 S., R. 3 E., Carter County (fig. 44). This section measured in a gully which cuts across the Hunton ridge. Strike of the beds 120 degrees (magnetic), dipping 50 degrees to the SW.

Analyses of some of the rocks from this section given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION

(exposed within a foot or so of the Henryhouse beds)

HUNTON GROUP (total 32 feet)

HENRYHOUSE FORMATION (total 14 feet)

C. *Lithology*: Partly covered; scattered crops of..14 feet
yellowish-gray marlstone. HC*l* insoluble residue about 35%, $MgCO_3$, 24%.
Remarks: Except for the high dolomitic character this rock is typical Hunton marlstone. One specimen of *Lissatrypoidea concentrica* found near the top of C, thus it is all Henryhouse.

CHIMNEYHILL FORMATION (total 18 feet, no Keel or Ideal Quarry members observed).

CLARITA MEMBER (total 5 feet)

B. *Lithology*: Gray, highly fossiliferous calcilutite..4 feet
with rare pink pelmatozoan plates. Bedding even, up to 6 inches. Peel shows this rock to be composed primarily of fossil material, a bioclastic calcilutite ranging into a calcarenite; the fossil debris shows only slight orientation. This rock has a low insoluble content, about 98% being $CaCO_3$.
Remarks: Typical Clarita lithology. No acetic acid residues prepared.

Covered..1 foot
Remarks: Probably represents the basal, shaly part of the Clarita.

COCHRANE MEMBER (total 13 feet)

A. *Lithology*: Gray, fossiliferous calcarenite with....................................13 feet
scattered grains of glauconite. No chert observed.
Remarks: This interval is typical Cochrane lithology, including the irregular, obscure bedding. The Chimneyhill was measured along a gully, and a fault appears to be present in the bottom of this gully; the section was measured on the west side of the fault, and the thickness obtained for the Cochrane and Clarita is believed to be approximately correct.

Covered (neither Keel nor Ideal Quarry members observed here, but they are present at Ca3, a short distance to the northwest).

STRATIGRAPHIC SECTION Ca5*

East of Cool Creek

Section described by T. W. Amsden, Oct. 29, 1957. About ¼ mile east of Cool Creek, NE¼ NE¼ sec. 1, T. 3 S., R. 2 E.; a very short distance south of the section line, Carter County, Oklahoma. Strike of the beds is 125 degrees (magnetic), dip approximately vertical.

WOODFORD FORMATION (exposed in contact with the Henryhouse; no chert or conglomerate in the basal part)

HUNTON GROUP (total 43 feet)

HENRYHOUSE FORMATION: yellowish-gray marlstone. Several specimens of *Lissatrypoidea concentrica* collected from this interval, including some from the upper few feet.
Ca5-E .... 28 feet

CHIMNEYHILL FORMATION (total 15 feet)

CLARITA MEMBER: Gray, fossiliferous calcilutite with rare pink pelmatozoan plates; evenly bedded, beds to 6 or 8 inches. The upper 2 feet (D) with a yellowish cast and a somewhat higher clay content.

feet above base of formation

Ca5-D .... 10 to 12

Ca5-C .... 0 to 10

COCHRANE MEMBER: Gray, fossiliferous calcarenite with scattered grains of glauconite.

Ca5-B .... 2 feet

KEEL MEMBER: Pale-gray, fossiliferous oolite; oolites mostly less than 1 mm in diameter. The base of A is covered; the soil appears to be Sylvan type and since no Ideal Quarry float observed it is probable that this member is absent.

Ca5-A .... 1 foot

Covered (weathered Sylvan?)

STRATIGRAPHIC SECTION Ca6

West of Cool Creek

Section described by T. W. Amsden, Oct. 30, 1957. It is located about 1,000 feet west of Cool Creek, SE¼ SE¼ sec. 35, T. 2 S., R. 2 E., Carter County, Okla. The strike of the beds is 120 degrees (magnetic), dip approximately vertical.

WOODFORD FORMATION (exposed within a foot of the Henryhouse formation)

HUNTON GROUP (total 56 feet)

HENRYHOUSE FORMATION (total, 40 feet)

C. *Lithology*: Yellowish-gray marlstone which is mottled with red in a few places. ....40 feet

Remarks: No fossils collected from unit C, but Henryhouse fossils are known to range throughout the marlstone at section Ca5, about ¾ mile east of Ca6. Unit C is exposed almost in contact with the Woodford; no conglomerate or chert seen near the contact.

CHIMNEYHILL FORMATION (total exposed, 16 feet)

CLARITA MEMBER (total, 12 feet)

B. *Lithology*: Gray, fossiliferous calcilutite with scattered pink pelmatozoan plates; locally mottled with pale red (10R 6/2). Peel of the red facies shows the typical fine-grained, highly fossiliferous calcilutite; an acetic acid residue of this red rock yields the characteristic Clarita microfauna of conodonts, and Foraminifera. ....12 feet

Remarks: Excluding the beds mottled with red, this is the typical calcilutite facies.

COCHRANE MEMBER (4 feet exposed)

A. *Lithology*: Light-gray, fossiliferous calcarenite with scattered grains of glauconite. ....4 feet

Remarks: No Keel or Ideal Quarry lithology exposed, but they are known to be present at Ca5 and are probably here, but covered.

Covered.

STRATIGRAPHIC SECTION Ca7

West of Washita River

Section described by T. W. Amsden, Oct. 30, 1957. About ¼ mile west of the Washita River, SE¼ SE¼ sec. 36, T. 2 S., R. 2 E., Carter County, Okla. The strike of the bedding is 35 degrees (magnetic), dip approximately vertical.

This section is of special interest because it is one of the few places where the Henryhouse rests directly on Cochrane, there being no Clarita present.

WOODFORD FORMATION (exposed within a foot of the Henryhouse formation)

HUNTON GROUP (total 43 feet)

HENRYHOUSE FORMATION (total 30 feet)

C. *Lithology*: Yellowish-gray marlstone. Washed HCl residues consist largely of silt-size, clear, subangular quartz with some mica. ....30 feet
Remarks: No fossils collected from unit C but it is almost certainly all Henryhouse as the marlstone beds at Ca5, about a half mile west of Ca7, carry a Henryhouse fauna.
Fossils: None collected.

CHIMNEYHILL FORMATION (total 13 feet with no Clarita member)

COCHRANE MEMBER (total 11 feet)

B. *Lithology*: Light-gray, fossiliferous calcarenite with scattered grains of glauconite. Small amount of vitreous chert in small nodules. ....11 feet
Remarks: Consists entirely of typical Cochrane including the chert and the irregular, somewhat obscure bedding. It is exposed in contact with the Henryhouse and there is no Clarita present here, or in the Hunton outcrops from Ca7 to the Washita River. The Clarita reappears to the west, there being 12 feet present at Ca5 about a half mile west.

KEEL MEMBER (total 2 feet exposed)

A. *Lithology*: Gray, oolitic and fossiliferous limestone. Oolites small, mostly less than 1 mm. .... 2 feet
Remarks: Parts of this rock have an increased fossil content, reduced oolitic content and a tan color, thus resembling the Ideal Quarry type of lithology; there is, however, very little development of the Ideal Quarry type rock.

Covered (probably SYLVAN SHALE).

STRATIGRAPHIC SECTION Ca8

West Spring Creek

Section described and collected by T. W. Amsden, April 1, 2, 1958. Located on the east side of West Spring Creek, NW¼ NE¼ sec. 12, T. 2 S., R. 2 W, Carter County, Okla. This section is of special interest because the Bois d'Arc formation, with a total thickness of 105 feet, consists entirely of the Cravatt lithofacies, the upper 50 feet of which has an unusually high percentage of chert; some of the chert is in elongate stringers, even approaching a bedded type of chert.

The marlstone part of this section (Chimneyhill to Bois d'Arc) totals 211 feet of which 167 (units F to J incl.) has yielded Henryhouse fossils so its stratigraphic position is not in doubt. The upper 44 feet has not yielded any diagnostic fossils and its age is therefore in question; 22 feet of this upper part is covered (unit K), and the remaining 22 feet (units L, M, N) is arbitrarily placed in the Haragan formation.

The strike of the bedding is fairly uniform at 140 degrees (magnetic), dipping about 25 degrees to the SW.

WOODFORD FORMATION (exposed within 2 or 3 feet Bois d'Arc formation)

HUNTON GROUP (total 340 feet)

BOIS D'ARC FORMATION (total 105 feet, all Cravatt lithofacies)

CRAVATT MEMBER (total 105 feet)

T. *Lithology*: Yellowish-gray, argillaceous, fossiliferous calcilutite with much light-brown to brown, vitreous chert; chert in nodules and elongate stringers, the latter up to 6 feet long and resembling beds. ....33 feet
Remarks: No calcarenite observed in this interval; it is exposed within a few feet of Woodford shale so the Fittstown lithofacies must be entirely absent. T is unusual in the high percentage of chert, and the fact that much of this chert is in very long lenses and resembles a bedded chert.
Fossils: This rock is highly fossiliferous, but no collection made. One conodont obtained from acetic acid residues.

S. *Lithology*: Yellowish-gray, fossiliferous, argillaceous calcilutite with much chert; chert is part brown-weathering tripolitic, in part vitreous; in upper part the chert becomes abundant, almost bedded, and S grades into T. ....22 feet
Remarks: Contact of T and S gradational. Acetic acid residues with numerous spindle-shaped fossils which may be holothurian plates; one conodont observed.
Fossils: No collection made.

R. *Lithology*: Covered....28 feet

Q. *Lithology*: Yellowish-gray marlstone with some red mottling. ....2 feet

P. *Lithology*: Covered....14 feet

O. *Lithology*: Yellowish-gray marlstone with some red mottling. Nodules of porous, brown-weathering chert. ....6 feet
Remarks: The base of the Bois d'Arc is placed at the base of O as it is the lowest chert observed.

HARAGAN FORMATION? (units L, M and N total 22 feet; see introductory discussion)

N. *Lithology*: Yellowish-gray marlstone; no chert observed. ....3 feet
Remarks: No diagnostic fossils collected above J; see introductory discussion.

M. *Lithology*: Covered....17 feet

L. *Lithology*: Yellowish-gray marlstone....2 feet
Remarks: No fossils collected; see introductory discussion.

HENRYHOUSE and/or HARAGAN FORMATION (see introductory discussion)

K. *Lithology*: Covered....22 feet

HENRYHOUSE FORMATION (total thickness of units F to J incl. is 167 feet; see introductory discussion)

J. *Lithology*: Yellowish-gray, fossiliferous marlstone. ....40 feet
Remarks: These rocks are lithologically like the beds above which are assigned to the Haragan. J is known to be Henryhouse by its fauna; no fossils collected from any of the higher beds.
Fossils: Characteristic Henryhouse fauna collected loose on the surface. This includes a trilobite, a horn coral, one orthoceroid cephalopod and the following brachiopods: *Atrypa tennesseensis, Discoelosia oklahomensis, Lissatrypoidea concentrica, Merista oklahomensis, Resserella brownsportensis, Stropheodonta* (*B.*) *attenuata*?, *Sieberella roemeri.*

I. *Lithology*: Partly covered; a few outcrops of yellowish-gray marlstone. ....16 feet
Fossils: No collection made.

H. *Lithology*: Mostly covered. Only a few widely scattered outcrops of yellowish-gray marlstone. ....86 feet
Fossils: No collection made.

G. *Lithology*: Yellowish-gray marlstone with some ....10 feet
pale red mottling.
Fossils: No collection made.

F. *Lithology*: Partly covered. Outcrops of ....15 feet
yellowish-gray marlstone.
Remarks: This is typical Henryhouse lithology. The upper part of the Clarita (units D, E) is somewhat shaly or marly, but carries the typical Clarita microfauna (acetic acid residues). Unit F not tested for microfauna.

CHIMNEYHILL FORMATION (total exposed, 24 feet; no Keel or Ideal Quarry strata observed)

CLARITA MEMBER (total 8 feet)

E. *Lithology*: Yellowish-gray, somewhat ....3 feet
argillaceous calcilutite. No pink pelmatozoan fragments observed.
Remarks: This rock has a higher percentage of shale than is common in the Clarita and somewhat resembles the overlying Henryhouse. Acetic acid residues yield many conodonts and arenaceous Foraminifera, a microfauna that is typical for the Clarita.
Fossils: Highly fossiliferous but no collection made except from the acetic acid residue.

D. *Lithology*: Yellowish-gray, argillaceous ....1 foot
calcilutite; no pink pelmatozoan plates observed.
Remarks: This resembles the overlying E, and also the Henryhouse strata to some extent. Acetic acid residues yield the Clarita microfauna.
Fossils: Fossiliferous but no collection made other than from the acetic residues.

C. *Lithology*: Light-gray, evenly-bedded ....4 feet
fossiliferous calcilutite with pink pelmatozoan plates. Beds to 6 or 8 inches.
Remarks: Typical Clarita lithology.
Fossils: No collection made.

COCHRANE MEMBER (total 16 feet)

B. *Lithology*: Yellowish-gray calcilutite with ....2 feet
nodules of vitreous chert. Little or no glauconite.
Remarks: This is not typical Cochrane, having more argillaceous material than is common, but it is included because of the chert.
Fossils: No collection made.

A. *Lithology*: Gray, fossiliferous calcarenite ....14 feet
with scattered grains of glauconite. Bedding irregular; no chert observed.
Remarks: Typical Cochrane lithology. No Keel or Ideal Quarry observed in this area and they are probably absent.
Fossils: None collected.

Covered

STRATIGRAPHIC SECTION Ca9

Westernmost Hunton outcrop

Section described and collected by T. W. Amsden, April 9, 10, 1958. It is the westernmost exposure of Hunton in the Arbuckle region, and is located about 1½ miles east of Pooleville on the Sparks Ranch; it begins in the SW¼ SW¼ sec. 36, and extends into the SE¼ SE¼ sec. 35, T. 1 S., R. 2 W.; Carter County, Okla.

This section extends from the Henryhouse-Chimneyhill contact to the top of the Hunton. The Chimneyhill is exposed on Ca9, but was not measured here as it is better exposed at Ca10, a short distance to the northwest. The marlstone part of this section (units A to K extending from the top of the Chimneyhill to the base of the Bois d'Arc) is poorly fossiliferous, but a few Henryhouse fossils were collected from J, 245 feet above the Chimneyhill; no fossils found in the upper 12 feet (K) so its age is in question, but in any case the Haragan is thin. The Haragan is also known to be thin at Ca8, about 2 miles southeast of Ca9.

The strike of the bedding averages 140 degrees (magnetic), dipping about 27 degrees to the southwest. The bearing of the section is 240 degrees (mag.); almost all of this section measured with a 100 foot tape and the stratigraphic thickness calculated.

Chemical analyses of rocks from this section given in the section on CHEMICAL ANALYSES.

WOODFORD SHALE (exposed within a few feet of the Bois d'Arc formation)

HUNTON GROUP (total 433 feet, including 51 feet of Chimneyhill measured at section Ca10)

BOIS D'ARC FORMATION (total 125 feet)

FITTSTOWN MEMBER (total thickness 13 feet)

O. *Lithology*: Light-gray, fossiliferous calcarenite....13 feet
with nodules of vitreous, light-gray chert. Few beds of argillaceous calcilutite.
Remarks: This unit is predominantly calcarenite but there are beds of argillaceous calcilutite or marlstone present, and it grades into the underlying unit.
Fossils: None collected.

CRAVATT MEMBER (total 112 feet)

N. *Lithology*: Yellowish-gray, fossiliferous....40 feet
argillaceous calcilutite or marlstone, with nodules of vitreous chert. Few beds of calcarenite in the upper part.
Remarks: Unit N grades into the overlying beds.

M. *Lithology*: Yellowish-gray, marlstone with many....36 feet
nodules of vitreous to porous chert.
Remarks: All of these strata are typical Cravett type lithology. The chert is of two types, porous and vitreous; the underlying L has almost entirely a porous type chert, and the overlying N almost entirely a vitreous type.

L. *Lithology*: Yellowish-gray, fossiliferous....36 feet
marlstone with nodules of brown-weathering, porous chert.
Remarks: This unit is distinguished from the underlying beds because it has chert.
Fossils: *Dicoelosia varica* is common in the lower part of L.

HARAGAN and/or **HENRYHOUSE FORMATION**

K. *Lithology*: Yellowish-gray marlstone....12 feet
Remarks: No fossils found in these beds; unit J carries definite Henryhouse fossils and unit L definite Helderbergian fossils; see introductory discussion.

HENRYHOUSE FORMATION (total 245 feet, excluding K)

J. *Lithology*: Yellowish-gray marlstone like above....7 feet
Remarks: This interval is known to be Henryhouse, and this formation may extend higher; see introductory discussion.
Fossils: 5 specimens of *Dicoelosia oklahomensis*, all typical Henryhouse representatives; also *Nucleospira raritas* and *Leptaena* sp.

I. *Lithology*: Covered....16 feet

H. *Lithology*: Mostly covered. Few outcrops of....36 feet
yellowish-gray marlstone.

G. *Lithology*: Yellowish-gray marlstone....20 feet
Remarks: Similar to beds above and below, but is separated because it is entirely exposed, and yields a few fossils.
Fossils: The following Henryhouse brachiopods collected: *Atrypa tennesseensis*?, *Dicoelosia oklahomensis*. Also a fenestellid bryozoan.

F. *Lithology*: Mostly covered. Few outcrops of yellowish-gray marlstone. ....36 feet

E. *Lithology*: Partly covered. Few outcrops of yellowish-gray marlstone. ....16 feet
Remarks: Separated because it yielded a few fossils.
Fossils: Two incomplete specimens of *Sieberella* cf. *S. roemeri*, one specimen of *Eophacops* sp., and a pygidium of *Encrinurus?* sp.

D. *Lithology*: Mostly covered. Few outcrops of yellowish-gray marlstone. ....62 feet

C. *Lithology*: Covered. ....21 feet
Remarks: The boundary between C and D is on the line between sec. 36 and sec. 35.

B. *Lithology*: Yellowish-gray marlstone. ....24 feet

A. *Lithology*: Dark, yellowish-gray or tan marlstone. ....7 feet

CHIMNEYHILL FORMATION

CLARITA MEMBER (contact with Henryhouse well exposed: see SECTION Ca10 for a description of the Chimneyhill formation in this area).

STRATIGRAPHIC SECTION Ca10

Westernmost Hunton outcrop

Section described by T. W. Amsden, April 9, 1958. It is the westernmost outcrop of Hunton in the Arbuckle region, and is about 1½ miles east of Pooleville on the Sparks Ranch; NE¼ SE¼ sec. 35, T. 1 S., R. 2 W., Carter County. Section Ca10 is located about ¼ mile northwest of Ca9; this section covers only the Chimneyhill formation, the Henryhouse and higher formations being measured and described at Ca9.

The strike of the bedding is 150 degrees (magnetic), dipping 30 degrees to the southwest.

Analyses of rock samples from this section given in the section on CHEMICAL ANALYSES.

HENRYHOUSE FORMATION (for description see Ca9)

CHIMNEYHILL FORMATION (total 51 feet)

CLARITA MEMBER (total 8 feet)

E. *Lithology*: Light-gray, fossiliferous calcilutite with scattered pink pelmatozoan plates. Evenly bedded, beds to 6 or 8 inches. 8-feet
Remarks: This is typical Clarita lithology. The contact with the underlying Cochrane is exposed and well marked, the Cochrane being coarser-grained, unevenly bedded and with chert.

D. *Fossils*: No collection made and no acetic acid residue prepared.

COCHRANE MEMBER (total 41 feet)

C. *Lithology*: Gray to pinkish-gray, fossiliferous calcarenite with nodules of chert; few scattered grains of glauconite. Considerable pink calcite and some of this may be pelmatozoan plates. Bedding irregular. ....22 feet
Remarks: The pink parts of this unit resemble coarse-grained Clarita, but the irregular bedding, glauconite and chert clearly relate it to the Cochrane.
Fossils: No collection made.

B. *Lithology*: Partly covered. Gray, fossiliferous calcarenite with scattered glauconite grains. No chert observed. ....19 feet
Remarks: This interval is poorly exposed, but appears to be typical Cochrane except that the glauconite is sparse.
Fossils: No collection made.

KEEL MEMBER (about 2 feet exposed)

A. *Lithology*: Light-gray, oolitic limestone; most oolites a millimeter or less in diameter. ....2 feet

Remarks: The Keel is not well exposed and has slumped some so that it is difficult to get a precise thickness. No Ideal Quarry type of lithology exposed here and the covered interval below probably represents Sylvan shale.

Covered.

STRATIGRAPHIC SECTION Ca11

Criner Hills - Rock Crossing

Section described and collected by T. W. Amsden, April 10, 1958. Located on the west bank of Hickory Creek a short distance south of the bridge at Rock Crossing; NE¼ SW¼ sec. 35, T. 5 S., R. 1 E., Carter County, Okla. This section extends from the Sylvan shale, which is exposed in contact with the Ideal Quarry member, up to and including several feet of Haragan; at the time the section was measured the upper part was covered, however, the Criner Hills map shows the Hunton in contact with the Woodford and it may be that some Woodford is exposed on the creek bank at low water.

The strike of the Chimneyhill bedding is 110 degrees (magnetic), dipping 40 degrees to the southwest; on the marlstone the strike is about 125 degrees (magnetic), dipping almost 65 degrees to the southwest. There may be a small fault between G and I.

Covered.

HUNTON GROUP (113 feet exposed)

HARAGAN FORMATION (28 feet plus)

K(1). *Lithology*: Yellowish-gray, fossiliferous marlstone. ....7 feet

Remarks: The section above K(1) is covered; see introductory discussion.

Fossils: K(1) carries a Helderbergian fauna and is certainly Haragan. The following brachiopods collected in situ: *Dicoelosia varica, Coelospira virginia, Kozlowskiellina?* sp., *Rhipidomelloides* sp.

K.(2). *Lithology*: Yellowish-gray marlstone like-beds above. ....21 feet

Remarks: All of K(2) is probably Haragan although the faunal evidence is not conclusive; unit J is covered and I carries a definite Henryhouse fauna.

Fossils: Two fairly large, fragmentary schuchertelloid brachiopods collected, probably *Schuchertella haraganensis.* One fragment of a *Scyphocrinites* bulb.

HARAGAN and/or HENRYHOUSE FORMATION

J. *Lithology*: Covered ....14 feet

Remarks: Underlain by definite Henryhouse beds and overlain by questionable Haragan; see discussion above.

HENRYHOUSE FORMATION (total 47 feet plus; includes units F. to I, excludes all of J)

I. *Lithology*: Yellowish-gray, fossiliferous marlstone. ....8 feet

Remarks: Lithologically like unit K above, but carries a Henryhouse fauna; a part or all of the overlying covered interval (J) may be Henryhouse.

Fossils: A moderately large Henryhouse fauna collected in situ. Includes a fragment of a *Scyphocrinites* bulb, a cranidium of *Calymene* and the following brachiopods: *Dicoelosia oklahomensis, Dictyonella gibbosa, Leptaena oklahomensis, Lissatrypoidea henryhousensis, Skenidioides henryhousensis, Stropheodonta (B.) attenuata, Sieberella roemeri?*.

H. *Lithology*: Mostly covered; a few outcrops of deeply weathered marlstone. ....35 feet
Fossils: No collection made.

G. *Lithology*: Yellowish-gray marlstone. One acetic acid residue prepared and this appears to be barren. ....2 feet
Fossils: No collection made.

F. *Lithology*: Yellowish-gray marlstone ....2 feet
Remarks: F is more calcareous than the overlying beds and more shaly than the underlying strata. One acetic acid residue prepared and this appears barren except for a single conodont which is unlike any of the Clarita conodonts observed. This, plus the 3 specimens of *Lissatrypoidea* collected in situ indicates that F is Henryhouse; see discussion under E.
Fossils: Three incomplete specimens of *Lissatrypoidea*, probably *L. concentrica* collected in situ. Also 2 trilobite fragments, both probably belong to *Calymene* and one conodont from the acetic residues.

CHIMNEYHILL FORMATION (total 24 feet)

CLARITA MEMBER (total 6 feet)

E. *Lithology*: Gray to yellowish-gray, fossiliferous calcilutite. No pink pelmatozoan plates observed. ....2 feet
Remarks: This unit is lithologically intermediate between the typical Clarita lithology of D and the overlying Henryhouse marlstone. It carries no pink pelmatozoan plates and has considerably more argillaceous material than is normal for Clarita, but less than typical Henryhouse. The acetic acid residues carry a prolific microfauna, in fact the bulk of the washed residues is composed of microfossils: this appears to be the characteristic Clarita microfauna and accordingly E is placed in that member. Note the abrupt decline in microfossils between E and F.
Fossils: No megafossils collected. Acetic acid residues with large microfauna.

D. *Lithology*: Light-gray, fossiliferous calcilutite with many pink pelmatozoan plates. Evenly bedded, up to 8 or 10 inches. ....4 feet
Remarks: Typical Clarita lithology and the acetic acid residues carry a prolific microfauna.
Fossils: No megafossils collected. Acetic acid residues with large microfauna.

COCHRANE MEMBER (total 15 feet)

C. *Lithology*: Light-gray, fossiliferous calcilutite with scattered grains of glauconite. Bedding irregular; no chert seen. ....15 feet
Remarks: The glauconite content is highly variable with some beds carrying a considerable quantity.
Fossils: No collection made.

KEEL MEMBER (total 1 foot)

B. *Lithology*: Gray, oolitic limestone ....1 foot
Remarks: Two peels show this rock is far from a typical Keel oolite. The rock consists of scattered oolites, some over 2 mm in diameter (pisolites); in addition to, and far more abundant than the oolites are irregular fragments (to several millimeters) having the same texture and presumably composition as the oolites; both oolites and fragments may in some cases be seen to have a fossil core, but many do not show this. Fossil debris is not common and is in almost all cases coated with the "oolitic" material. The texture of this "oolitic" material consists of fine granules packed closely together; the granules can be easily distinguished at 100X, most being 0.01 mm or less. The fragments and the oolites generally do not touch each other, being imbedded in a matrix of

clear calcite. The origin of this rock is in question; it may represent fragmentation of an oolite, but some of the debris is too large for this; futhermore the shape of some of the irregular fragments is clearly related to the shape of the core. This rock has some resemblance to the lithology of the middle Keel member at J1-C, although the latter furnishes better evidence of being a fragmented oölite. Photomicrograph illustrated on plate XI, figure 5.

Fossils: None collected.

IDEAL QUARRY MEMBER (total 2 feet)

A. *Lithology*: Yellowish-brown, fossiliferous calcarenite. .... 2 feet

Remarks: Two peels made, neither being very satisfactory (the Ideal Quarry lithology does not yield good peels); the rock is a a bioclastic calcarenite with probably better than 50% fossil debris.

SYLVAN SHALE (exposed in contact with the Ideal Quarry)

STRATIGRAPHIC SECTION Ca12

Criner Hills—northwest of Overbrook

Section described and collected by T. W. Amsden, April 15, 1958. About 1 mile northwest of Overbrook, NW¼ SW¼ sec. 36, T. 5 S., R. 1 E., Carter County, Okla. The section begins near 3 oil tanks resting on the Chimneyhill, and extends on a bearing of N 20 E to the Woodford. The exposures of marlstone are poor, but both Henryhouse and Haragan strata can be demonstrated to be present although the thickness of each cannot be determined with any degree of precision. It is reasonably certain that no Bois d'Arc is present.

Analyses of rock specimens from this section given in the section on CHEMICAL ANALYSES.

The strike of the beds is about 135 degrees (magnetic), dipping 30 degrees to the northeast.

WOODFORD FORMATION (shale exposed in place; a short distance to the northeast is a quarry)

HUNTON GROUP (total 98 feet)

HARAGAN FORMATION

H. *Lithology*: Mostly covered. Rare outcrops of yellowish-gray marlstone. .... 28 feet

Remarks: No evidence observed of any Bois d'Arc chert in this interval, although some of the fossils collected are partly silicified.

Fossils: A few Helderbergian fossils collected: *Dicoelosia varica*, *Kozlowskiellina (M.) velata* and 3 specimens of *Levenea subcarinata pumilis*. No Henryhouse seen above unit F.

HARAGAN and/or HENRYHOUSE FORMATION

G. *Lithology*: Covered. .... 28 feet

Remarks: No fossils collected and this unit could be either Henryhouse or Haragan, or the contact could fall within G.

HENRYHOUSE FORMATION

F. *Lithology*: Partly covered. Few crops of yellowish-gray marlstone. .... 11 feet

Remarks: Evidence for assigning this to the Henryhouse is poor, as only a single fossil was found. Dirt road in this interval.

Fossils: One brachiopod collected: *Atrypa tennesseensis*?

E. *Lithology*: Partly covered. Few outcrops of yellowish-gray marlstone. .... 9 feet

Remarks: This interval yields a small, but unquestionable Henryhouse fauna.

Fossils: One fenestellid bryozoan and the following brachiopods collected: *Atrypa tennesseensis*, *Pseudodicoelosia oklahomensis* and *Sieberella roemeri*.

CHIMNEYHILL FORMATION (total 22 feet)

CLARITA MEMBER (total 2 feet)

D. *Lithology*: Light-gray, fossiliferous calcilutite..2 feet
with many scattered pink pelmatozoan plates. Evenly bedded, beds to 6 inches.
Remarks: Typical Clarita lithology and the acetic acid residues carry a large microfauna of conodonts and arenaceous Foraminifera.
Fossils: Rock is highly fossiliferous but no megafauna collected; acetic acid residues carry a large microfauna.

COCHRANE MEMBER (total 17 feet)

C. *Lithology*: Calcarenite ranging into a calcirudite....................................7 feet
with scattered grains of glauconite. Color gray to pale-greenish-gray mottled with pink. Much crinoidal material present, some of the plates pink. Bedding highly irregular. Peel shows this rock contains a substantial amount of fossil material, probably over 50%; there is also much clear calcite, some of which appears to replace the fossils; some of the fossils appear to be broken, although it is difficult to distinguish the breakage from the possible effects of recrystallization.
Remarks: This rock has the bedding characteristics and abundant glauconite of typical Cochrane, but it also has much pink pelmatozoan material like that found in the Clarita. Acetic acid residues yield Cochrane conodonts, but are almost barren of Foraminifera; the microfauna combined with the glauconite and irregular bedding places this unit in the Cochrane. Much of the glauconite has the shape of some type of fossil and is either the filling of a hollow part (steinkern), or a replacement; some of the pelmatozoan plates are impregnated with glauconite, possibly as a replacement or as a filling of the pores.
Fossils: Rock is abundantly fossiliferous but no megafauna collected. Acetic acid residues carry conodonts.

B. *Lithology*: Gray to greenish-gray calcarenite with............................10 feet
much red mottling. Scattered grains of glauconite. Peel shows this rock to contain a substantial amount of fossil debris including many pelmatozoan plates. Acetic acid residues yield Cochrane conodonts and much glauconite in the shape of sponge spicules; no Foraminifera observed.
Remarks: This rock is somewhat finer-grained than C, but otherwise the two units are very similar. It carries a fair amount of glauconite much being either a filling of some hollow fossil such as an ostracod, or a gastropod; some may represent replacement.

KEEL MEMBER (total thickness approximately 3 feet)

A. *Lithology*: Yellowish-brown (10YR 5/4), locally....................................3 feet
with a reddish cast, oolitic limestone. Oolites generally small, a millimeter or less in diameter, but in places grading into a pisolite, Most of the oolites have a lighter color than the matrix.
Remarks: This rock is not well exposed in place so the thickness is in question. It is not typical Keel oolite. The color is darker than is customary and many of the oolites have obscure boundaries. Some of the oolites show a fossil core and have a radial structure, thus resembling the oolites found in the Keel at other localities. However, with rare exceptions the matrix is not calcite, being almost indistinguishable from the oolites. There is considerable fossil material dispersed through this rock. Another unusual feature of this rock is the shape of some of the oolites. In places these are not spherical, and a section cut in one particular direction will show the majority of oolites with an elliptical outline. This could be due to deformation, but it is equally possible that this shape was primary; at least some with this elliptical cross section have a radial structure that does not appear distorted.

Covered (probably Sylvan shale).

STRATIGRAPHIC SECTION Ca13

Near northern end of the Criner Hills

Section described and collected by T. W. Amsden, April 16, 1958. It is near the north end of the northernmost Hunton outcrop in the Criner Hills; SE¼ NW¼ sec. 9, T. 5 S., R. 1 E., Carter County, Okla. This section was measured just a short distance north of 2 oil tanks where the upper part of the Hunton and the lower Woodford are exposed in a trench.

The strike of the bedding is about 140 degrees (magnetic), dip almost vertical to slightly overturned.

Analyses of rocks from this section given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION (exposed within 1 foot of the Henryhouse)

HUNTON GROUP (total thickness 96 feet)

HENRYHOUSE FORMATION (total thickness 75 feet)

D. *Lithology*: Yellowish-gray, fossiliferous marlstone. .... 29 **feet**

Remarks: This unit is completely exposed by a trench. Henryhouse fossils collected in situ within a foot or so of the Woodford so there is no doubt that both the Haragan and Bois d'Arc formations are absent. The washed HC*l* insoluble residues contain some limonite (?), a few fragments of silicified fossils, and a small quantity of clear, silt-size quartz.

Fossils: A Henryhouse fauna collected in situ from the upper few feet. This includes a *Calymene* pygidium, a fenestellid bryozoan, 2 horn corals and the following brachiopods: *Atrypa tennesseensis*, *Leptaena* sp., *Leptaenisca irregularis*, *Merista oklahomensis*, *Sieberella* sp., *Strophonella attenuata*, *Strophonella prolongata*.

C. *Lithology*: Partly covered. Few outcrops of yellowish-gray marlstone. .... 46 **feet**

Remarks: Similar to the beds above although not so well exposed. The HC*l* acid residues carry a large amount of some dark-brown mineral (probably limonite) plus much clear, subangular silt-size quartz; there are a few arenaceous Foraminifera. Acetic acid residues with a few spherical Foraminifera and one compound conodont.

Fossils: No megafossils collected. Acetic and HC*l* residues with a sparse microfauna; see above.

CHIMNEYHILL FORMATION (total 21 feet, with no Keel observed)

CLARITA MEMBER (total 6 feet)

B. *Lithology*: Light gray, highly fossiliferous calcilutite with scattered pink pelmatozoan plates. .... 6 **feet**

Remarks: This is typical Clarita lithology. Acetic acid residues carry conodonts, arenaceous Foraminifera and inarticulate brachiopods.

Fossils: No megafossils collected; acetic acid residues carry a substantial microfauna.

COCHRANE MEMBER (total thickness 15 feet)

A. *Lithology*: Gray, fossiliferous calcarenite with scattered grains of glauconite. Beds to 2 or 3 feet, irregular. .... 15 **feet**

Remarks: Typical Cochrane lithology. No Keel or Ideal Quarry strata observed in this area.

Covered (probably Sylvan)

STRATIGRAPHIC SECTION Ca14

Criner Hills - northwest of Rock Crossing

Section measured and collected by T. W. Amsden, April 17, 1958. It crosses a northwest-southeast dirt road about 200 yards north of the junction with another dirt road; NE¼ NE¼ sec. 34, T. 5 S., R. 1 E., Carter County, Okla.

The Criner Hills Geologic Map (1957) shows Woodford resting on Hunton in the vicinity of this section, but I did not see any Woodford in this belt, and it is probably largely or entirely removed by faulting. On and near section Ca14 the highest Hunton exposed is Henryhouse, followed by a small covered interval and then a limestone sequence. There are a few pieces of chert float which could be Woodford, but if this formation is present it must be extremely thin. It seems probable that all of the Hunton on this section belongs to the Chimneyhill and Henryhouse with the Devonian part removed by erosion; this is the relationship that exists at Ca13 to the north.

The strike of the Chimneyhill bedding is 155 degrees (magnetic), dipping 35 degrees to the SW; the strike of the bedding on the upper part of the Henryhouse is 145 degrees, dipping 50 degrees to the SW.

Covered (?Woodford; see discussion above)

HUNTON GROUP (124 feet exposed; probably close to the true thickness)

HENRYHOUSE FORMATION (85 feet exposed)

H. *Lithology*: Yellowish-gray, fossiliferous marlstone. .... 39 feet

Remarks: Typical Hunton marlstone lithology with a characteristic Henryhouse fauna. No Haragan fossils seen on this section.

Fossils: A fragment of *Camarocrinus*, 2 Bryozoa, 3 horn corals and the following brachiopods: *Anastrophia delicata*, *Atrypa tennesseensis*, *Dictyonella gibbosa*, *Merista* sp., *Pseudodicoelosia oklahomensis*, *Resserella brownsportensis*.

G. *Lithology*: Covered. .... 21 feet

Remarks: A dirt road occupies most of this interval.

F. *Lithology*: Partly covered. Scattered outcrops of yellowish-gray marlstone. .... 25 feet

Fossils: None collected.

CHIMNEYHILL FORMATION (total 39 feet)

CLARITA MEMBER (total 4 feet)

E. *Lithology*: Light-gray, fossiliferous calcilutite with scattered pink pelmatozoan plates. .... 4 feet

Remarks: Typical Clarita lithology.

COCHRANE MEMBER (total 33 feet)

C., B. *Lithology*: Light-gray calcarenite with some calcilutite and scattered grains of glauconite. .... 33 feet

Remarks: Most of this unit is fairly typical Cochrane lithology although the glauconite content is somewhat lower than usual. One peel made of the fine-grained phase and this shows an unusually low fossil content for the Cochrane, much of the rock being rather finely divided clear calcite.

KEEL MEMBER (total 2 feet)

A. *Lithology*: Light-gray, oolitic to pisolitic limestone. .... 2 feet The concentration of oolites and pisolites varies greatly, in places being packed close together and other parts not in contact. Much of the matrix consists of irregular pellets which have the same granular texture as do the oolites and pisolites; many of these pellets, as well as the oolites, have a fossil core. The oolites and pellets are embedded in a matrix of clear calcite. One piece of float shows the oolitic rock in contact with a rock that appears megascopically to be algal. A peel of this, however,

shows that it is composed of fairly large fossils which are coated with the same granular material as that which composes the pellets, oolites and pisolites. There is no digitate or head-like "reef" structure present in this rock. This rock (as well as Keel specimens from other areas) gives the definite impression that the granular "oolitic material" is a coating; whether this was precipitated from solution or was the result of algal action is not entirely clear although here, and elsewhere, there is no development of reef-like masses.
Remarks: No Ideal Quarry rock seen here. The Sylvan is exposed in a small gully within a few feet of the Chimneyhill.
Covered (probably Sylvan).

STRATIGRAPHIC SECTIONS J1, J4, J5

Southwest of Wapanucka

The Hunton outcrop belt which lies southwest of Wapanucka (T. 2 S., R. 8 E.) and extends from J1 to J5 (includes J4; no J2 or J3 described), exhibits some stratigraphic complexities involving the Clarita-Cochrane relations. At the south end, in the area around J1, the Clarita is absent and glauconitic limestone, which appears to be typical in all respects for the Cochrane member, is directly overlain by marlstone. Towards the northwest the Clarita member wedges in beneath the post-Chimneyhill unconformity; this rock is, for the most part, a characteristic Clarita lithology and carries what appears to be a Clarita conodont fauna. However, in this northern area, from J4 to J5, the stratigraphic relations are complicated by the fact the Cochrane locally loses its glauconitic character and has many pink pelmatozoan plates, thus resembling the Clarita. In general this part of the

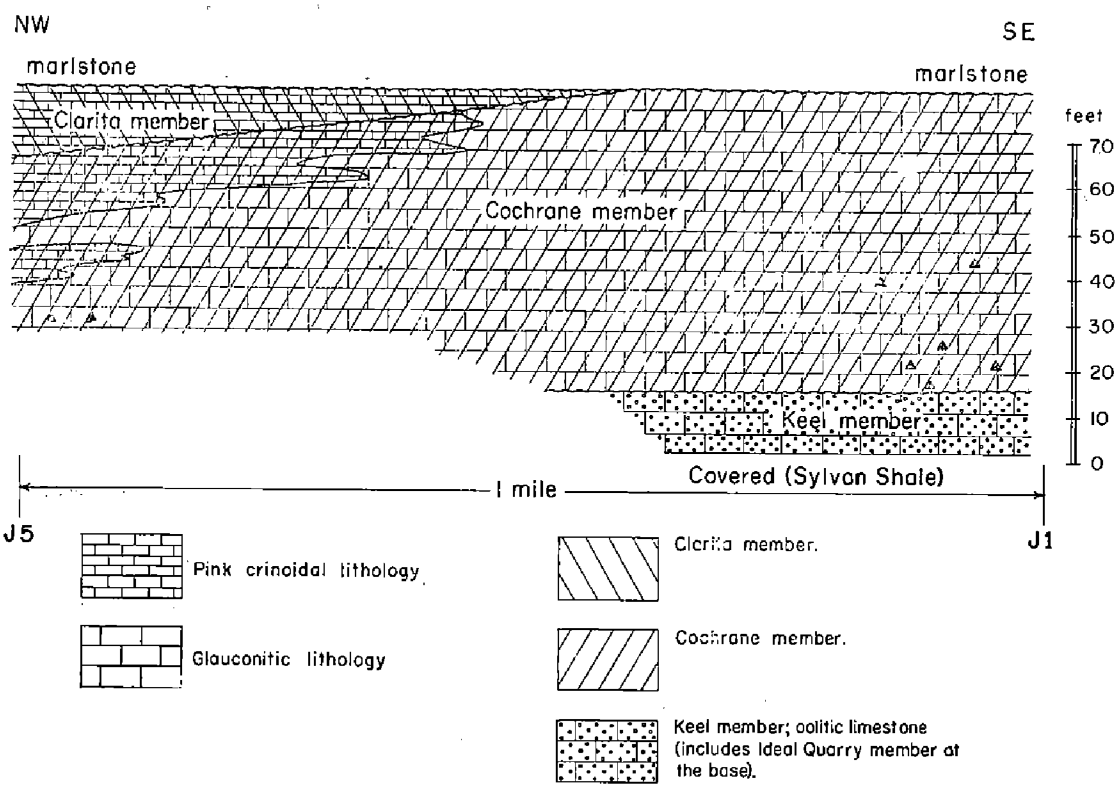

Figure 50. Stratigraphic section showing the inferred Clarita-Cochrane relationship in the Hunton belt extending from J1 to J5. The diagonal lines slanting to the upper right are believed to mark the beds with a Cochrane conodont fauna and those to the upper left a Clarita conodont fauna.

Cochrane has somewhat obscure bedding, but even this feature is partly lost. A tentative study of the conodont faunas obtained from the acetic acid residues, plus a detailed examination of all stratigraphic and lithologic features indicates a relationship like that shown in figure 50, and described in sections J1, J4, J5. A detailed study of the conodont faunas is needed to confirm this interpretation.

STRATIGRAPHIC SECTION J1

Southwest of Wapanucka

Section described and collected by T. W. Amsden, Oct. 3, 4, 1958. About 1½ miles southwest of Wapanucka, NE¼ SE¾ sec. 27, T. 2 S., R. 8 E., Johnston County, Oklahoma. The strike of the beds is about 140 degrees (magnetic); dip approximately vertical. (See text fig. 50).

WOODFORD SHALE (Covered interval of 25 feet between lowest exposure of Woodford and highest Hunton; this interval is probably underlain by Woodford also).

HUNTON GROUP (total 198 feet)

BOIS D'ARC FORMATION (total 105 feet)

CRAVATT MEMBER (total 105 feet)

I. *Lithology*: Yellowish-gray, argillaceous........105 feet calcilutite with nodules of chert throughout. Color mostly yellowish-gray (5Y 7/2 to 5Y 8/4) but locally with pink mottling. Chert mostly a porous, brown-weathering tripolitic type, with only a few vitreous nodules. Limestone is fine grained throughout with little or no calcarenite. One HCl insoluble residue (based on parts of 6 different rock specimens) yielded 13%. Bedding ranges from 4 to 8 inches.

Fossils: Fossiliferous but no collection made.

HARAGAN FORMATION (total 20 feet)

H. *Lithology*: Yellowish-gray, argillaceous........3 feet calcilutite.

Remarks: This unit, which is completely exposed, is lithologically like unit I except for its lack of chert.

Fossils: None collected.

G. *Lithology*: Covered........17 feet

Fossils: Specimens of *Orthostrophia* sp., *Phacops* and *Camarocrinus* collected loose on the surface, indicating that a part of G is Haragan. A questionable *Phacops* collected loose on the upper part of F and so it seems quite probable that the Haragan - Henryhouse contact is very close to the contact of F and G.

HENRYHOUSE FORMATION (total 3 feet)

F. *Lithology*: Yellowish-gray (5Y 7/2) mottled........3 feet with pale red (10R 6/2) marlstone. One HCl insoluble residue 20%.

Remarks: This unit is lithologically sharply marked off from the underlying strata and is covered above. It has the typical Henryhouse lithology and yields a few fossils which are certainly Silurian and probably Henryhouse; this collection includes one excellent trilobite pygidium which appears to be identical to specimens of *Encrinurus* found in unquestioned Henryhouse beds. In addition there are several specimens of *Lissatrypoidea* (including a pedicle interior) which appears to be like *Lissatrypoidea concentrica* although none of the specimens is complete enough to permit a positive species identification. Unit F could possibly represent a marly facies of the Clarita; specimens of a small brachiopod resembling *Lissatrypoidea* have been found in the Clarita (C1-F); however, the combination of lithology and fauna make it appear much more likely that this is Henryhouse. The acetic acid residues do not carry a prolific microfauna, yielding only a few fragments of an inarticulate brachiopod and a few pieces of a spherical arenaceous Foraminifera; probably the same as J5, units E and F.

One fragmentary and questionable specimen of *Phacops* was found in the upper part of F, suggesting that the Henryhouse Haragan contact could fall within F; however, this specimen is not complete enough to give a positive identification.

Fossils: See discussion under *Remarks*.

CHIMNEYHILL FORMATION (total 70 feet)

COCHRANE MEMBER (total 57 feet)

E. *Lithology*: Gray, glauconitic, fossiliferous....57 feet calcarenite. The glauconite, which is present in small grains generally less than 2 mm, is variable in amount but is present throughout unit E and is common in most beds. One peel made of the upper part which shows a bioclastic calcarenite, well over half the rock being fossil fragments. The bedding is irregular, ranging up to 2 feet. Chert is sparingly present, in the form of small nodules which are largely concentrated in the lower 10 feet.

Remarks: The lithologic and bedding characteristics indicate all of E belongs in the Cochrane. It may be observed in contact with the overlying marlstone, there being no Clarita lithology present; see *Remarks* under F.

Fossils: None collected.

KEEL MEMBER (3 subdivisions with a total of 12 feet)

UPPER OOLITE

D. *Lithology*: Gray, oolitic limestone. Oolites....2 feet mostly small, generally less than 1 mm in diameter. Upper part locally silicified. HCl insolubles 0.2%; $CaCO_3$ 99.1%; $MgCO_3$ 0.47%.

MIDDLE LAMINATED SUBMEMBER

C. *Lithology*: Gray to yellowish-gray, partly....6 feet oolitic limestone. In part laminated, the laminae being a fraction of an inch thick. Some beds are conglomeratic, the pebbles (limestone) ranging up to a half inch in length; pebbles mostly flattish, and appearing to be an intraformational, flat-pebble limestone conglomerate. Peels show this rock to be composed largely of limestone fragments, the larger ones elongate in the bedding plane, set in a matrix composed in part of clear calcite and in part of more argillaceous material. The pebbles are unusual in their texture, all having a uniformly fine granular texture which much resembles that of the oolites; oolites are present although many appear to be broken (the fragmentary oolites can generally be recognized by their radial structure). This would appear to be a clastic rock, formed in part of fragmented oolites; however, many of the larger pieces (up to a half inch in length) which have the same granular texture as the oolites, are much too large to be broken oolites. Photomicrograph illustrated on plate XI, figure 4. HCl insolubles 5.5%; $CaCO_3$ 93.0%; $MgCO_3$ 1.22%.

Fossils: None collected.

LOWER OOLITE

B. *Lithology*: Gray, oolitic limestone. The....4 feet lower part of this unit has coarse oolites and small pisolites which grade upward into fine oolite, the oolites being only a fraction of one mm.

Fossils: None collected.

IDEAL QUARRY MEMBER

A. *Lithology*: Brown-weathering, oolitic (?), fossiliferous calcarenite. ....2 feet
Remarks: This unit resembles the overlying oolite, being only slightly darker in color and, apparently, with fewer oolites.
Fossils: None collected.

Covered (Sylvan formation?)

STRATIGRAPHIC SECTION J4

Southwest of Wapanucka

Section described by T. W. Amsden, Oct. 3, 1956. About 1½ miles southwest of Wapanucka; NW¼ NE¼ sec. 27, T. 2 S., R. 8 E., Johnston County, Okla. This section is located about half way between J1 and J5; see discussion under J5 and text figure 50. Analyses of rock samples given in the section on CHEMICAL ANALYSES.

Covered (WOODFORD float).

HUNTON GROUP (total 168 feet)
BOIS D'ARC FORMATION (total 95 feet)
CRAVATT MEMBER (total 95 feet)

J. *Lithology*: Argillaceous calcilutite with many nodules of brown-weathering, porous chert. This rock is yellowish-gray, with some red mottling in the upper part. Bedding even, ranging up to a foot in thickness. ....95 feet
Remarks: The top of this unit is covered, but the presence of Woodford shale float indicates that almost all of the Bois d'Arc is exposed. Little or no calcarenite in this interval.
Fossils: None collected.

HARAGAN FORMATION (total 21 feet?)

I. *Lithology*: Yellowish-gray marlstone. No chert observed. ....6 feet
Remarks: No fossils observed in this interval and it is assigned to the Haragan because of its position with respect to J1-G and J5-G.

H. *Lithology*: Covered ....15 feet
Remarks: The lower part of this interval could include some Henryhouse.

HENRYHOUSE FORMATION? (total 5 feet?)

G. *Lithology*: Gray, glauconitic calcarenite with some pink pelmatozoan plates. HCl residues composed in large part of glauconite and partly silicified fossils. ....1 foot
Remarks: This unit seems to be clearly a local facies of the underlying marlstone which carries a Silurian, probably Henryhouse, fauna. Acetic acid residues carry a conodont fauna similar to that found at J5-E, and unlike the conodonts from the underlying bed E of this section.
Fossils: Conodonts present in the acetic acid residues.

F. *Lithology*: Yellowish-gray, locally mottled with red, marlstone. One HCl insoluble residue, 26%; washed residues mostly silt size quartz with little or no glauconite. ....4 feet
Fossils: A few poorly preserved fossils collected, including *Lissatrypoidea* cf. *L. concentrica* and a possible *Merista*. This could be a marly facies of the Clarita, but the lithology and fossils suggest Henryhouse. No conodonts observed in the acetic acid residues.

CHIMNEYHILL FORMATION (total 48 feet)

CLARITA MEMBER (total 8 feet)

E. *Lithology*: Gray calcilutite with many scattered pink pelmatozoan plates. Evenly bedded, beds to 5 or 6 inches. ....7 feet
Remarks: Typical Clarita lithology and the acetic acid residues yield a fauna of condonts which appears to be characteristic for this member. E, and the underlying covered interval, can be traced south a short distance where they wedge out beneath the marlstone (fig. 50).
Fossils: Acetic acid residues yield conodonts.

D. *Lithology*: Covered....1 foot

COCHRANE MEMBER (total 39 feet)

C. *Lithology*: Gray to pinkish-gray calcilutite with scattered pink pelmatozoan plates. Parts of this rock are heavily glauconitic, other parts have almost none. ....3 feet
Remarks: Much of this rock has a lithology similar to the Clarita; however, if these beds are traced south they grade laterally into typical Cochrane lithology. This, plus the fact the conodont faunas appear to be of the Cochrane type, indicates that C is merely a facies of the Cochrane as shown in figure 50.
Fossils: Acetic acid residues with conodonts.

B. *Lithology*: Gray, calcilutite and calcarenite. Glauconite content variable, but common in most beds. Little or no chert. ....36 feet
Remarks: This unit is composed almost entirely of typical Cochrane lithology. Acetic acid residues yield a conodont fauna like that of C.
Fossils: Acetic acid residues with a conodont fauna.

KEEL MEMBER (1 foot exposed)

A. *Lithology*: Tan, mottled with gray, oolitic dolomite. Oolites to a millimeter or so; HC*l* insoluble residues, 2.35%; $CaCo_3$ 60.72%; $MgCO_3$ 36.38%. ....1 foot
Remarks: This is the only dolomitic specimen of Keel which I have observed. Its high $MgCO_3$ content is especially remarkable in view of the fact that in all other areas where the Keel has been analyzed it yields 1% or less $MgCO_3$. However, the rock is clearly dolomitic, reacting only weakly to acetic acid; the chemical analysis was run twice.

Covered.

STRATIGRAPHIC SECTION J5

Southwest of Wapanucka

Section described by T. W. Amsden, Oct. 5, 1956. It is located about 1½ miles south of Wapanucka; SE¼ SW¼ sec. 22, T. 2 S., R. 8 E., Johnston Co., Okla. See introductory discussion preceding J1 and figure 50.
Covered (Woodford float)

HUNTON GROUP (total 171 feet)

BOIS D'ARC FORMATION (total 85 feet)

CRAVATT MEMBER (total 85 feet)

H. *Lithology*: Yellowish-gray, argillaceous calcilutite with nodules of tripolitic to vitreous chert. Little or no calcarenite. ....85 feet
Remarks: The top of H is covered, but the presence of Woodford shale float indicates that most of the Bois d'Arc is exposed.
Fossils: None collected, but specimens of *Levenea* and *Orthostrophia* observed near the top.

HARAGAN FORMATION (total 19 feet?)

G. *Lithology*: Mostly covered. Scattered outcrops of yellowish-gray marlstone. No chert observed. ... 19 feet

Fossils: Only a few poorly preserved fossils collected loose on surface: *Levenea subcarinata pumilis*, *Leptaena* sp., and a few fragments of dalmanitid trilobites. The lower part of G could include some Henryhouse.

HENRYHOUSE FORMATION? (total 5 feet?)

F. *Lithology*: Yellowish-gray marlstone with glauconite. The washed HC1 insoluble residues are largely silt-size clear quartz and rounded nodules of glauconite. No arenaceous Foraminifera observed. ... 1 foot

Remarks: This rock grades into the underlying glauconitic limestone with which it appears to be closely related.

Fossils: A few fragmentary specimens of *Lissatrypoidea* observed. See discussion under E below.

E. *Lithology*: Yellowish-gray, argillaceous and glauconitic calcarenite. HC1 insoluble residues with much glauconite and some incompletely silicified fossils; some large spherical Foraminifera. ... 4 feet

Remarks: The age of this interval is in question. It grades into unit F which has a few fossils suggesting Henryhouse. The acetic residues yield a large conodont fauna including both simple and many compound blade types which appear unlike those from the the underlying unit E. The presence of Henryhouse in this belt of Hunton is open to some question, but the evidence from J1 (see J1-F), J4 and J5 strongly suggests the presence of a few feet of Henryhouse; this basal part of the marlstone could be Clarita, but the faunal evidence is more in favor of Henryhouse. A detailed study of the conodont fauna will probably furnish conclusive evidence on this point.

Fossils: Rich conodont fauna; see *Remarks* above.

CHIMNEYHILL FORMATION (total 63 feet, no Keel exposed)

CLARITA MEMBER (total 13 feet)

D. *Lithology*: Gray calcilutite with scattered pink pelmatozoan plates. Evenly bedded, beds to 4 or 5 inches. HC1 residues with limonite and pyrite in addition to the silt size quartz; some glauconite present; Foraminifera rare. Acetic acid with many conodonts. ... 12 feet

Remarks: Unit D has a typical Clarita lithology and carries a large conodont fauna which appears also to be typical for this member. Thus unit D would appear to be unquestionably Clarita, although its upper (see above) and lower (see below) boundaries may be in doubt.

Fossils: Large conodont fauna.

C. *Lithology*: Covered ... 1 foot

COCHRANE MEMBER (total 50 feet, no Keel exposed)

B. *Lithology*: Gray calcilutite with pink pelmatozoan fragments. Some glauconite present. ... 12 feet

Remarks: Lithologically this unit is more like D above than A below; however, it can be traced laterally into typical Cochrane lithology (like A), thus the stratigraphic evidence indicates B is a facies of the Cochrane. The conodont faunas seem to support this interpretation as the fauna from B is like that of A, and unlike that of the overlying D.

Fossils: Acetic acid residues yield conodonts and arenaceous Foraminifera.

A. *Lithology*: Gray calcarenite and calcilutite.......................................38 feet
Lower part strongly glauconitic, upper part becoming less so. Upper part developing some beds of "'pink-crinoidal" type of lithology. Lower part with some chert.
Remarks: The lower part of A is typical Cochrane lithology which grades up into a lithology more like the Clarita. Conodonts are like those from B and differ from C, thus supporting the evidence that A and B are all properly included in the Cochrane.
Fossils: Acetic acid residues with conodonts.

Covered (no KEEL exposed).

STRATIGRAPHIC SECTION J6*

West of Wapanucka

Section described by T. W. Amsden, Oct. 11, 12, 1956. About 4 miles west of Wapanucka; measured in bed of a small stream, E½ SW¼ sec. 18, T. 2 S., R. 8 E., Johnston County, Okla. This section is of interest because it is one of the areas where the Bois d'Arc can be observed directly in contact with the Cochrane member.

Covered (much WOODFORD float).

HUNTON GROUP (total 198 feet)

BOIS D'ARC FORMATION (total 190 feet)

CRAVATT MEMBER: Yelowish-gray, argillaceous calcilutite with nodules of brown to light-brown, tripolitic chert. Few beds mottled with red. Rare beds of calcarenite, almost all being calcilutite. Evenly bedded, beds to a foot. See plate VI, figure 1.
J6-D .... 190 feet

CHIMNEYHILL FORMATION (total 8 feet)

COCHRANE MEMBER: Gray, strongly glauconitic, fossiliferous limestone. Acetic acid residues with conodonts, all appearing to be of the Cochrane type.
J6-C .... 6 feet

KEEL MEMBER: Yellowish-gray, oolitic limestone.
J6-B .... 1 foot

IDEAL QUARRY MEMBER: Brown, fossiliferous calcarenite.
J6-A .... 1 foot

Covered.

STRATIGRAPHIC SECTION J7*

West of Wapanucka

Section described by T. W. Amsden, Oct. 12, 1956. About 4 miles west of Wapanucka, and approximately 1,000 feet northwest of section J6; NW¼ SW¼ sec. 18, T. 2 S., R. 8 E., Johnston County, Okla. This is only a partial section, recorded because the Bois d'Arc can be observed directly in contact with the Cochrane member; this is the same relationship found at J6; however, at J7 the Cochrane has tripled in thickness.

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with many modules of brown-weathering, porous chert. Thickness not measured.

CHIMNEYHILL FORMATION

COCHRANE MEMBER: Gray, fossiliferous calcarenite with much glauconite.
J7-A .... 16 feet

Covered.

STRATIGRAPHIC SECTION J9*

North of Reagan

Section described by T. W. Amsden, Oct. 23, 1956. About 2 miles north of Reagan, SE¼ SE¼ sec. 18, T. 2 S., R. 6 E., Johnston County, Okla. The

outcrops are poor throughout this Hunton belt extending from the SE¼ sec. 18, T. 2 S., R. 6 E., to the NW¼ sec. 24, T. 2 S., R. 5 E. A careful examination of the strata in this area shows only Bois d'Arc, there being no evidence for any marlstone (Haragan or Henryhouse), or any Chimneyhill. It is therefore presumed that the Bois d'Arc strata rest directly on the Sylvan shale as shown in panel III, plate C.
Covered.

BOIS D'ARC FORMATION (approximately 80 feet exposed).

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with many nodules of brown-weathering chert.
J9-A .... 80 feet (approx.)
Covered.

STRATIGRAPHIC SECTION J10

This location covers the Hunton exposures in the SW¼ sec. 15, T. 2 S., R. 5 E., Johnston County, Okla. The exposures are poor in this area, but a careful examination of the outcrops shows that both the Bois d'Arc and the Cochrane are present; thus the Chimneyhill reappears between J9 and J10.

STRATIGRAPHIC SECTION J11

West of Mill Creek town

Section described and collected by T. W. Amsden, Oct. 24, 25, 1958. It is located about ¾ mile west of Mill Creek town; entire section measured in the bed of a small creek, SE¼ NW¼ sec. 12, T. 2 S., R. 4 E., Johnston County, Okla.

This is the thickest section of Bois d'Arc (220 feet) that I have measured. This formation is well exposed with both the Cravatt and Fittstown lithofacies represented. A moderately large brachiopod fauna was collected from the upper 5 feet of the Fittstown member (J11-L). A columnar section of this formation is shown in figure 40; analyses of rock samples from J11 are given in the section, CHEMICAL ANALYSES. (See also Amsden 1958A, p. 28; 1958B, p. 32).
Covered (much WOODFORD float)

HUNTON GROUP (total 301 feet)
BOIS D'ARC FORMATION (total 220 feet)
FITTSTOWN MEMBER (total 140 feet)

L. *Lithology*: Light-gray to yellowish-gray,...5 feet
fossiliferous calcarenite, locally grading into a calcirudite. Beds to 8 inches. No chert observed. Three HC*l* residues, 2%, 3% and 5%.
Remarks: The upper contact is covered, but the abundant Woodford shale float indicates a nearly complete exposure of Fittstown. No conodonts observed in the acetic acid residues.
Fossils: A number of brachiopods collected in situ: *Strophonella (S.) bransoni*, *Leptostrophia beckii tennesseensis*, *Leptostrophia* sp. 2, *Leptaena* cf. *L. rhomboidalis*, *Schellwienella marcidula*, *Sphaerirhynchia lindenensis*, *Obturamentella wadei*, *Coelospira virginia*, *Howellella cycloptera*, *Meristella atoka*, *Rhynchospirina maxwelli*.

K. *Lithology*: Partly covered. Few outcrops of...18 feet
yellowish-gray argillaceous calcilutite with nodules of chert; rare beds of calcarenite. HC*l* insoluble residue, 14.5%.

J. *Lithology*: Yellowish-gray calcarenite with a...26 feet
small amount of chert. Two HC*l* insoluble residues, 5.5%, 6%. Beds to 8 inches.
Fossils: Highly fossiliferous; no collection made.

I. *Lithology*: Covered...16 feet

H. *Lithology*: Yellowish-gray calcilutite and calcarenite. Nodules of vitreous chert. One HC*l* insoluble residue, 5%. ....20 feet

G. *Lithology*: Yellowish-gray calcarenite with beds of argillaceous calcilutite. Nodules of vitreous chert. HC*l* residue, 5%. ....55 feet

Remarks: This interval is transitional between the overlying calcarenites and the underlying marlstones. The specimen tested for HCl residues yielded only 5%, but some of the more argillaceous calcilutites would undoubtedly test much higher.

CRAVATT MEMBER (total 80 feet)

F. *Lithology*: Yellowish-gray, argillaceous calcilutite with nodules of vitreous to porous chert. Two HC*l* insoluble residues, 23% and 17%. ....20 feet

Fossils: No collection made but this interval is fossiliferous.

E. *Lithology*: Yellowish-gray, argillaceous calcilutite with nodules of vitreous to tripolitic chert. Two HC*l* insoluble residues, 9.5%, 11%. ....60 feet

Remarks: This unit is lithologically similar to the underlying Haragan, except E has chert.

Fossils: No collection made.

HARAGAN FORMATION (total 74 feet?)

D. *Lithology*: Yellowish-gray, argillaceous calcilutite or marlstone. Bedding nodular, up to 3 or 4 inches in thickness. No chert observed. ....29 feet

Remarks: Unit D was measured in a small stream bed which yielded no fossils, but a fairly typical Haragan fauna was collected from the equivalent strata about 100 feet west of the stream.

Fossils: A small Haragan fauna collected including the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Leptaena acuticuspidata, Meristella atoka.*

Covered ....45 feet

Remarks: No rock exposed in this interval and no fossils were seen; some Henryhouse could be included in the lower part.

CHIMNEYHILL FORMATION (total 7 feet)

COCHRANE MEMBER (total 3 feet)

C. *Lithology*: Gray, fine- to medium-grained calcarenite with small nodules of glauconite. ....3 feet

Remarks: Typical Cochrane lithology; no Clarita observed in this area. Acetic acid residues yield no conodonts nor arenaceous Foraminifera.

KEEL MEMBER (total 2 feet)

B. *Lithology*: Grey, oolitic limestone. Most of the oolites are less than a millimeter. ....2 feet

IDEAL QUARRY MEMBER (total 2 feet)

A. *Lithology*: Brown-weathering, fossiliferous calcarenite with few scattered oolites. ....2 feet

Covered.

STRATIGRAPHIC SECTION J12*

West of Ravia

Section described and collected by T. W. Amsden, Oct. 24, 1956. Located about 2 miles west of Ravia, on the boundary between section 4 and 5, about 1/3 mile south of the northern edge of these sections, T. 4 S., R. 5 E.; Johnston County, Okla. Analyses of rock samples from this section given in the section, CHEMICAL ANALYSES.

WOODFORD SHALE (exposed in contact with the Bois d'Arc)

HUNTON GROUP (total 136 feet)

BOIS D'ARC FORMATION (total thickness 30 feet)

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with nodules of vitreous chert.

J12-F .... 30 feet

HARAGAN FORMATION: Yellowish-gray, argillaceous calcilutite or marlstone with no chert. The following Haragan fossils collected from unit E: 1 snail, a dalmanitid trilobite, *Phacops*? sp., and the following brachiopods: *Atrypa* sp., *Camarotoechia*? *haraganensis*, *Levenea subcarinata pumilis*, *Meristella atoka*, *Rhipidomelloides oblata*? No fossils were found in unit D and this lower part could include some Henryhouse.

feet above base of formation

J12-E .... 15 to 83 feet

J12-D .... 0 to 15

HENRYHOUSE FORMATION: Yellowish-gray marlstone like above. Two specimens of *Lissatrypoidea* sp. collected. Exact position of Henryhouse-Haragan contact not determined.

J12-C .... 14 feet

CHIMNEYHILL FORMATION (total 9 feet)

CLARITA MEMBER: Gray, fossiliferous calcilutite with scattered pink pelmatozoan fragments. Acetic acid residue with conodonts and arenaceous Foraminifera

J12-B .... 5 feet

COCHRANE MEMBER: Gray, fossiliferous calcilutite and calcarenite with sparse, small nodules of glauconite. Acetic acid residues with conodonts. No evidence for any Keel or Ideal Quarry in this area and the Cochrane probably rests directly on the Sylvan.

J12-A .... 4 feet

Covered (Sylvan float).

STRATIGRAPHIC SECTIONS J13 to J18

Oil Creek area

Stratigraphic section J13 to J18 describe a cherty carbonate unit of uncertain age. These sections are located near Oil Creek, in the western part of Johnston County; the general geographic and geologic relation is shown in figure 44. This stratigraphic unit is thin, nowhere exceeding 25 feet in thickness, and is overlain by the Woodford shale and underlain by the Sylvan shale. It thus occupies the position of the Hunton and past investigators have treated it as an erosional remnant of the Chimneyhill (Cochrane member). In my opinion, however, the preponderance of evidence strongly points to a post-Hunton age and it is accordingly informally termed the Woodford? brown carbonate (the query emphasizing the uncertainties concerning its stratigraphic relationships). For a discussion of this unit see the section on WOODFORD? BROWN CARBONATE.

STRATIGRAPHIC SECTION J13

near Oil Creek

Section described by T. W. Amsden, May 15, 1957. Located on the Goddard Ranch, just a short distance east of the lake on Oil Creek; NW¼ SW¼ sec. 17, T. 3 S., R. 4 E., Johnston County, Okla. The geographic and stratigraphic relationship of the section is shown on figure 44; two analyses given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION

A. *Lithology*: Fissile, dark shale with some thin .... beds of blocky siltstone.

Remarks: This is typical Woodford lithology and completely unlike any unquestionable Hunton. It is exposed in contact with the underlying strata.

WOODFORD? BROWN CARBONATE (total 7 feet)

B. *Lithology*: Brown (10YR 8/6 to 10YR 5/4), glauconitic and dolomitic limestone. Four specimens tested for HC*l* insoluble residues, 7%, 9.4%, 9.9%, 12%; two tested for $MgCO_3$, 1.6% and 9.7%; two $CaCO_3$, 87.1% and 80%. HCl residues with much glauconite and some brown mineral, possibly limonite; also silt and sand size clear detrital quartz with some grains being fairly well rounded. Chert rare or absent. ......7 feet

Parts of this rock are porous, the open spaces being lined with crystals of carbonate; some of these holes may be the molds of fossils. The glauconite in this rock, which is extensive, is mostly in the form of small angular fragments; there is little or none of the rounded, polylobate nodules and fossil fillings that are so common in the Cochrane member.

Remarks: There is no doubt that the Woodford? brown carbonate J13 is the same as that at J14 to the south and J15 to the north; this unit can be traced more or less continuously throughout this area. There are certain features of this rock at J13 which are unusual and significant in determining its relationship. One specimen tested had a $MgCO_3$ content of 1.6% and an insoluble residue content of 9.4%, a composition which is not unlike that exhibited by some Chimneyhill units although the residues are somewhat higher than common in that formation; in spite of this similarity in composition this rock bears no resemblance to any undoubted Chimneyhill, either in a hand specimen or in a thin section. Two thin sections were cut (see photomicrographs, pl. XV, figs. 5, 6), both showing a crystalline carbonate with no fossil material. The glauconite is also interesting as it shows little resemblance to the Cochrane type glauconite; in J13-B the glauconite is in small angular fragments whereas the Cochrane glauconite is mostly in the form of rounded nodules or as fossil steinkerns. Finally J13-B is distinctive because of the presence of well-rounded, frosted quartz grains ranging up to sand size; these are not especially common, but they are virtually unknown in the Chimneyhill. Thus J13-B shows almost no lithologic resemblance to any unquestioned Chimneyhill strata and there is no evidence in the form of excessive dolomite or silica to indicate that it is altered Hunton.

Fossils: None collected although some of the porous spaces may be molds; see above.

SYLVAN SHALE (exposed in contact with J13-B)

STRATIGRAPHIC SECTION J14

Near Oil Creek

Section described by T. W. Amsden, May 15, 21, 1958. On the Goddard Ranch, about a half mile east of the lake on Oil Creek; SE¼ SW¼ sec. 17, T. 3 S., R. 4 E., Johnston Co., Okla. (see fig. 44). An analysis is given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION

A. *Lithology*: Fissile shale and thin, blocky siltstones. ......

Remarks: This is typical Woodford shale.

WOODFORD? BROWN CARBONATE (total 6 feet)

B. *Lithology*: Brown to dark-brown, glauconitic and dolomitic limestone. This rock has considerable chert and the upper 1 foot is almost solid chert. Most of the non-cherty parts ......6 feet

(i. e. portions showing little external evidence of silicification) have a rather low HCl insoluble residue; 4 specimens tested yielded 3%, 3½%, 5% and 11%. The washed residues of specimens with a low insoluble content are mostly glauconite, a brown mineral (possible limonite) and detrital quartz; the detrital quartz grains are commonly well rounded and frosted, and some range well into the sand size. The more cherty portions have small quartz crystals as a residue.

Parts of this rock have considerable dark-gray to black carbonaceous material. The residues from this are coated with a dark, tar-like material.

Remarks: This rock occupies exactly the same position as, and is almost certainly continuous with, the brown carbonate at J18 and J13.

Fossils: None observed.

SYLVAN SHALE

STRATIGRAPHIC SECTION J15

Near Oil Creek

Section described by T. W. Amsden, May 21, 1957. On the Goddard Ranch, a short distance west of the lake on Oil Creek: SE¼ NE¼ sec. 18, T. 3 S., R. 4 E., Johnston County, Okla. See figure 44.

WOODFORD SHALE

A. *Lithology*: Dark, fissile shale with thin beds of blocky siltstone.

Remarks: This is typical Woodford shale.

B. *Lithology*: Yellowish-gray (5Y 7/2) to grayish-yellow (5Y 8/4) clay and siltstone. Thinly bedded, beds less than ½ inch but not fissile. It is strongly glauconitic with some of the glauconite filling or replacing fossils. Little or no carbonate; will not react when powdered and placed in hot HCl; only the cavities (fossils?) show a faint reaction. .... 2 feet

Remarks: Unit B is similar to the underlying bed (C) in being richly glauconitic with the glauconite replacing or filling fossils. B is, however, unlike any Hunton known being without any carbonate; it is almost certainly a part of the Woodford and is sharply marked off from C by its lack of carbonate.

C. *Lithology*: Pale yellowish-brown (10YR 6/2) to dark yellowish-brown (10YR 4/2) shale; beds less than ½ inch but without fissility. Richly glauconitic. .... 1 foot

Remarks: This rock is like unit B except for color. It is not calcareous and would seem to belong in the Woodford.

WOODFORD? BROWN CARBONATE (total 5 feet)

D. *Lithology*: Brown-weathering (10YR 7/4, 5YR 6/4, 10YR 4/2) dolomite. Richly glauconitic with the glauconite mostly in rounded grains, but some as a replacement or filling of fossils. Texture mostly a calcilutite, somewhat porous. HCl insoluble residues, 5½%; prepared by digesting pieces of 9 different rock specimens in hot HCl; residues largely glauconite with some reddish-brown mineral, possibly limonite. Also silt size subangular to subrounded clear detrital quartz, some grains fairly well rounded and frosted. Some spongy silica. Percentage $MgCO_3$ not determined but it must be high as there is only a weak reaction to cold, dilute HCl. .... 4 feet

No chert observed although the residues suggest some silicification. In places this rock has a brecciated texture; this has been observed at several places and appears to be a primary structure.

Remarks: D is sharply marked off from the overlying beds by its carbonate content, but is linked to C by its pronounced glauconite contact which appears to be in an identical form. This rock is not a bioclastic limestone (although it does have a few fossils) and except for its glauconite is unlike any known Cochrane; if it is the latter it must have been intensely altered by dolomitization (note the presence of well-rounded quartz grains).

E. *Lithology*: Fractured, porous chert with some porous dolomite. Only minor glauconite . HC*l* residues, which are very high, probably over 70%, are composed largely of drusy quartz. ....1 foot
Remarks: E is the basal part of D with which it appears to be intimately related.

Covered (probably Sylvan shale).

STRATIGRAPHIC SECTION J16

Near Oil Creek

Section described by T. W. Amsden, May 21, 1957. Located on the Goddard Ranch, a short distance west of the lake on Oil Creek; it is about 100 yards northwest of J15, SW¼ NE¼ sec. 18, T. 3 S., R. 4 E., Johnston County, Oklahoma. (fig. 44). See CHEMICAL ANALYSES.

WOODFORD SHALE

A. *Lithology*: Fissile shale with thin beds of blocky siltstone. Some of the siltstone is dolomitic. ....
Remarks: This is typical Woodford shale.

B. *Lithology*: Tan silty dolomite. One sample tested yielded 28% HC*l* insoluble residues, 41.8% $CaCO_3$, and 25.8% $MgCO_3$. HC1 washed insolubles almost entirely in the form of subangular, silt-size quartz; one thin section also brings out the angular to subangular character of the detrital grains. Possibly some pyrite present, but very little glauconite. ....2 feet
Remarks: This unit is retained within the Woodford because of its substantial silt content. If it is Hunton it must represent the marlstone, but the absence of fossil material makes this appear unlikely.

C. *Lithology*: Brown, dolomitic siltstone. Glauconitic with some of the glauconite fossiliferous. Few conodonts from acetic residues. One HC*l* insoluble residue calculated at 78%; residues with some rounded and frosted detrital grains which would seem to relate it to the underlying beds. ....1 foot
Remarks: Possibly this bed and B should be placed with the underlying strata.

WOODFORD? BROWN CARBONATE (total 4 feet)

E. *Lithology*: Brown to brownish-gray, glauconitic dolomite. HC*l* insoluble residue, 5%; washed residue largely glauconite with some silt and sand size clear quartz, some of which is rounded and frosted; also some spongy silica which probably represents a secondary quartz. ....1 foot

Acetic acid residues yield 5 or 6 fragmentary conodonts; these are broken so it will be difficult to identify them.
Remarks: Stratigraphically this unit seems to be related to the overlying D; it also has the same type of residues as does D but has a much higher carbonate content.

F. *Lithology*: Brown weathering, strongly silicified dolomite with some glauconite. One HC*l* residue, 76%; residues mostly quartz crystals and aggregates of quartz crystals indicating silicification. ....2 feet

G. *Lithology*: Brown, silicified dolomite like F; very little glauconite. Much of the rock appears brecciated. HC*l* insolubles residues 71%; residues almost entirely composed of secondary quartz. ....1 foot

Remarks: G is lithologically the same as, and stratigraphically a part of F. These two units differ from E in having much more silica but otherwise seem to be similar; units E, F, and G are probably part of the same closely related sequence of beds, and possibly C and D also should be included.

SYLVAN SHALE (exposed in contact)

STRATIGRAPHIC SECTION J17

Near Oil Creek

Section described by T. W. Amsden, May 21, 1957. On the Goddard Ranch about ¼ mile west of the lake on Oil Creek; it is approximately 300 yards west of J16: SW¼ NE¼ sec. 18, T. 3 S., R. 4 E., Johnston County, Okla. (see fig. 44).

WOODFORD SHALE

A. *Lithology*: Fissile, gray shale with thin, blocky siltstone beds.

B. *Lithology*: Tan, dolomitic and argillaceous siltstone. Washed HC*l* residues mostly clear quartz grains with considerable mica; some quartz grains are rounded and frosted.
Remarks: This rock is lithologically like J16B and since it occupies the same stratigraphic position the two are probably the same bed (see *Remarks* under J16-B).

C. *Lithology*: Covered.......2 feet

WOODFORD? BROWN CARBONATE

D. *Lithology*: Brown weathering, glauconitic dolomite.......2 feet HC*l* insoluble residue, 8½% washed residues with much glauconite and considerable spongy, drusy quartz that probably represents silicification; some detrital quartz.
Remarks: This would appear to be the same bed as the brown carbonate at J16.

SYLVAN SHALE

Lithology: Greenish shale with some beds of silty dolomite in the upper 30 feet. One specimen of the siltstone analyzed: 18.1%, HC*l* insoluble residue: 44.74% $CaCO_3$; 26.1% $MgCO_3$; photomicrograph illustrated, pl XVI, figure 6.

STRATIGRAPHIC SECTION J18

Near Oil Creek

Section described by T. W. Amsden, May 15, 21, 1957. On the Goddard Ranch, about 1 mile southeast of the lake on Oil Creek this section is well exposed on the bed of a small creek flowing southwest into Oil Creek; NW¼, NE¼ sec. 20, T. 3 S., R. 4 E., Johnston County, Okla. (fig 44). This is the most southeastern exposure of the Woodford? brown carbonate that I have seen. For analyses see CHEMICAL ANALYSES. Thin sections illustrated, pl XV.

WOODFORD SHALE

Lithology: Gray, fissile shale with thin beds of blocky siltstone.

A. *Lithology*: Brown, silty dolomite in beds to 3 or 4 inches.......4 feet HC*l* insoluble residue 18%; washed residues composed almost entirely of silt size quartz; no glauconite observed.
Remarks: The Woodford is well exposed in the stream bed and this dolomite bed can be seen to be a lens, about 20 feet long, and completely enclosed in shale. There are other similar lenses in the lower part of the Woodford.

B. *Lithology*: Fissile shale with blocky, thin siltstones.......30 feet
Remarks: Typical Woodford shale.

WOODFORD? BROWN CARBONATE (total 23 feet)

C. *Lithology*: Chert with some glauconitic dolomite................................1 foot
Parts appear to be brecciated.
Remarks: This rock appears to be the upper part of D from which it is separated because of its greater chert content. Much of C is solid chert.

D. *Lithology*: Brown-weathering, glauconitic dolomite............................19 feet
and limestone. There is considerable chert present. Analysis of three specimens selected to avoid the chert shows HC*l* insolubles ranging from 6 to 16%, $MgCO_3$ from 2.4 to 33%. The washed residues show some silt and sand size quartz grains which are rounded and frosted. In places this rock has much carbonaceous material; this is a soft, black "tar" that is slightly soluble in carbon tetracloride. Parts of D appear brecciated. Photomicrographs illustrated on plate XV, figures 1, 2.
Remarks: Units C, D and E appear to be a part of the same sequence. Few steinkerns of megafossils.

E. *Lithology*: Brown, porous, glauconitic dolomite....................................3 feet
Like above but with little or no chert. This rock is porous and at least some of the holes appear to be cavities occupied by fossils. Two specimens analyzed: HC*l* insolubles 4.0 and 4.5%; $MgCO_3$, 36.2% and 36.6%. Washed residues mostly glauconite and silt to sand size clear quartz, some of which is rounded and frosted.
Remarks: Both E and D carry some poor casts of fossils, none of which can be identified. Acetic acid residues from E yield fragments of conodonts. Photomicrographs illustrated, plate XV, figure 3.

Covered.

STRATIGRAPHIC SECTION L1

Criner Hills - southwest of Overbrook

Section described by T. W. Amsden, April 15, 16, 1958. About ½ mile southwest of Overbrook; NW¼ SE¼ sec. 1, T. 6 S., R. 1 E., Love County, Okla. There is considerable structural deformation in this area and it is possible that L1 is affected by this. The exposed marlstone appears to be unfaulted, but there may be faulting in the lower covered portion; the total thickness of the marlstone (Henryhouse plus Haragan) on L1 is 101 feet, and 86 feet on L2, indicating that if faulting does affect these sections it is minor. Strike of the beds is 160 degrees (magnetic), dipping 30 degrees to the northeast.

Covered (Woodford float)

HUNTON GROUP (total 147 feet exposed)

BOIS D'ARC FORMATION (total 24 feet exposed)

CRAVATT MEMBER

H. *Lithology*: Partly covered. Scattered outcrops.......................................24 feet
of yellowish-gray marlstone with nodules of porous to vitreous chert.
Remarks: Poorly exposed, but there are exposures of cherty marlstone. Upper contact covered and may be faulted.

HARAGAN FORMATION (total 47 feet)

G. *Lithology*: Yellowish-gray marlstone with many....................................28 feet
Camarocrinus bulbs.
Remarks: Units D. to G inclusive are completely exposed by a bulldozer trench.

F. *Lithology*: Yellowish-gray marlstone with many....................................9 feet
Camarocrinus bulbs.
Fossils: Unit is marked by numerous bulbs of *Scyphocrinites* (*Camarocrinus*), many of which can be observed in situ. In addition,

1 snail, a solitary horn coral and the following brachiopods collected: *Leptaena acuticuspidata*, *Lissostrophia (L.) lindenensis?*, *Meristella atoka*, *Rhipidomelloides* sp.

E. *Lithology*: Yellowish-gray marlstone........10 feet

Remarks: Lithologically like the beds above and with the same Haragan fauna; also lithologically like the underlying beds, but these carry a Henryhouse fauna.

Fossils: Five horn corals, 3 snails, a *Phacops?* sp. and the following brachiopods collected: *Atrypina hami*, *Dicoelosia varica*, *Leptaena acuticuspidata*, *Levenea subcarinata pumilis*, *Meristella atoka*, *Orthostrophia strophomenoides parva*, *Rhipidomelloides* sp.

HENRYHOUSE FORMATION (total 53 feet)

D. *Lithology*: Yellowish-gray marlstone........3 feet

Remarks: This unit appears to be lithologically like unit E above; the contact between these two is completely exposed and gives no evidence of a stratigraphic break. D carries a typical Henryhouse fauna, except for a single specimen of *Kozlowskiellina (M.) velata* which was collected loose and which almost certainly represents float from E.

Fossils: The pygidium of a trilobite, 3 small horn corals and the following brachiopods collected loose on the surface: *Atrypa tennesseensis*, *Leptaena oklahomensis*, *Lissatrypoidea concentrica*, *Rhipidomelloides* sp., *Kozlowskiellina (M.) velata* (see under *Remarks*).

C. *Lithology*: Covered........50 feet

CHIMNEYHILL FORMATION (22 feet exposed)

COCHRANE MEMBER (22 feet, no other Chimneyhill exposed)

A. *Lithology*: Gray, calcarenite with a few........22 feet scattered grains of glauconite. Bedding irregular, up to 2 or 3 feet.

Remarks: This rock is only sparingly glauconitic, but the general character of its lithology and bedding places it in the Cochrane. It is the only Chimneyhill member observed near this section; the Keel is present at L2, but no Clarita was observed near either section and presumably this member is absent.

Covered.

STRATIGRAPHIC SECTION L2*

Criner Hills - southwest of Overbrook

Section described by T. W. Amsden, April 16, 1958. Criner Hills, about ½ mile southwest of Overbrook; SE¼ NW¼ sec. 1, T. 6 S., R. 1 E., Love County, Okla. See introductory remarks under L1. (Analyses given in section on CHEMICAL ANALYSES).

HUNTON GROUP

BOIS D'ARC FORMATION

CRAVATT MEMBER: Few beds of yellowish-gray marlstone with brown-weathering chert exposed on top of the ridge. Exposures are poor and the thickness cannot be determined.

L2-G ....

HARAGAN FORMATION: Yellowish-gray marlstone; upper 15 feet completely exposed by a bulldozer trench. Carries a typical Helderberg fauna including the following brachiopods: *Leptaena acuticuspidata*, *Levenea subcarinata pumilis*, *Orthostrophia strophomenoides parva*, *Rhipidomelloides* sp. Also a few horn corals, a phacopid pygidium and the bulbs of *Scyphocrinites (Camarocrinus)*.

	Feet above base of formation
L2-F	28 to 43
L2-E (partly covered)	8 to 28
L2-D	0 to 8

HENRYHOUSE and/or **HARAGAN FORMATION:** Yellowish-gray marlstone like above. Yields a mixture of Henryhouse and Haragan fossils: *Levenea* sp., *Meristella atoka*, *Lissatrypoidea concentrica*, *Isorthis arcuaria*? plus a few corals including a *Pleurodictyum*.

L2-C .... 3 feet

HENRYHOUSE FORMATION: Yellowish-gray marlstone like above. Several good specimens of *Lissatrypoidea concentrica* and a pygidium of *Eophacops*? sp.

	Feet above base of formation
L2-B	38 to 40
L2-A (Covered)	0 to 38

CHIMNEYHILL FORMATION: There are good exposures of both Cochrane and Keel in this area, but the rocks are structurally deformed so it was not possible to obtain a reliable thickness. No Clarita seen here or at L1.

STRATIGRAPHIC SECTION M1

Vines dome

Section described by T. W. Amsden, Oct. 25, 26, 27, 1955. Located on the southeast end of Vines dome, about 250 feet northeast of Oklahoma Highway 7C, approximately 1 mile north of Dougherty, Murray County, Okla.; NW¼ NW¼ sec. 2, T. 2 S., R. 2 E. The base of this section (Clarita member) is almost on the east-west section line, about 600 feet east of the northwest corner of sec. 2; it extends in an easterly direction to the top of the ridge formed by the Bois d'Arc and down the dip slope to the Woodford contact. The lowest bed exposed on this section is the Clarita member; the Cochrane is probably present, although not exposed, but the Keel and Ideal Quarry members are believed to be absent in this region. Strike of the beds from 35 to 45 degrees (magnetic), dipping 25 degrees to the southeast.

Analyses of selected rock specimens given in the section, CHEMICAL ANALYSES (see also figs. 24, 25, 26). A summary of this section given in Amsden 1958A, p. 29; 1958B, p. 33.

WOODFORD SHALE (exposed within a few feet of the Hunton)

HUNTON GROUP (post-Chimneyhill strata 204 feet)

BOIS D'ARC FORMATION (total 52 feet)

CRAVATT MEMBER (total 52 feet)

O. *Lithology*: Yellowish-gray (5Y 7/2), argillaceous .... 26 feet
calcilutite with nodules of vitreous chert. Evenly bedded, beds to 18 inches. Three analyses range from 3.9% to 10.1% $MgCO_3$. HC*l* insoluble residue from 3% to 10.1%; washed residues mostly silt size, subangular quartz with some mica and rounded nodules of glauconite. Peel shows this rock to be mostly finely divided carbonate and insoluble debris with some scattered fossils. Rock mostly calcilutite with little or no calcarenite. Acetic acid residues did not yield any conodonts or arenaceous Foraminifera.
Remarks: Locally the upper 3 or 4 feet of this unit is dolomitized; also with considerable glauconite. M is similar to O except for its vitreous chert.
Fossils: This unit is fossiliferous and some beds have a fairly high fossil concentration. It is difficult to extract satisfactory specimens but a few were collected, all being brachiopods: *Levenea subcarinata pumilis*, *Leptaenisca concava*, *Kozlowskiellina (M.) velata*, *Howellella cycloptera*, *Meristella* sp. 2.

M. *Lithology*: Yellowish-gray (10YR 7/4) .... 26 feet
fossiliferous calcilutite with nodules and small lenses of porous, brown weathering (5YR 4/4) chert. Some of the chert lenses are

moderately elongate along the bedding, reaching a length of 3 feet. HCl insoluble residue 10.1%; washed residues mostly silt size, clear, subangular quartz; there is also much spongy silica that probably represents incipient chert. No arenaceous Foraminifera observed in the HCl residues, nor were Foraminifera or conodonts seen in the acetic acid residues.
Remarks: The lower part of M makes the top of the Hunton ridge with the upper part forming a partial dip slope. M is quite similar to O except for its tripolitic type of chert. (Note the letter N was not used on this section).
Fossils: This unit is fossiliferous, although it is rather difficult to collect satisfactory specimens. A small fauna, almost entirely brachiopods, was collected: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Rhipidomelloides oblata, Dicoelosia varica, Anastrophia grossa, Strophonella (S.) bransoni, Stropheodonta (S.) gibbera, Leptaena* cf. *L. rhomboidalis, Coelospira virginia, Kozlowskiellina (M.) velata, Meristella atoka.*

HARAGAN FORMATION (total 90 feet)

L. *Lithology*: Mostly covered. Few outcrops of yellowish-gray marlstone like below. ....38 feet
Remarks: The few beds exposed are lithologically like M except for their lack of chert.
Fossils: A small fauna collected loose on the surface (some specimens may be float from M). It is dominantly brachiopods with a few snails, rare corals and trilobites. The following brachiopods collected: *Orthostrophia strophomenoides parva, Dicoelosia varica, Rhipidomelloides oblata, Anastrophia grossa, Strophonella (S.) bransoni, Stropheodonta (S.) gibbera, Leptaena acuticuspidata, Camarotoechia ? haraganensis, Atrypina hami, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Nucleospira ventricosa, Meristella atoka, Rhynchospirina maxwelli.*

K. *Lithology*: Pale greenish-yellow (10YR 8/2) fossiliferous marlstone. Bedding nodular, up to 3 inches. Two HCl insoluble residues calculated, 17.4% and 25%; washed residues mostly clear, silt size, subangular quartz with some mica; no arenaceous Foraminifera observed, nor were any microfossils seen in the acetic acid residues. $MgCO_3$ about 4%. ....16 feet
Remarks: There is no essential lithologic difference between J and K, the separation being for purposes of collecting. L was separated because it is so poorly exposed.
Fossils: A number of fossils collected loose on the surface. A few corals and phacopid trilobites were found, but the fauna is mostly brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Stropheodonta (S.) gibbera, S. (S.) arata Leptaenisca concava, Leptaena acuticuspidata, Sphaerirhynchia lindenensis, Camarotoechia? haraganensis. Coelospira virginia, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Meristella atoka, Rhynchospirina maxwelli.*

J. *Lithology*: Yellowish-gray (5Y 8/4 to 5Y 7/2 to 10Y 8/2) fossiliferous marlstone. Bedding nodular, to 2 inches. Two HCl insoluble residues, 17% and 18%; washed residues mostly silt size, subangular, clear quartz with some mica; no arenaceous Foraminifera observed nor were any fossils seen in the acetic residues. A peel of this rock shows it is composed of finely divided (less 1/16 mm) carbonate and insoluble debris with scattered fossils. One specimen yielded about 5% $MgCO_3$. ....7 feet
Remarks: This unit is lithologically similar to the beds above and below from which it was separated for collecting.
Fossils: A moderate fauna collected including a few Bryozoa, corals, trilobites, snails and the following brachiopods: *Ortho-*

strophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Isorthis pygmaea, Stropheodonta (S.) gibbera, Leptaena acuticuspidata, Sphaerirhynchia lindenensis, Coelospira virginia, Kozlowskiellina (M.) velata, Meristella atoka.

I. *Lithology*: Partly covered. Few beds of .... 5 feet

yellowish-gray fossiliferous marlstone. Two HC*l* residues, 11% and 17%; washed residues mostly silt size, clear, subangular quartz with some mica; no arenaceous Foraminifera observed, nor were any microfossils observed in the acetic acid residues. $MgCO_3$ about 3%. Peel shows this rock to be silt and finer debris with scattered fossils.

Remarks: Lithologically like beds above and below; separated for collecting.

Fossils: Uppermost bed is almost solid *Scyphocrinites* (*Camarocrinus*) bulbs. The following brachiopods collected: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Leptaena acuticuspidata, Schuchertella haraganensis, Camarotoechia? haraganensis, Kozlowskiellina (M.) velata, Meristella atoka.*

H. *Lithology*: Glade with scattered outcrops of .... 14 feet

yellowish-gray marlstone like beds above and below. Two HC*l* insoluble residues, 16.8% and 17.5%; washed residues mostly silt size clear quartz with some mica; one or two questionable Foraminifera present. No microfossils observed in acetic acid residues. Peel shows this rock to be largely finely divided (below 1/16 mm) carbonate and insoluble debris with fossils scattered through the matrix. $MgCO_3$ content low, about 1%.

Remarks: About 60% exposed. Separated for collecting only.

Fossils: A fairly large fauna collected loose on the surface. All are typical Haragan species with one exception: a single specimen of *Dictyonella* was collected; this consists of about two-thirds of a pedicle valve and looks identical to the Henryhouse species *D. gibbosa*. Since this is the only anomalous species in an otherwise typical Haragan assemblage, and since it appears to be identical to the Henryhouse specimens of *D. gibbosa*, it is assumed to represent contamination (i.e. float) and not an indigenous specimen. The remainder of the fauna consists of a few phacopid trilobites and corals, and the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Rhipidomelloides oblata, Leptaena acuticuspidata, Schellwienella marcidula, Sphaerirhynchia lindenensis, Camarotoechia? haraganensis, Coelospira virginia, Atrypina hami, Kozlowskiellina (M.) velata, Meristella atoka.*

G. *Lithology*: Partly covered: outcrops of .... 10 feet

yellowish-gray (5Y 7/2 to 5Y 8/4) marlstone. One HC*l* insoluble residue, 21.8%; washed residues silt size, clear quartz with some mica; no arenaceous Foraminifera observed, nor were any microfossils seen in the acetic residues.

Remarks: This unit is lithologically like the beds above and below. G carries a typical Haragan fauna and F a typical Henryhouse fauna, but there is no lithologic or stratigraphic evidence for a break.

Fossils: A typical Haragan fauna collected; this includes a few corals, snails and trilobites, and the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Rhipidomelloides oblata, Leptaena acuticuspidata, Sphaerirhynchia lindenensis, Atrypina hami, Meristella atoka.*

HENRYHOUSE FORMATION (total 62 feet)

F. *Lithology*: Fossiliferous, yellowish-gray ....6 feet
(5Y 6/4 to 5Y 7/2) marlstone. Two HC*l* insoluble residues, 26% and 19%; washed residues silt size, clear quartz with some mica; one or two questionable arenaceous Foraminifera seen but no microfossils seen in the acetic acid residues. $MgCO_3$ less than 1%.
Remarks: Unit F, and the underlying Henryhouse beds B to E, are lithologically like the Haragan. Both consist of fossiliferous marlstone with a relatively low $MgCO_3$ content. The Henryhouse has some red beds in its lower part, but the rest is a yellowish-gray like the Haragan. The HC*l* insoluble residue averages for both formations are shown on figure 24; $MgCO_3$ on figure 25.
Fossils: Moderate fauna collected loose on the surface. With the exception of a single specimen of *Levenea* which was collected loose from the upper 2 feet, all the fossils are Henryhouse. Six specimens of corals, 3 snails and 2 trilobites plus the following brachiopods: *Merista oklahomensis, Lissatrypoidea concentrica, Coelospira saffordi, Leptaena oklahomensis?, Rhipidomelloides* sp.

E. *Lithology*: Yellowish-gray (5Y 7/2), ...10 feet
fossiliferous, argillaceous calcilutite. HC*l* insoluble residue, 8%; washed residues mostly silt size with some mica; no arenaceous Foraminifera observed, nor were any microfossils seen in the acetic acid residues. Peel shows this rock to be composed largely of finely divided (silt and smaller) carbonate and insoluble debris; fossils are scattered through this matrix but constitute only a small part of the rock. $MgCO_3$ less than 1%.
Remarks: Unit E makes a distinct bench which can be traced for some distance along the strike; this topographic expression is probably related to its reduced insoluble content which makes it more resistant. E differs from D in color, the latter being red, and in its lower insoluble content.
Fossils: Moderately large Henryhouse fauna collected. Trilobites including specimens of *Calymene* sp. and *Eophacops* sp., several corals and bulbs of *Scyphocrinites* (*Camarocrinus*), plus the following brachiopods: *Anastrophia delicata, Atrypa tennesseensis, Dicoelosia oklahomensis, Lissatrypoidea concentrica, Lissostrophia cooperi, Merista oklahomensis?, Ptychopleurella rugiplicata, Sieberella roemeri. Coelospira saffordi.*

D. *Lithology*: Mottled grayish-red (10YR 4/2) and ....16 feet
yellowish-gray (5Y 7/2) marlstone. Bedding uniform, up to 6 inches. Two HC*l* insoluble residues, 12% and 25%; washed residues silt size quartz with some mica; no arenaceous Foraminifera observed, and no microfossils seen in the acetic acid residues. Peel shows the rock to be mostly silt and smaller carbonate and insoluble debris with scattered fossils; fossils constitute only a small part of the rock.
Remarks: This unit is characterized by its predominantly red color.
Fossils: Sparingly fossiliferous. A few specimens of corals, Bryozoa and snails collected; also the trilobites *Calymene* sp. and *Eophacops* sp., plus the following brachiopods: *Atrypa tennesseensis, Dicoelosia oklahomensis, Leptaena oklahomensis, Pseudodicoelosia oklahomensis, Sieberella roemeri.*

C. *Lithology*: Covered ....27 feet

B. *Lithology*: Yellowish-gray (5Y 8/4) marlstone ....3 feet
Bedding up to 2 inches. Two HC*l* insoluble residues, 25% and 26%: residues mostly silt size quartz with some mica; no arenaceous Foraminifera observed, nor were any microfossils seen in the acetic acid residues.
Remarks: In the field this unit appears to grade into the underlying Clarita, but there is actually a marked lithologic difference between them. B has a much higher insoluble content, around

25% as compared to about 8%; its fossil content is relatively low, consisting of only scattered fossils, compared to unit A which is composed in large part of fossil debris. Also B appears to be barren of microfossils whereas in A the HC*l* and acetic residues carry a prolific fauna of Foraminifera and conodonts.
Fossils: No collection made.

CHIMNEYHILL FORMATION (only Clarita member exposed)

CLARITA MEMBER (about 15 feet exposed)

A. *Lithology*: Yellowish-gray (5YR 7/2) to grayish-orange (10Y 7/4) fossiliferous calcilutite with scattered pink (10R 7/4) pelmatozoan plates. Evenly bedded, beds to 6 or 8 inches. Three HC*l* insoluble residues, 5%, 7%, 9%; washed residues with silt size quartz and some mica; arenaceous Foraminifera common. Acetic acid residues with a large microfauna of arenaceous Foraminifera, inarticulate brachiopods and conodonts. $MgCO_3$ content low, less than 1%. Peels show this rock to have a high fossil content, well over 50% recognizable fossils; the fossil debris is of all sizes from microscopic up to large specimens; on the whole the texture of this rock is fine, a calcilutite, but much of the fossil debris is considerably above silt size so the term is somewhat misleading.
Remarks: The upper part of unit A appears to grade into the lower part of B, but the two units are lithologically so distinct (see *Remarks*: under B) as to indicate that no gradation actually exists.

Covered (in the vicinity of section M1 the base of the Clarita is not exposed).

WHITE MOUND AREA

Stratigraphic sections M2, M3, and M4

I have described three sections, M2, M3, M4, from the White Mound area covering all parts of the Hunton group. The general geologic setting of this region as well as the location of these sections, is shown in figure 51 (Amsden 1958C, p. 131-135). A composite section summarizing the data from these sections is given below:

HUNTON GROUP (total 293 feet)

Bois d'Arc formation
Fittstown member..........85 feet
Gray, fossiliferous calcarenite with some beds of marlstone; nodules of vitreous chert.
Cravatt member..........56 feet
Gray, fossiliferous marlstone with some beds of calcarenite; nodules of porous to vitreous chert.
Haragan formation marlstone..........110 feet
Henryhouse formation marlstone..........22 feet
Chimneyhill formation
Clarita member..........17 feet
Light-gray, fossiliferous calcilutite with scattered pink crinoid plates.
Cochrane member..........5 feet
Light-gray, fossiliferous calcarenite with scattered grains of glauconite.
Covered (probably Sylvan shale).

The Haragan formation in this general area is richly fossiliferous and I have assembled a fine collection of well-preserved fossils. In making this collection I have been aided by W. E. Ham (Sept. 1955), Richard Alexander and Carl C. Branson (June 1957), and William Ventress (June 1958). A summary of these sections is given in Amsden 1958A, p. 21-31; 1958B, p. 32-33.

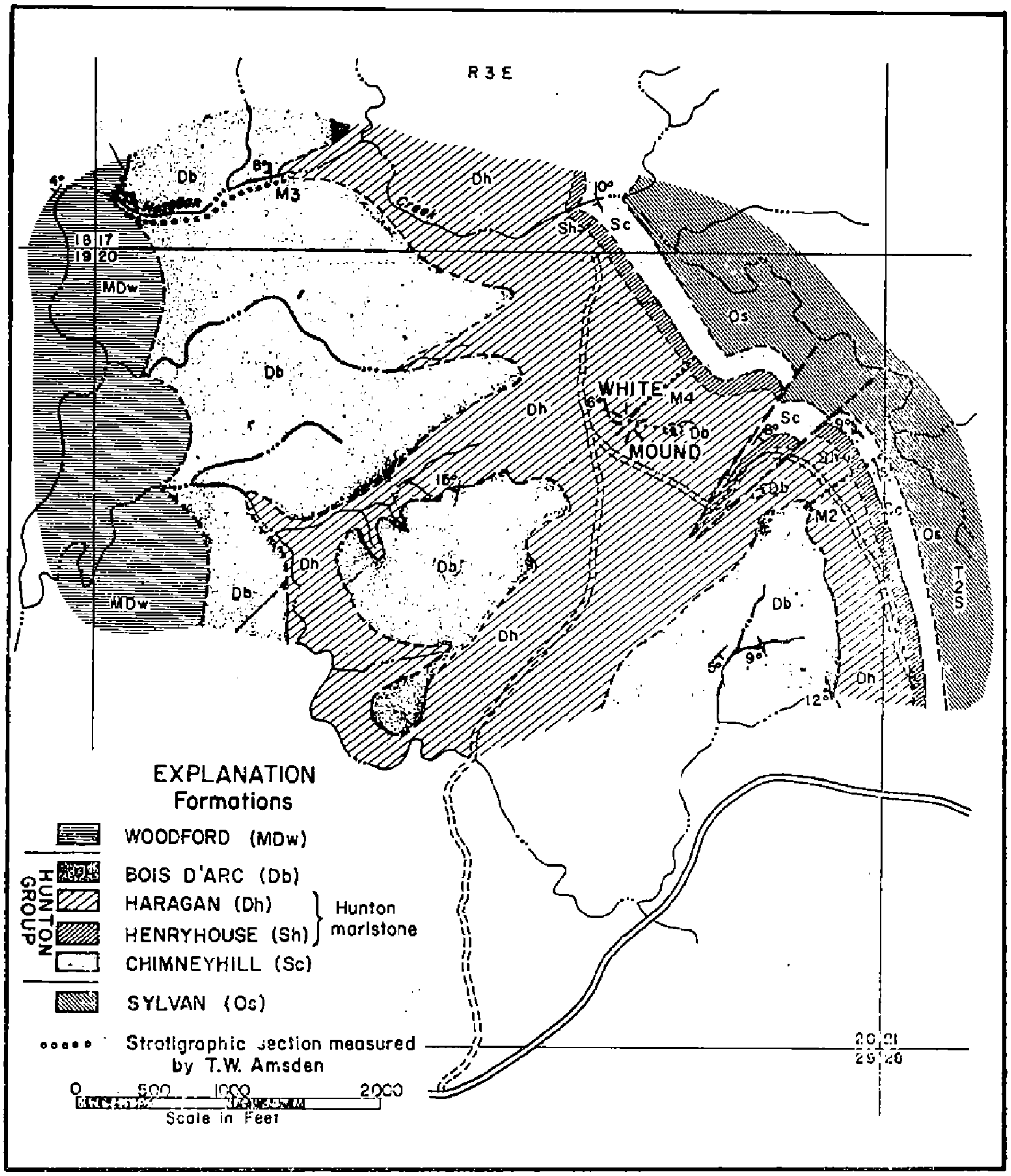

Figure 51. Geologic map of the White Mound area showing the location of sections M2, M3, M4, (after Amsden 1958).

STRATIGRAPHIC SECTION M2*

Near White Mound

Section described by T. W. Amsden, June 17-19, 1956 (fossil collections from the Haragan of this section were also made by T. W. Amsden and W. E. Ham in Sept. 1955; by T. W. Amsden, C. C. Branson and R. Alexander in June, 1957; T. W. Amsden and W. Ventress, June 1958. It is about 1,000 feet southeast of White Mound, SE¼ NE¼ sec. 20, T. 2 S., R. 3 E., Murray County, Okla. (fig. 51). This is the type section for the Haragan formation. The strike of the beds ranges from 140 to 165 degrees (magnetic), dipping 6 to 14 degrees to the southwest.

HUNTON GROUP

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray, fossiliferous calcilutite with nodules of porous, brown-weathering chert. This carries a Helderbergian fauna with such brachiopods as *Levenea subcarinata pumilis*, *Dicoelosia varica*, and *Stropheodonta* (*B.*) *gibbera*. The lower part of this member caps the ridge; its thickness was not measured here (see M3).

M2-O ....

HARAGAN FORMATION: Yellowish-gray, fossiliferous marlstone. This interval is partly covered. A large Haragan fauna collected from this interval, including trilobites, corals, Bryozoa and the following brachiopods: *Orthostrophia strophomenoides parva*, *Skenidium insigne*, *Levenea subcarinata pumilis*, *Dicoelosia varica*, *Rhipidomelloides oblata*, *Anastrophia grossa*, *Stropheodonta* (*B.*) *gibbera*, *S.* (*B.*) *arata*, *Lissostrophia* (*L.*) *lindenensis*, *Leptaena acuticuspidata*, *Leptaenisca concava*, *Schuchertella haraganensis*, *Plectondonta petila*, *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Obturamentella wadei*, *Trigonirhynchia acutirostella*, *Camarotoechia? haraganensis*, *Coelospira virginia*, *Atrypina hami*, *Kozlowskiellina* (*M.*) *velata*, *Atrypa oklahomensis*, *Meristella atoka*, *Cyrtina dalmani nana*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

	feet above base of formation
M2-N Covered)	100 to 110
M2-M	78 to 100
M2-L	58 to 78
M2-K	39 to 58
M2-J	27 to 39
M2-I (covered)	14 to 27
M2-H	7 to 14
M2-G (covered; part Henryhouse?)	0 to 7

HENRYHOUSE FORMATION: Partly covered. Outcrops of yellowish-gray marlstone like above. A small Henryhouse fauna collected, including a few fragmentary trilobites, small horn corals and the following brachiopods: *Atrypa* sp., *Rhipidomelloides* sp., *Lissatrypoidea concentrica*, *Sieberella roemeri*, *Resserella brownsportensis*, *Merista* sp., *Leptaena* sp.

	feet above base of formation
M2-F (?)	19 to 22
M2-E	15 to 19
M2-D	0 to 15

CHIMNEYHILL FORMATION

CLARITA MEMBER: Light-gray, fossiliferous calcilutite with scattered pink pelmatozoan plates; becomes somewhat argillaceous in the upper part. No fossils collected but the acetic acid residues carry a prolific microfauna of conodonts, arenaceous Foraminifera, inarticulate brachiopods.

	feet above base of formation
M2-C	10 to 17
M2-B	0 to 10

COCHRANE MEMBER: Light-gray to greenish-gray fossiliferous calcarenite with scattered grains of glauconite; some pink pelmatozoan plates present. About 5 feet exposed with the base covered.

M2-A ....

Covered (Sylvan shale?)

STRATIGRAPHIC SECTION M3

White Mound area - Haragan Creek

Section described by T. W. Amsden, June 19, 20, 1956. Along Haragan Creek, about 3,000 feet northwest of White Mound (fig. 51); SW¼ SW¼ sec. 17, T. 2 S., R. 3 E., Murray County, Okla. This section begins at the Haragan-Bois d'Arc contact and extends west along the creek bed to the Woodford contact; it is almost 100 percent exposed. The pre-Bois d'Arc part of the Hunton is described in section M2. Analyses given in the section, CHEMICAL ANALYSES.

WOODFORD FORMATION (contact with Bois d'Arc exposed; chert bed just above contact)

HUNTON GROUP

BOIS D'ARC FORMATION (total 139 feet)

FITTSTOWN MEMBER (total 83 feet)

F. *Lithology*: Yellowish-gray (5Y 8/1) to grayish-yellow (10YR 7/4) fossiliferous calcarenite with one bed of argillaceous calcilutite. HC*l* insoluble residue 7.5%; $MgCO_3$ 11.2%. .....5 feet

Remarks: This unit is exposed in contact with the Woodford; there is a thin chert bed above F, followed by typical Woodford shale. F is similar to beds below but lacks chert.

Fossils: None collected due to the difficulty of collecting.

E. *Lithology*: Yellowish-gray, fossiliferous calcarenite with some finer, somewhat more argillaceous beds. Nodules of light colored, vitreous chert. HC*l* insoluble residue, 3.7%; $MgCO_3$, 1.9%. .....39 feet

Remarks: Unit E is similar to the underlying D, but has a slightly lower silt-clay content.

Fossils: A small fauna of brachiopods collected: *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *Obturamentella wadei*, *Atrypa oklahomensis*, and *Howellella cycloptera*.

D. *Lithology*: Fossiliferous calcarenite and yellowish-gray argillaceous calcilutite. Some chert nodules present. Beds from 1 to 3 inches. One specimen yielded 7.8% HC*l* residues. .....30 feet

Remarks: Like beds above but with a slightly higher silt-clay content.

Fossils: No collection made.

C. *Lithology*: Fossiliferous calcarenite and argillaceous calcilutite. No chert observed. Two HC*l* insoluble residues, 5.5% and 9.6% $MgCO_3$, 1.3% and 5.6%. .....9 feet

Remarks: Essentially like unit above but lacks chert.

Fossils: The following brachiopods collected: *Orthostrophia strophomenoides parva*, *Levenea subcarinata pumilis*, *Rhipidomelloides oblata*, *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Meristella atoka*.

CRAVATT MEMBER (total 56 feet)

B. *Lithology*: Yellowish-gray, argillaceous calcilutite in beds to 1 inch. The upper 18 inches and lower 18 inches consist of vitreous chert. One HC*l* insoluble residue made of the limestone, 11%; $MgCO_3$, 2.6%. .....4 feet

Remarks: The boundary between the Cravatt and Fittstown member members is quite obscure on M3: actually the Cravatt has a somewhat lower silt-clay content than is usual, and the Fittstown has a somewhat higher silt-clay content than normal.

Fossils: None collected.

A(3). *Lithology*: Yellowish-gray, argillaceous calcilutite with nodules and elongate lenses of vitreous chert. Some of the chert appears to be bedded, in beds to 1 inch. HC*l* residues, 11.1% .....16 feet

Remarks: Units A(1), A(2), and A(3) have essentially the same lithology and were separated only for the purpose of taking lithologic samples. As may be seen in the section on CHEMICAL ANNALYSES there is no basic difference in the $CaCO_3$ $MgCO_3$ or insoluble content.
Fossils: A few specimens of *Kozlowskiellina* (*M.*) *velata* collected. In addition specimens of *Meristella atoka* and *Levenea* sp. were seen.

A(2). *Lithology*: Yellowish-gray, argillaceous calcilutite; like beds above and below. Nodules and beds of light-brown, vitreous chert to 3 or 4 inches thick. HC*l* residues, 16.1%. ....15 feet
Remarks: See A(3).
Fossils: None collected.

A(1). *Lithology*: Yellowish-gray, argillaceous calcilutite with nodules of vitreous to porous chert. HC*l* insoluble residue, 8.7%. ....21 feet
Remarks: For comparison with overlying beds see A(3). Like the underlying Haragan except the latter lacks chert.

HARAGAN FORMATION (not measured or described at M3; see M2, M4).

STRATIGRAPHIC SECTION M4*

White Mound

This section includes White Mound proper and its surrounding glade. It is one of the most fossiliferous exposures of the Haragan in the entire outcrop area, and has been a prime source of fossils for many years. The Mound is in the NW¼ NE¼ sec. 20, T. 2 S., R. 3 E., Murray County, Okla.; see figure 51, and discussion preceding M2. During the years 1955, 1956, 1957 and 1958 I have visited White Mound several times and have made some large collections, being assisted at various times by W. E. Ham, C. C. Branson, R. Alexander and W. Ventress.

HUNTON GROUP

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray, argillaceous, fossiliferous calcilutite with nodules of brown-weathering chert. Caps a small knob just east of the Mound (fig. 51).

HARAGAN FORMATION: Yellowish-gray marlstone, highly fossiliferous.

	feet above Clarita
(partly covered)	86 to 100
M4 (collections made from here)	75 to 86

White Mound includes the strata which lie approximately 75 to 86 feet above the Clarita member. A large collection was made from these beds including trilobites, corals, Bryozoa, Mollusca and the following brachiopods: *Orthostrophia strophomenoides parva*, *Skenidium insigne*, *Levenea subcarinata pumilis*, *Dicoelosia varica*, *Rhipidomelloides oblata*, *Isorthis pygmaea*, *Anastrophia grossa*, *Strophonella* (*S.*) *bransoni*, *Stropheodonta* (*B.*) *gibbera*, *S.* (*B.*) *arata*, *Lissostrophia* (*L.*) *lindenensis*, *Leptaenisca concava*, *Leptaena acuticuspidata*, *Schuchertella haraganensis*, *Plectodonta petila*. *Sphaerirhynchia glomerosa*, *S. lindenensis*, *Trigonirhynchia acutirostella*, *Camarotoechia? haraganensis*, *Coelospira virginia*, *Atrypina hami*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Howellella cycloptera*, *Nucleospira ventricosa*, *Meristella atoka*, *Cyrtina dalmani nana*, *Trematospira* cf. *T. hippolyte*, *Rhynchospirina maxwelli*, *Rensselaerina haraganana*.

HARAGAN AND **HENRYHOUSE FORMATIONS**: covered.

Covered ....0 to 75 feet above Clarita

CHIMNEYHILL FORMATION

CLARITA MEMBER: Gray calcilutite with scattered pink pelmatozoan plates.

STRATIGRAPHIC SECTION M5*

Road to Price's Falls

Section described by T. W. Amsden, April 19, 1957. This section crosses the road to Price's Falls about ¼ mile east of Highway 77: SE¼ NE¼ sec. 30, T. 1 S., R. 2 E., Murray County, Okla. (location shown in figure 52). Beds strike approximately 100 degrees (magnetic), dip almost vertical.

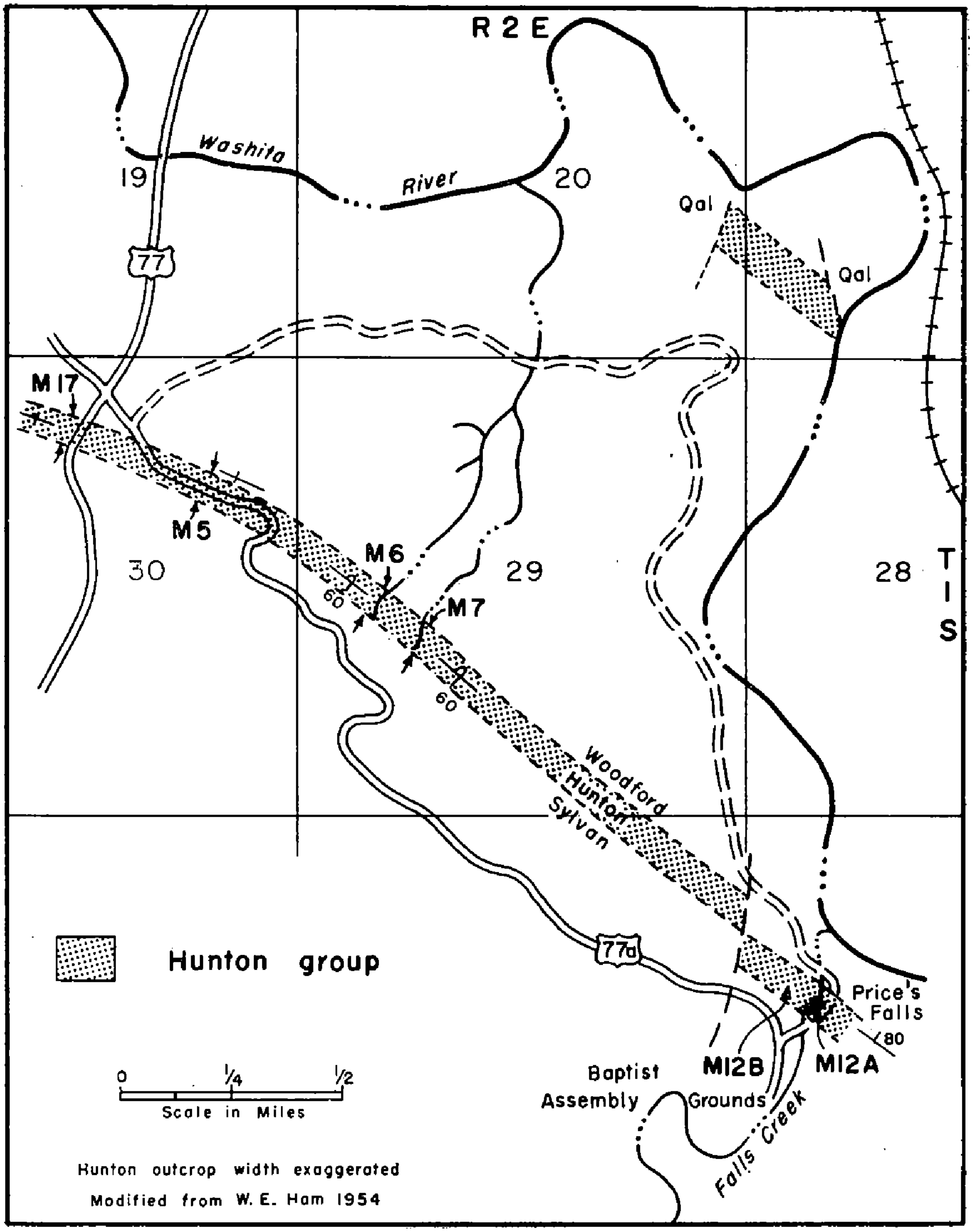

Figure 52. Map showing the location of stratigraphic sections M5, M6, M7, M12A, M12B, and M17.

This section shows an interesting relationship between the lowermost Woodford beds and the Hunton. The latter appears to represent a normal stratigraphic section except for the absence of the Bois d'Arc formation which has been removed in this general area by post-Hunton erosion (see pl. A, panel III; fig. 53). The basal Woodford consists of 2 to 3 feet of a brown fractured chert with considerable carbonate; HCl insoluble residue 76.1%, $CaCO_3$ 16.6%, $MgCO_3$ 6.3%; see CHEMICAL ANALYSES. This cherty bed can be traced along strike for a hundred feet or so in both directions and then is lost, apparently lensing out. Lithologically this rock resembles the brown Woodford? carbonate exposed near Oil Creek (sections J13 to J18): in the Oil Creek area this cherty carbonate rests directly on the Sylvan shale(see discussion under WOODFORD BROWN? CARBONATE) and has been interpreted as altered Chimneyhill. On the other hand at section M5 the cherty carbonate rests on a normal Hunton section and is clearly post-Hunton in age. Whether these strata at M5 are actually correlative with those in the Oil Creek area is open to question, but it is at least significant that this type of lithology can be demonstrated in post-Hunton strata.

The relationship of M5 to M6 and M7 is shown in figure 53.

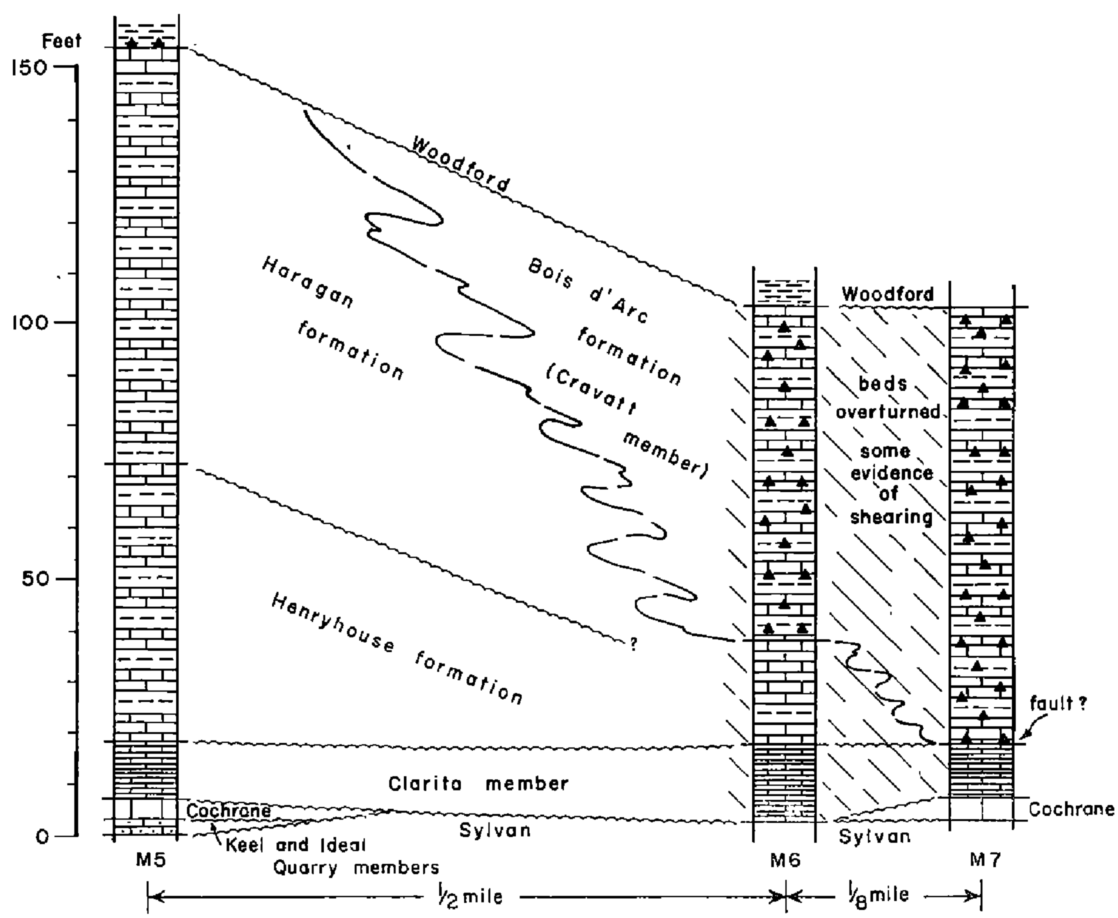

Figure 53. Three columnar sections showing the inferred stratigraphic relations of sections M5, M6 and M7. These sections are located in figure 52.

WOODFORD SHALE (basal bed is a calcareous chert exposed almost in contact with the Hunton; see discussion above, and CHEMICAL ANALYSES)

HUNTON GROUP (total 151 feet)

HARAGAN FORMATION: Partly covered, exposures of yellowish-gray marlstone; specimens of *Levenea subcarinata pumilis* collected.

	feet above base of formation
M5-H	40 to 81
M5-G (covered; may include some Henryhouse)	0 to 40

HENRYHOUSE FORMATION: Partly covered. Exposures of yellowish-gray marlstone like above. Specimens of *Lissatrypoidea concentrica* collected from the upper 4 feet.

	feet above base of formation
M5-F	50 to 54
M5-E (covered)	0 to 50

CHIMNEYHILL FORMATION (total 16 feet)

CLARITA MEMBER: Gray, richly fossiliferous calcilutite with scattered pink pelmatozoan plates. The upper 2 feet or so is more yellowish and probably has an increased silt-clay content; acetic acid residues from the uppermost beds, as well as the typical Clarita lithology, carry a substantial microfauna. The lower 1 foot (M5-C) is a marlstone, with 22% HC*l* insoluble residue.

	feet above base of member
M5-D	1 to 11
M5-C	0 to 1

COCHRANE MEMBER: Gray, bioclastic calcarenite with scattered grains of glauconite.

M5-B .... 2 feet

IDEAL QUARRY MEMBER: Brown, fossiliferous calcarenite: many spherical bodies but these appear to be an "algal type" oolite rather than the Keel type; see discussion of KEEL MEMBER.

M5-A .... 3 feet

Covered.

STRATIGRAPHIC SECTION M6*

North of road to Price's Falls

Section described by T. W. Amsden, April 19, 1957. In a small gully about 100 yards north of the Price's Falls road: NW¼ SW¼ sec. 29, T. 1 S., R. 2 E., Murray County, Oklahoma. The location of this section, as well as sections M17, M5, M7, M12A, M12B, is shown in the sketch map, figure 52.

There is a marked change in the stratigraphic relations between M5 and M6-M7. Between M5 and M6 the combined Henryhouse-Haragan strata thin from 135 feet to 18 feet, and the Bois d'Arc formation which is absent at M5 thickens to 45 feet. This trend appears to continue and at M7, a short distance to the southeast, the Bois d'Arc is 85 feet thick and rests directly on the Clarita. My interpretation of these three sections is shown in figure 53. It should be noted that there is considerable structural deformation in the area around M6 and M7: the strata are overturned and some of the beds appear to be sheared. It is therefore possible that the absence of the Henryhouse at M7 is the result of faulting, although the general stratigraphic trend shown in figure 53 indicates thinning (if not complete absence) in this general area. The Chimneyhill also shows stratigraphic changes in this area: at M5 a normal section is present, but at M6 the Clarita appears to rest directly on the Sylvan; at M7 the Cochrane is again present. Note that in the vicinity of Price's Falls (M12A and M12B) the Cochrane shows marked thinning in a short distance.

WOODFORD FORMATION

HUNTON GROUP (total 99 feet)

BOIS D'ARC FORMATION (total 65 feet)

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with many nodules of vitreous chert. No calcarenite observed; no porous, tripolitic-type chert observed. Beds are overturned and there is considerable shearing and brecciation so the thickness may not be entirely reliable.

feet above base of formation

M6-F .... 45 to 65
M6-E .... 0 to 45

HARAGAN and/or HENRYHOUSE FORMATIONS: Partly covered. Exposures of yellowish-gray marlstone with some red mottling. No fossils observed and this unit may be either Henryhouse, Haragan, or both; acetic acid residues appear to be barren.

feet above Chimneyhill formation

M6-D .... 1 to 19
M6-C .... 0 to 1

CHIMNEYHILL FORMATION (total exposed 15 feet)

CLARITA MEMBER: Gray to yellowish-gray, fossiliferous calcilutite with some pink pelmatozoan plates. The upper foot is more yellowish and has a greater HCl insoluble residue content, thus resembling the overlying marlstone. The acetic acid residues from this member, including the upper foot, carry a substantial microfauna. There is no evidence for any Cochrane or Keel in the vicinity of M6, and the covered interval just below M6-A has a greenish color suggesting the Sylvan.

feet above the base o fthe member

M6-B .... 14 to 15
M6-A .... 0 to 14

Covered (probably Sylvan)

STRATIGRAPHIC SECTION M7*

North of road to Price's Falls

Section described by T. W. Amsden, April 19, 1957. In a gully about 1/8 mile southeast of M6; NW¼ SW¼ sec. 29, T. 1 S., R. 2 E., Murray County, Okla. The location of this section is shown in figure 52, and its relation to sections M5 and M6 is shown in figure 53. For a discussion of this section see M6.

Covered (Woodford shale float)

HUNTON GROUP (total 97 feet)

BOIS D'ARC FORMATION (total 86 feet)

CRAVATT MEMBER: Yellowish-gray to light-gray argillaceous calcilutite with nodules of vitreous chert. No calcarenite observed and all of the chert appears to be the vitreous rather than porous type. Beds overturned and show some shearing, and it is possible that the absence of the marlstone on this section is the result of faulting.

M7-C .... 85 feet
Covered .... 1 foot

CHIMNEYHILL FORMATION (total exposed 11 feet)

CLARITA MEMBER: Gray to yellowish-gray calcilutite with rare pink pelmatozoan plates; evenly bedded. Fairly typical Clarita lithology.

M7-B .... 9 feet

COCHRANE MEMBER: Gray calcarenite with abundant grains of glauconite. No Keel or Ideal Quarry observed in this area and the covered interval below has a greenish soil suggesting Sylvan.

M7-A .... 2 feet

Covered (probably Sylvan).

STRATIGRAPHIC SECTION M8

Northwest of Vines dome

Section described by T. W. Amsden, April 24, 1957. About ¼ mile southeast of the Dolese Bros. Rayford Quarry; SE¼ NE¼ sec. 28, T. 1 S., R. 2 E., Murray County, Okla.

This section is of special interest because a considerable thickness of the Clarita member is strongly argillaceous and resembles the Henryhouse.

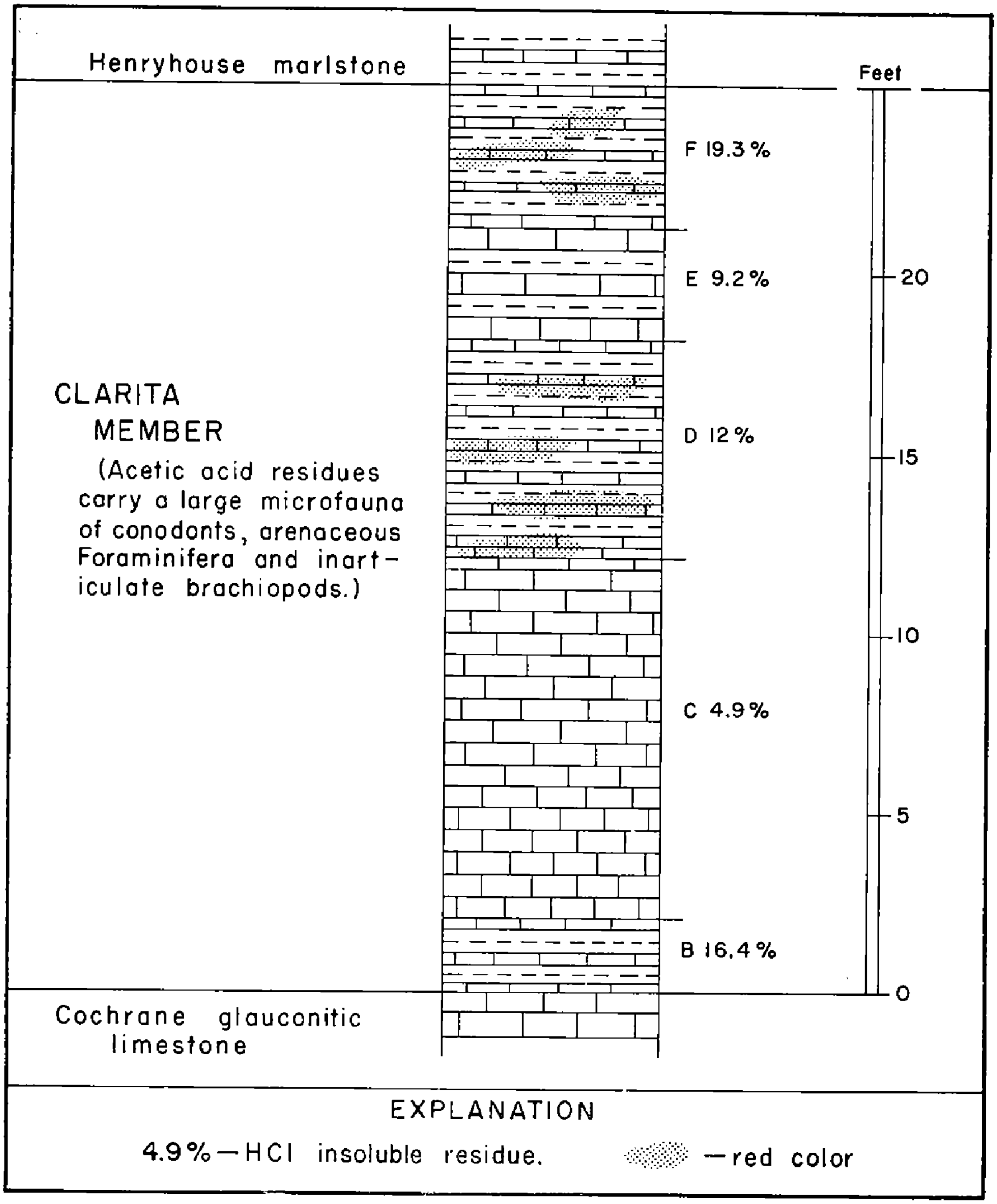

Figure 54. Columnar section to show the argillaceous character of the Clarita at M8. The Clarita microfauna can be recovered from units B to F inclusive.

This condition is not unusual, but on most sections it involves only a foot or so of beds whereas at M8 there are 12 feet of shaly beds; furthermore this upper 12 feet is mottled with red giving a color like the Henryhouse mottled red beds. Only unit C has the typical Clarita lithology, D, E, and F resembling the Hunton marlstone to a marked degree; however, the acetic acid residues carry what is believed to be a typical Clarita microfauna of arenaceous Foraminifera, conodonts and inarticulate brachiopods (the same microfauna is present in D, E, and F, as in C). The Clarita member of M8 is illustrated on figure 54. A somewhat similar relationship is found at M10. A summary of this section given in Amsden 1958A, p. 31; 1958B, p. 35.

The bedding (Chimneyhill) strikes 140 degrees (magnetic), dipping 75 degrees to the southwest.

Covered (Woodford float)

HUNTON GROUP (total 252 feet)

BOIS D'ARC FORMATION (total 46 feet)

CRAVATT MEMBER (total 46 feet)

S. *Lithology*: Rusty-brown. HC*l*............1 foot
insoluble residue 11%; washed residues mostly glauconite and quartz, the latter partly as clear shards and partly milky quartz.
Remarks: This bed could represent a basal Woodford unit (seeM5) but HC1 residues are similar to those below.
Fossils: Some fossils present but none collected.

R. *Lithology*: Yellowish-gray, argillaceous............18 feet
calcilutite with nodules of vitreous chert, most of the chert being concentrated in the lower part. Little or no calcarenite present. Washed HC*l* insoluble residues mostly a milky "chalcedony", plus some glauconite and silt size detrital quartz.
Fossils:This unit is highly fossiliferous and a number of specimens of *Meristella atoka* were observed in the upper few feet.

Q. *Lithology*: Yellowish-gray, laminated,............ 2 feet
argillaceous calcilutite with nodules of brown chert. Parts of the rock are conspicuously laminated, the individual laminae being a millimeter or so thick.
Fossils: Fossiliferous; no collection made.

P. *Lithology*: Yellowish-gray, argillaceous............25 feet
calcilutite with nodules of chert. In the lower part the chert is mostly a porous, brown-weathering type (tripolitic), while in the upper part it is largely the vitreous type.
Remarks: This is typical Cravatt lithology. Unit P (and Q) cap the Hunton ridge, and was measured on the scarp face.
Fossils: Fossiliferous but no collection made.

HARAGAN FORMATION (total 107 feet, including all of unit K)

O. *Lithology*: Covered............38 feet
Remarks: All of O is assigned to the Haragan since the Cravatt is more resistant and commonly makes good outcrops.

N. *Lithology*: Fossiliferous, yellowish-gray............6 feet
marlstone. No chert observed.
Fossils: A small fauna collected loose on the surface. This includes two snails and the following brachiopods: *Levenea subcarinata pumilis*, *Dicoelosia varica*, *Anastrophia grossa*, *Leptaenisca concava*, *Atrypina hami*, *Atrypa oklahomensis*, *Meristella atoka*, *Rhynchospirina maxwelli*.

M. *Lithology*: Covered............21 feet

L. *Lithology*: Yellowish-gray, fossiliferous............5 feet
marlstone.
Fossils: A small fauna collected loose on the surface, all being typical Helderbergian fossils. This collection includes a few horn

corals and the following brachiopods: *Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Leptaena acuticuspidata, Coelospira virginia, Atrypina hami, Meristella atoka.*

HARAGAN FORMATION?

K. *Lithology*: Covered.....37 feet

Remarks: The rocks of this covered interval are underlain by strata carrying a typical Henryhouse fauna and overlain by strata with a typical Haragan fauna. It is arbitrarily assigned to the Haragan but may well include some Henryhouse beds.

HENRYHOUSE FORMATION (total 70 feet, excluding all of unit K)

J. *Lithology*: Yellowish-gray, fossiliferous.....10 feet marlstone.

Remarks: Lithologically like unit L above.

Fossils: A substantial fauna collected; all forms appear to be typical Henryhouse species. Includes fragments of *Camarocrinus, Encrinurus?* sp., *Eophacops?* sp., and pieces of a dalmanitid trilobite; several Bryozoa, several horn corals and the following brachiopods: *Atrypa tennesseensis, Delthyris kozlowskii, Isorthis arenaria, Lissatrypoidea concentrica, Merista oklahomensis, Sieberella roemeri, Stropheodonta (B.) attenuata.*

I. *Lithology*: Fossiliferous marlstone;.....8 feet yellowish-gray rather strongly mottled with red.

Remarks: This is the highest red bed observed on section M8. No microfossils observed in the acetic acid residues.

Fossils: No collection made: see units above and below.

H. *Lithology*: Mottled yellowish-gray and red.....20 feet marlstone.

Remarks: Like the beds above; separated for collecting. Acetic acid residues with a few fragments of arenaceous Foraminifera; no conodonts observed.

Fossils: A typical Henryhouse fauna collected from this unit. A few horn corals, Bryozoa and specimens of *Calymene* sp., *Eophacops?* sp., *and Encrinurus?* sp., plus the following brachiopods: *Atrypa tennesseensis, Delthyris kozlowskii, Lissostrophia (L.) cooperi, Merista oklahomensis, Sieberella roemeri, Strophonella laxiplicata, S. prolongata, Stropheodonta (B.) attenuata.*

G. *Lithology*: Mostly covered. Few outcrops of.....32 feet yellowish-gray marlstone.

Remarks: No megafossils collected from G, but as the rock exposed appears to be a typical marlstone lithology it is included within the Henryhouse. There is, however, a question concerned with the exact position of the Henryhouse-Clarita contact. Unit F is lithologically like the Henryhouse, but carries a large microfauna like the beds below and is therefore placed in the Clarita (see introductory discussion). A few arenaceous Formaminifera were found in the acetic residues from the lower part of G, but no conodonts or inarticulate brachiopods were observed. Possibly some of G belongs in the Clarita, but if so the thickness of beds involved is probably small.

Fossils: Few arenaceous Foraminifera from acetic acid residues.

CHIMNEYHILL FORMATION (total 28 feet)

CLARITA MEMBER (total 24 feet)

F. *Lithology*: Mottled yellowish gray and red.....3 feet argillaceous calcilutite. HC*l* insoluble residues 19.3%.

Remarks: Some parts of this interval have a reduced silt-clay content and approach a typical Clarita lithology, but most is a red, earthy limestone which looks like the Henryhouse. (See introductory discussion and figure 54).

Fossils: A few fragmentary megafossils collected; two of these appear to be specimens of *Plectodonta* although this identification is only tentative and no interiors have been observed; I have never collected a representative of this genus from unquestioned Henryhouse strata.

The acetic acid residues yield arenaceous Foraminifera, inarticulate brachiopods and conodonts; this fauna looks like that obtained from the underlying beds, and from the typical Clarita at other localities. It is on the basis of its microfauna that F is placed in the Clarita.

E. *Lithology*: Yellowish gray, fossiliferous calcilutite with a few pink pelmatozoan plates. HC*l* residues 9.2%. ....3 feet
Remarks: This unit is most like C below, except for its higher silt-clay content.
Fossils: Acetic acid residues with a large microfauna of conodonts and arenaceous Foraminifera. Thus the fauna appears to be typically Clarita, the lithology intermediate between Clarita and Henryhouse.

D. *Lithology*: Mottled yellowish-gray and red, fossiliferous, argillaceous calcilutite. HC*l* insoluble residue 12%. ....6 feet
Remarks: Lithologically this unit is similar in color and in its silt-clay content to typical Henryhouse. Its microfauna appears to be characteristic of the Clarita and it is on this evidence that D is included in this member. One peel was made of the red bed lithology and this shows considerable fossil material, but it is clearly a fossiliferous marlstone rather than a bioclastic limestone.
Fossils: Acetic acid residues with many arenaceous Foraminifera and conodonts.

C. *Lithology*: Gray to slightly yellowish-gray calcilutite with scattered pink pelmatozoan plates. Evenly bedded, in beds to 5 or 6 inches. HC*l* insolubles residues 4.9%. ....10 feet
Remarks: This is typical Clarita lithology and the microfauna appears to be characteristic for this member.
Fossils: Acetic acid residues with a large microfauna of arenaceous Foraminifera, conodonts and inarticulate brachiopods.

B. *Lithology*: Yellowish-gray, argillaceous calvilutite. HC*l* insoluble residues 16.4%; some glauconite present. ....2 feet
Remarks: This appears to be the basal, argillaceous part of the Clarita.
Fossils: Acetic acid residues with many arenaceous Foraminifera, and conodonts; much of this fauna appears to be like the typical Clarita but there are a number of compound conodonts present in addition to the cones.

COCHRANE MEMBER (total 4 feet exposed)

A. *Lithology*: Gray, fossiliferous calcarenite with many scattered grains of glauconite. Bedding irregular, commonly obscure; few beds range up to 18 inches in thickness. No chert seen. ....4 feet
Remarks: The base of A is covered; no Keel or Ideal Quarry beds observed in this area and the Cochrane probably rests directly on the Sylvan.
Fossils: No megafossils collected, but the acetic acid residues carry conodonts; these do not look like those from the overlying Clarita.

Covered (probably Sylvan).

STRATIGRAPHIC SECTION M9*

North of Dougherty

Section described and collected by T. W. Amsden, April 25, 1957. Located about 2½ miles north of Dougherty, and a short distance west of Southern Rock Asphalt Quarry; NW¼ SE¼ sec. 25, T. 1 S., R. 2 E., Murray County, Okla. (see Amsden 1958A, p. 32; 1959B, p. 35).

This is an incomplete section which begins in the Haragan; the lower part of the Haragan is covered, and below this cover is Sylvan shale. No Chimneyhill was observed in this area and it may be absent; however, there is considerable faulting and it is possible that the Haragan is faulted against the Sylvan. In spite of being incomplete this section is important: (1) The Haragan is richly fossiliferous and I was able to assemble a rather large collection; (2) A pit has been opened in the Haragan exposing about 6 feet of beds; a channel sample of reasonably fresh marlstone was collected for analysis; see section, CHEMICAL ANALYSES.

The strike of the Bois d'Arc strata on top of the hill is about 200 degrees (magnetic), dipping 10 degrees to the northwest.

Covered.

HUNTON GROUP

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of vitreous to porous chert. The lower 20 feet or so is well exposed on top of the hill; the overlying strata, on the dip slope, are poorly exposed and the top is covered. The following brachiopods were collected from the lower 20 feet: *Rhipidomelloides oblata, Dicoelosia varica, Stropheodonta (B.) arata, Meristella atoka.*

M9-E ....

HARAGAN FORMATION: Yellowish-gray, fossiliferous marlstone. A channel sample was taken of the lower 6 feet (unit A): HC*l* insoluble residues 28.03%: $CaCO_3$ 66.43%; $MgCO_3$ 4.50%. A rather large fauna collected from the Haragan beds: corals including *Favosites* cf. *F. conicus, Pleurodictyum* and horn corals; several Bryozoa, a few snails and trilobite fragments; brachiopods as follows: *Orthostrophia strophomenoides parva; Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Anastrophia grossa, Stropheodonta (B.) gibbera, S. (B.) arata, Strophonella (S.) bransoni, Leptaenisca concava, Leptaena acuticuspidata, Sphaerirhynchia glomerosa, S. lindenensis, Camarotoechia? haraganensis, C.?* sp., *Coelospira virginia, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Howellella cycloptera, Meristella atoka, Rhynchospirina maxwelli.*

	Feet above base of section
M9-D (covered)	49 to 58
M9-C	22 to 49
M9-B (covered)	6 to 22
M9-A (channel sample)	0 to 6

Covered.

STRATIGRAPHIC SECTION M10

Buckhorn Ranch, northeast of Dougherty

Section described and collected by T. W. Amsden, April 25, May 10, 1957. On the Buckhorn Ranch about 4 miles northeast of Dougherty; it lies just east of a small stream flowing north into Little Buckhorn Creek: SW¼ SE¼ sec. 33, T. 1 S., R. 2 E., Murray County, Okla. This is a good section of the Hunton, being well exposed and almost complete; it lacks only the Keel and Ideal Quarry members at the base and the Frisco formation at the top. The Henryhouse strata are moderately fossiliferous, and the Haragan beds are richly fossiliferous, this being one of the better collecting localities for this formation. A summary of this section appears in Amsden 1958A, p. 32, and Amsden 1958B, p. 36.

A rock specimen from each of the stratigraphic units listed below has been analyzed (see CHEMICAL ANALYSES).

The strike of the beds averages about 95 degrees (magnetic); dip averages about 45 degrees to the north.

Covered (No Woodford outcrops seen in this area)

HUNTON GROUP (total 228 feet exposed)
BOIS D'ARC FORMATION (72 feet exposed)
FITTSTOWN MEMBER (25 feet exposed)

P. *Lithology*: Gray, fossiliferous calcarenite in..25 feet
beds to 6 inches. Some beds with much glauconite. HC*l* insoluble residue 3.8%.
Remarks: This interval is almost entirely free of calcilutite; the change from the underlying Cravatt calcilutite to the Fittstown calcarenites is abrupt, which is unusual for this contact.
Fossils: The following brachiopods collected in situ: *Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptaena* cf. *Leptaena rhomboidalis, Sphaerirhynchia lindenensis, Howellella cycloptera, Meristella atoka.*

CRAVATT MEMBER (total 47 feet)

O. *Lithology*: Yellowish-gray, fossiliferous..27 feet
calcilutite. Some argillaceous material present. HC1 insoluble residue, 5.2%.
Remarks: This interval differs from N in its reduced silt-clay content and in the absence of chert.
Fossils: Fossiliferous but no collection made.

N. *Lithology*: Yellowish-gray, fossiliferous,..20 feet
argillaceous calcilutite with nodules of porous chert. HC*l* insoluble residue, 22.6%.
Remarks: This unit differs from the underlying Haragan strata principally in having chert.
Fossils: Fossiliferous; no collection made.

HARAGAN FORMATION (total 108 feet)

M. *Lithology*: Partly covered. Outcrops of..44 feet
yellowish-gray, fossiliferous marlstone. No chert observed. HC*l* residues 23%.
Remarks: Separated from beds below for collecting.
Fossils: A large Helderbergian fauna collected, including some mollusks, ostracodes and the following brachiopods: *Dicoelosia varica, Rhipidomelloides oblata, Isorthis pygmaea, Strophonella (S.) bransoni, Stropheodonta (B.) gibbera, S. (B.) arata, Leptaena acuticuspidata, Leptaenisca concava, Schuchertella haraganensis, Sphaerirhynchia lindenensis, Camarotoechia? haraganensis, Coelospira virginia, Atrypina hami, Kozlowskiella (M.) velata, Howellella cycloptera, Nucleospira ventricosa, Meristella atoka, Rhynchospirina maxwelli.*

L. *Lithology*: Partly covered. Outcrops of..17 feet
yellowish-gray marlstone. HC*l* insoluble residues, 24.8%.
Remarks: Separated from beds above and below for collecting.
Fossils: Rather large Helderbergian fauna collected including the following brachiopods: *Orthostrophia strophmenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Isorthis pygmaea, Strophonella (S.) bransoni, S. (B.) gibbera, S. (B.)* arata, *Leptaenisca concava, Leptaena acusticuspidata, Sphaerirhynchia glomerosa, S. lindenensis, Obturamentella wadei, Camarotoechia? haraganensis, Atrypina hami, Kozlowskiellina (M.) velata*, *Mertistella atoka, Cyrtina dalmani nana, Rhynchospirina maxwelli.*

K. *Lithology*: Partly covered. Outcrops of..28 feet
yellowish-gray marlstone. HC*l* insoluble residues 12.5%.
Remarks: Lithologically like beds above and below; separated for collecting.
Fossils: Fossiliferous but no collection made.

J. *Lithology*: Mostly covered. Few outcrops of..13 feet
yellowish-gray marlstone. HC*l* insoluble residue 20.2%.

Remarks: Like beds above and below.
Fossils: A small Helderbergian fauna collected, including 2 trilobites, a few horn corals and the following brachiopods: *Rhipidomelloides oblata, Leptaena acuticuspidata, Kozlowskiellina (M.) velata, Meristella atoka.*

I. *Lithology*: Yellowish-gray marlstone. HCl insoluble residue 29%. ....6 feet
Remarks: This unit is lithologically similar to the beds below except for its higher HC*l* insoluble residues. There is no lithologic evidence for an unconformity in this part of the section, but the Haragan-Henryhouse contact must fall either at the base of I, or in the lower part of it. The underlying unit H carries a typical Henryhouse fauna, and I carries a Helderbergian fauna except for a single specimen of *Lissatrypoidea* sp. All of the fossils collected from the beds above I are characteristic Haragan species.
Fossils: A small fauna collected loose on the surface. Includes a fragment of *Camarocrinus*, a few snails and the Haragan brachiopods, *Levenea subcarinata pumilis* and *Stropheodonta (B.) gibbera.* In addition one specimen of the Henryhouse brachiopod, *Lissatrypoidea* sp. was collected.

HENRYHOUSE FORMATION (total 28 feet)

H. *Lithology*: Yellowish-gray, fossiliferous marlstone. HC*l* insoluble residue 12.3%. ....6 feet
Remarks: Lithologically like the beds above except for the reduced HC*l* insolubles. See *Remarks* under I.
Fossils: A small fauna collected, all being typical Henryhouse species. One bryozoan, a specimen of *Calymene* and the following brachiopods: *Stropheodonta (B.) attenuata, Lissatrypoidea concentrica, Merista oklahomensis, Strixella acutisulcata.*

G. *Lithology*: Mottled red and yellowish-gray, fossiliferous marlstone. HCl insoluble residue 19.6%. No microfossils observed in either the HC*l* or the acetic acid residues. Beds up to 6 inches. ....16 feet
Remarks: This unit unquestionably belongs in the Henryhouse, as it carries a large Henryhouse megafauna. No microfossils observed in the acetic acid or HC*l* insoluble residues.
Fossils: A typical Henryhouse fauna collected. This includes several Bryozoa, a few corals; *Calymene* sp., *Eophacops?* sp., and several fragments of dalmanitid trilobites, plus the following brachiopods: *Atrypa tennesseensis, Coelospira saffordi, Delthyris* sp., *Leptaena* sp., *Lissatrypoidea concentrica, Lissostrophia (L.) cooperi, Resserella brownsportensis, Rhipidomelloides henryhousensis, Pseudodicoelosia oklahomensis, Sieberella roemeri, Strophonella loeblichi, S. prolongata.*

F. *Lithology*: Yellowish-gray marlstone. HC*l* insoluble residue 16%. ....6 feet
Remarks: This unit has a typical Henryhouse marlstone lithology although no fossils were observed; the acetic acid residues appear to be barren. The underlying unit E differs in its reduced HCl insoluble content, in its numerous pink pelmatozoan plates, and in its prolific microfauna. There can, therefore, be little doubt that the Henrryhouse-Clarita contact falls at the boundary of E and F; however, it should be noted that unit D has an increased silt-clay content and thus resembles F.
Fossils: None collected.

CHIMNEYHILL FORMATION (total 20 feet, no Keel or Ideal Quarry members observed)

CLARITA MEMBER (total 15 feet)

E. *Lithology*: Gray to yellowish-gray, fossiliferous calcilutite with many pink pelmatozoan plates. HC*l* insoluble ....3 feet

residues, 9.4%. Acetic acid residues with a prolific microfauna of arenaceous Foraminifera and conodonts.
Remarks: This unit has a fairly typical Clarita lithology (HCl residues are slightly high) and appears to have the characteristic Clarita microfauna. See *Remarks* under F.
Fossils: No megafossils collected. Acetic acid residues carry a large microfauna.

D. *Lithology*: Yellowish-gray, argillaceous........4 feet
calcilutite with rare pink pelmatozoan plates. HCl insoluble residues, 11.5%.
Remarks: This is not typical Clarita lithology; the silt-clay content is too high and pelmatozoan plates are rare. However, it carries a typical Clarita microfauna, and is overlain by strata having a characteristic Clarita lithology.
Fossils: No megafossils collected. Acetic acid residues carry a large microfauna of arenaceous Foraminifera and conodonts.

C. *Lithology*: Gray, fossiliferous calcilutite with........7 feet
many pink pelmatozoan plates. HCl insoluble residues, 6.4%. Evenly bedded, beds to 6 inches.
Remarks: Typical Clarita lithology.
Fossils: No megafossils collected. Acetic acid residues with a large microfauna of arenaceous Foraminifera, conodonts and inarticulate brachiopods.

B. *Lithology*: Covered........1 foot
Remarks: This is probably the basal, argillaceous zone of the Clarita.

COCHRANE MEMBER (total 5 feet)

A. *Lithology*: Gray, fossiliferous calcarenite with........5 feet
scattered grains of glauconite. Glauconite not abundant in most beds. HCl insoluble residues, 2.2%.
Remarks: This is typical Cochrane lithology although the glauconite content is somewhat lower than normal. I did not observe any Keel or Ideal Quarry beds in this area and the Cochrane probably rests directly on the Sylvan.
Fossils: No megafossils collected. Acetic acid residues carry a few conodonts; no Foraminifera observed.

Covered (probably Sylvan).

STRATIGRAPHIC SECTION M11*

Southeast of Sulphur

Section described and collected by T. W. Amsden, May 7, 1957. About 4 miles southeast of Sulphur and 1½ miles west of Oklahoma Highway 18, on the C. H. Abernathy Ranch; SW¼ SE¼ sec. 30, T. 1 S., R. 4 E., Murray County, Okla.

This may be an incomplete section; it starts in the Haragan and extends through the Bois d'Arc formation. No Chimneyhill or Henryhouse was observed from section M11, north throughout sec. 30, the lower part being covered, and the Haragan may rest directly upon the Sylvan. The nearest complete section (including Chimneyhill) is at M14, about 2½ miles to the southwest. A summary of this section appeared in Amsden 1958A, p. 33 and 1958B, p. 36.

The strike of the Bois d'Arc strata is about 110 degrees (magnetic), dipping approximately 30 degrees to the west. (Difficult to get an accurate strike so the Bois d'Arc thickness may not be exact).

Covered (Woodford shale?)

BOIS D'ARC FORMATION (total 148 feet?)

CRAVATT MEMBER: Yellowish-gray, fossiliferous, argillaceous calcilutite; nodules of brown-weathering, porous chert in the lower 68 feet. Few beds of calcarenite in the upper 20 feet. The following brachiopods collected in situ from the upper 20 feet (M11-E) *Orthostrophia strophomenoides parva; Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptostrophia beckii tennesseensis, Leptaenisca concava, Leptaena acuticuspidata, Camarotoechia? singularis, Atrypa oklahomensis, Meristella atoka, Meristella* sp. 2.

	feet above base of formation
M11-E	128 to 148
M11-D	68 to 128
M11-C	0 to 68

HARAGAN FORMATION: Yellowish-gray, fossiliferous marlstone. No chert observed. A Helderbergian fauna collected from M11-A; includes *Favosites* cf. *F. conicus*, horn corals, several trilobites and Bryozoa plus the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Rhipidomelloides oblata, Isorthis pygmaea, Strophonella (S.) bransoni, Leptaenisca concava, Leptaena acuticuspidata, Camarotoechia? haraganensis, Coelospira virginia, Meristella atoka, Rhynchospirina maxwelli.*

	feet above base of section (M11-A)
M11-B (covered)	38 to 64
M11-A	0 to 38

Covered (see discussion above).

STRATIGRAPHIC SECTION M12A

Price's Falls

Section described by T. W. Amsden, May 7, 1957. On the east side of Falls Creek at Price's Falls; SW¼ NW¼ sec. 33, T. 1 S., R. 2 E., Murray County, Oklahoma (see map, fig. 52).

This section covers the Chimneyhill and lower part of the Henryhouse formation, the upper Hunton beds being covered. It is of special interest because of the Chimneyhill stratigraphic relations: the Cochrane member is only two inches thick and is overlain by 2 feet of red and green shale which presumably represents the basal shaly zone of the Clarita.

At this locality Decker (1935, pp. 436-446; Amsden 1956, p. 15-19) collected the following graptolites from a Henryhouse bed five feet above the base of the formation: *Monograptus bohemicus, M. crinitus, M. vulgaris.* I did not find any graptolites in the Henryhouse at this locality.

The strike of the beds is about 130 degrees (magnetic) dipping 80 degrees to the northeast. Analyses of selected rock samples given in the section CHEMICAL ANALYSES.

Covered

HUNTON GROUP

HENRYHOUSE FORMATION (60 feet exposed)

F. *Lithology*: Yellowish-gray marlstone, locally with red mottling. ....60 feet

Remarks: The contact with the underlying Clarita is well exposed and is marked by a rather well-defined lithologic break. All of the marlstone exposed on the east side of the creek is Silurian as Henryhouse fossils were collected from the upper few feet.

Fossils: One snail and two brachiopods, *Lissatrypoidea concentrica* and *Sieberella roemeri*, collected from the upper few feet.

CHIMNEYHILL FORMATION (total 24 feet)

CLARITA MEMBER (total 18 feet)

E. *Lithology*: Gray to yellowish-gray, fossiliferous calcilutite with rare pink pelmatozoan plates. HCl insoluble residues with many arenaceous Foraminifera. ....5 feet

Remarks: This rock has substantially less insoluble material, and a considerably greater fossil content than do the overlying beds. It probably has more insolubles than D.

Fossils: None collected.

D. *Lithology*: Gray to yellowish-gray calcilutite with many scattered pink pelmatozoan plates. Richly fossiliferous; Evenly bedded, beds to 6 inches. ....11 feet
Remarks: This is typical Clarita lithology. It rests directly on a red and green shale.

C. *Lithology*: Slightly fissile, red and green shale. Strongly glauconitic. HCl insoluble residues 93%. ....2 feet
Remarks: This unit is included within the Clarita although it is much more argillaceous than is common for the basal part of this member; in fact it is the only true shale which I have observed in the Hunton.
Fossils: None observed.

COCHRANE MEMBER (total 2 inches)

Lithology: Gray, fossiliferous calcarenite with scattered grains of glauconite. Acetic acid residue with glauconite and pyrite, no conodonts observed. One peel made covering the contact between this rock and the underlying Keel. The Cochrane shows much pelmatozoan material and no oolites; oolites in the underlying Keel are actually cut off along the contact. ....2 *inches*
Fossils: None collected.

KEEL MEMBER (total 3 feet)

B. *Lithology*: Light-gray, oolitic limestone; oolites range up to 2 mm. HC*l* insoluble residue 0.8%, $MgCO_3$ 0.11%. A peel shows closely spaced oolites, many with a fossil core; all of the fossil material appears to be coated with a layer of material having a similar texture to that of the oolite; the quantity of fossil debris is small. ....3 feet
Remarks: This rock is exposed in contact with the Cochrane. See remarks above.
Fossils: None collected.

IDEAL QUARRY MEMBER (total 3 feet)

A. *Lithology*: Brown-weathering fossiliferous calcarenite. HC*l* insoluble residue, 2.5%; $MgCO_3$ 0.94%. A thin section (pl. X, figs. 1, 2) shows this rock is different from the Keel; it has a much higher fossil content, and is in fact a bioclastic limestone (much of the fossil debris is pelmatozoan plates): the fossils are coated with layers of calcite (probably algal deposits), but nowhere attain the high degree of sphericity that the Keel oolites have. ....3 feet
Fossils: Richly fossiliferous, no fossils collected.

Covered (probably Sylvan shale).

STRATIGRAPHIC SECTION M12B

West of Price's Falls

Section described by T. W. Amsden, Oct. 31, 1957. A hundred feet or so west of Price's Falls (and section M12A), near the west edge of the NW¼ sec. 33, T. 1 S., R. 2 E., Murray County, Okla. (see map, figure 52). This section covers only the Chimneyhill formation, the strata below and above being covered. No Henryhouse was observed and this formation may be cut out by faulting. The Chimneyhill stratigraphic relations are interesting when compared with M12A; at the latter the Cochrane is only 2 inches thick, whereas at M12B it is 4 feet thick.

Strike of the beds 125 degrees (magnetic), dip about vertical.

Covered (no marlstone observed)

HUNTON GROUP
CHIMNEYHILL FORMATION (21 feet exposed)
CLARITA MEMBER (12 feet exposed)

D. *Lithology*: Gray, fossiliferous calcilutite with scattered pink pelmatozoan plates. Evenly bedded. ....12 feet
Remarks: Typical Clarita lithology.

COCHRANE MEMBER (total 4 feet)

C. *Lithology*: Light-gray, fossiliferous calcarenite with many scattered grains of glauconite. ....4 feet
Remarks: This is typical Cochrane lithology. Compare to the Cochrane at M12A where it is only 2 inches thick.

KEEL MEMBER (total 1 foot)

B. *Lithology*: Light-gray, oolitic limestone. Most of the oolites less than 1 mm. ....1 foot

IDEAL QUARRY MEMBER (4 feet exposed)

A. *Lithology*: Brownish-gray, fossiliferous calcarenite. Some partly silicified fossils. ....4 feet

Covered.

STRATIGRAPHIC SECTION M13

South of Sulphur

The Hunton strata in the SW¼ SW¼ sec. 22, T. 1 S., R. 3 E. (Murray County) were examined May 5, 1957. There are exposures of fossiliferous Bois d'Arc (mostly, if not entirely, Cravatt) on a small hill, but no marlstone or Chimneyhill beds were seen in this area. The Arbuckle map shows this Hunton outcrop belt extending west across the road to a small creek. However, I could find no evidence of any Hunton west of the road; on the creek to the west of the road the Fernvale crops out within 120 feet stratigraphically of the Woodford, the interval between being covered. Probably the Hunton is removed by the Woodford unconformity before reaching the road. In any event the Hunton exposures in this area are not suitable for a stratigraphic section.

STRATIGRAPHIC SECTION M14*

West of Oklahoma Highway 18

Section described and collected by T. W. Amsden, May 8, 1957. About 100 yards west of Oklahoma Highway 18 (near a bridge crossing), NE¼ SE¼ sec. 2, T. 2 S., R. 3 E., Murray County, Oklahoma. This is a nearly complete Hunton section except for the absence of the Ideal Quarry and Keel members at the base, and the Frisco limestone at the top. This section is quite similar, both in stratigraphic units present and in total thickness, to a Hunton section described by W. E. Ham (1955, p. 49) about a half mile west of M14. A summary of section M14 given in Amsden 1958A, p. 33; 1958B, p. 37.

The strike of the beds ranges from 80 to 95 degrees (magnetic), dipping about 50 degrees to the north. Analyses of rock samples given in the section CHEMICAL ANALYSES.

Covered (Woodford exposed within 10 feet of the Hunton)

HUNTON GROUP (total 230 feet)

BOIS D'ARC FORMATION (total 75 feet)

FITTSTOWN MEMBER: Gray, fossiliferous calcarenite in beds to 6 inches. Some beds with much glauconite; no chert observed. two HC*l* insoluble residues, 0.9% and 2.8%. No collection made.
M14-L .... 25 feet

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with nodules of chert, porous in lower part becoming vitreous above; beds of calcarenite in upper part and grading into overlying member. Two HC*l* insoluble residues, 11.3% and 14.14%. The following brachiopods collected from the lower 32 feet (M14-J): *Orthostrophia strophomenoides parva*, *Isorthis pygmaea*, *Strophonella (S.) bransoni*, *Leptaena* cf. *L. rhomboidalis*, *Kozlowskiellina (M.) velata*, *Meristella* sp. 2.

	feet above base of member
M14-K	32 to 50
M14-J	0 to 32

HARAGAN FORMATON: Yellowish-gray, fossiliferous marlstone. A small fauna collected; consists of a few Bryozoa, snails, horn corals: one trilobite pygidium, and the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Anastrophia grossa, Strophеodonta (B.) gibbera, Lissostrophia (L.) lindenensis, Leptaena acuticuspidata, Schuchertella haraganensis, Sphaerirhynchia glomerosa, S. lindenensis, Caramotoechia? haraganensis, Coelospira virginia, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Nucleospira ventricosa, Meristella atoka, Rhynchospirina maxwelli.* (Note: on Oct. 18, 1958 T. W. Amsden and P. Sutherland collected a specimen of *Rensselaerina haraganana* from M14-F; this is significant because it shows that *R. haraganana* ranges throughout the Haragan formation. See Amsden 1958A, p. 14).

	feet above the base of formation
M14-I (mostly covered)	29 to 102
M14-H	25 to 29
M14-G (Covered)	16 to 25
M14-F	11 to 16
M14-E	0 to 11

HENRYHOUSE FORMATION: Yellowish-gray, fossiliferous marlstone; like beds above except for minor red mottling on some beds. A small fauna collected, including a few horn corals, and the following brachiopods: *Atrypa* sp., *Lissatrypoidea concentrica, Leptaena* sp., *Merista oklahomensis, Rhipidomelloides henryhousensis, Sieberella roemeri, Strophonella prolongata.*

	feet above base of formation
M14-D	11 to 35
M14-C	0 to 11

CHIMNEYHILL FORMATION (total 18 feet, no Keel or Ideal Quarry beds present)

CLARITA MEMBER: Light-gray, fossiliferous calcilutite with scattered pink pelmatozoan plates.

	feet above base of member
M14-B	2 to 13
M14- (covered)	0 to 2

COCHRANE MEMBER: Gray, fossiliferous calcarenite with scattered grains of glauconite. Beds irregular, ranging up to 2 feet in thickness.

M14-A .... 5 feet

Covered (probably Sylvan shale).

STRATIGRAPHIC SECTION M15

North of Camp Classen

Section described by T. W. Amsden, May 9, 10, 1957. On the Hunton ridge about ¼ mile north of Camp Classen; SE¼ SW¼ sec. 13, T. 1 S., R. 1 E., Murray County, Oklahoma.

In this area the Woodford rests directly upon the Henryhouse, the contact of these two formations being exposed in several places. The Cochrane apparently rests directly on the Sylvan throughout this belt as no Keel or Ideal Quarry beds were observed from Camp Classen north to section M15.

The strike of the beds (taken on the Clarita) is 135 degrees (magnetic), dipping 65 degrees to the NE. There are some structural complications a short distance north of the line of section, but at M15 there does not appear to be any folding or faulting.

Analyses of rock specimens from this section are given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION

HUNTON GROUP (total 101 feet)

HENRYHOUSE FORMATION (total 88 feet)

E. *Lithology*: Yellowish-gray, marlstone. HCl insoluble residues about 22%; washed residues mostly clear, subangular, silt-size quartz with some mica. ....15 feet

Remarks: This is typical marlstone lithology which is similar to unit D, the separation being made for collecting purposes. Henryhouse fossils can be collected within a foot or so of the Woodford cantact.

Fossils: A small, Henryhouse fauna collected loose on the surface. Brachiopods include *Atrypa tennesseensis*, *Lissatrypoidea concentrica*, *Sieberella roemeri?*, *Strophonella laxiplicata;* also a few small horn corals.

D. *Lithology*: Yellowish-gray marlstone. Three specimens tested for HCl insoluble residues range from 23% to 32%, average 27%; the washed residues are almost entirely clear silt-size, subangular quartz. ....23 feet

Remarks: This interval is lithologically similar to E from which it was separated for collecting. No fossils collected from D.

C. *Lithology*: Covered ....50 feet

Remarks: Assigned to the Henryhouse as the Clarita limestones commonly make good outcrops.

CHIMNEYHILL FORMATION (total 12 feet, no Keel or Ideal Quarry observed)

CLARITA MEMBER (total 5 feet)

B. *Lithology*: Gray calcilutite with scattered pink pelmatozoan plates. Two HCl insoluble residues gave 3.5% and 5%, average about 4%; washed residues mostly clear, subangular quartz (silt-size) with many arenaceous Foraminifera. ....3 feet

Remarks: Typical Clarita lithology including abundant arenaceous Foraminifera.

B. *Lithology*: Covered ....2 feet

Remarks: This probably represents the basal, shaly part of the Clarita.

COCHRANE MEMBER (7 feet)

A. *Lithology*: Gray calcilutite with scattered grains of glauconite. Much light-gray to pinkish-gray vitreous chert present. Glauconite in small grains, not too abundant. Two HCl insoluble residues yielded 1.9 and 3%, averaging about 2.5%; the washed residues with some clear, subangular, silt-size quartz; also some white silica that probably represents incipient knots of silicification; minor glauconite ....7 feet

Covered (no Keel or Ideal Quarry beds seen in this area)

STRATIGRAPHIC SECTION M16*

Southeastern Murray County

Section measured and described by T. W. Amsden, May 22, 1957. It is located on the Goddard Ranch in the southeastern part of Murray County, about 2 miles southeast of White Mound and a couple of miles west of Oklahoma Highway 18; SW¼ NE¼ sec. 34, T. 2 S., R. 3 E.

For the most part, this is not a satisfactory section as the exposures are indifferent and there is considerable small scale faulting; the primary value of M12 is to furnish further information on the distribution and thickness of the different Hunton stratigraphic units. One analysis given in the section CHEMICAL ANALYSES.

Covered (much Woodford float)

HUNTON GROUP (total 174 feet)

BOIS D'ARC FORMATION (total 73 feet)

FITTSTOWN MEMBER: Gray to yellowish-gray, bioclastic calcarenite grading into calcirudite. Beds to 6 inches; no chert seen. Peel shows this rock to be composed in large part of fossil debris; matrix mostly clear calcite; considerable evidence of fragmentation of fossils, possibly with some recrystallization; incipient silicification. HC*l* insoluble residue 6.37%; $CaCO_3$ 93.66%; $MgCO_3$ 0.45%.

M16-F .... 8 feet

CRAVATT MEMBER: Yellowish-gray, argillaceous calcilutite with nodules of brown-weathering, porous chert. The upper 25 feet interbedded with calcarenite, and grading into the overlying strata.

feet above base of member

M16-E .... 40 to 65

M16-D .... 0 to 40

HENRYHOUSE and HARAGAN FORMATIONS: Mostly covered. Some outcrops of yellowish-gray marlstone. Henryhouse fossils found on the lower part of this unit and Haragan fossils on the upper part. This is so poorly exposed and has such meager fossils that no separation of the Henryhouse and Haragan was attempted, but the Henryhouse is probably about 25 feet thick.

M16-C........ 85 feet

CHIMNEYHILL FORMATION (total 16 feet; no Keel or Ideal Quarry observed)

CLARITA MEMBER: Gray, fossiliferous calcilutite with scattered, pink pelmatozoan plates. Bedding even, up to 6 inches.

M16-B .... 10 feet

COCHRANE MEMBER: Gray, fossiliferous limestone with scattered grains of glauconite.

M16-A .... 6 feet

Covered (no Keel or Ideal Quarry rocks observed in this area).

STRATIGRAPHIC SECTION M17

U. S. Highway 77

Section described by T. W. Amsden, Oct. 29, 30, 1957. About ¾th mile south of the Washita River, on the west side of U. S. Highway 77; NE¼ NW¼ sec. 30, T. 1 S., R. 2 E. Most of the section was measured in a small quarry located about 300 feet west of the highway where much of the Hunton marlstone is well exposed, including the Henryhouse-Haragan contact. The best exposure of the Haragan-Woodford contact is in a small gully just east of Highway 77. The strike of the beds is 95 degrees (magnetic), dipping about 90 degrees. Analyses of rock specimens from this section given in the section, CHEMICAL ANALYSES.

WOODFORD FORMATION (contact with Haragan exposed)

HUNTON GROUP (total 170 feet)

HARAGAN FORMATION (total 70 feet)

K. *Lithology*: Yellowish-gray, fossiliferous........ 61 feet marlstone. One specimen tested for HC*l* insoluble residue, approximately 21%; $MgCO_3$ content very low, less than 1%.

Remarks: The lower 25 feet of this unit is well exposed north of the quarry on the west side of the highway; the upper part, including the Woodford contact, is exposed just east of the highway.

Fossils: Several Haragan fossils collected from the lower 35 feet of this unit. Brachiopods: *Meristella atoka, Rhipidomelloides oblata, Levenea subcarinata pumilis, Kozlowskiellina velata.* One specimen of *Phacops* also collected.

J. *Lithology*: Yellowish-gray marlstone like beds .... 9 feet above. One specimen tested for HC*l*, 30.7%; $MgCO_3$ content less than 1%.
Remarks: Like beds above and below, separation for collecting.
Fossils: Several specimens of *Levenea subcarinata pumilis* collected from this interval. The bulbs of *Scyphocrinites* (*Camarocrinus*) are numerous.

HENRYHOUSE and/or HARAGAN FORMATIONS

I. *Lithology*: Yellowish-gray marlstone. 26% HC*l* .... 4 feet insolubles, and 4.7% $MgCO_3$, this being the highest dolomite content of any of the marlstones tested from M17.
Remarks: No fossils were found in this unit and it may be either Henryhouse or Haragan; or the contact may fall within unit I.

HENRYHOUSE FORMATION (total 85 feet including unit I)

H. *Lithology*: Yellowish-gray marlstone like beds .... 11 feet above. One specimen with 23% HC*l* insoluble residues; $MgCO_3$ content less than 1%.
Remarks: This unit was measured in the quarry on top of the hill, the top of H being the northernmost bed exposed in the quarry at the time the section was measured. Unit H carries a typical Henryhouse fauna.
Fossils: The following fossils collected in situ: *Lissatrypoidea concentrica*, *Merista oklahomensis*, *Dicoelosia oklahomensis*, *Encrinurus* sp.

G. *Lithology*: Yellowish-gray marlstone mottled with .... 7 feet red. Lithologically like the beds above and below except for red color. One specimen yielded 32% HC*l* insoluble residues, and 1% $MgCO_3$.
Remarks: The red mottling is quite irregular in its development and seems to be a local feature; traced along the strike it appears to die out in both directions. Henryhouse fossils can be collected in situ from the overlying beds so the Henryhouse-Haragan contact does not coincide with the red color.

F. *Lithology*: Yellowish-gray marlstone .... 7 feet
Remarks: This unit is similar to the beds above except for its reduced insoluble content (19.5%).

E. *Lithology*: Yelowish-gray marlstone .... 23 feet
Remarks: No fossils collected.

D. *Lithology*: Yellowish-gray marlstone like beds .... 33 feet above. One sample yielded 31.9% HC*l* insoluble residues.
Remarks: No fossils collected from this unit but it is a typical marlstone lithology: it has a much higher insoluble content than C (which has 8.9%) and a much lower fossil content.

CHIMNEYHILL FORMATION (total 19 feet, all members present)

CLARITA MEMBER (total 11 feet)

C. *Lithology*: Gray, highly fossiliferous calcilutite .... 11 feet with scattered pink pelmatozoan plates. Beds up to a foot or so, evenly bedded. Upper foot or so becomes more argillaceous.
Remarks: This lithology is typical for the Clarita, differing from the overlying Henryhouse in its reduced clay content and increased fossil content. The HC*l* insoluble residue from one specimen yielded 8.9%.
Fossils: Highly fossiliferous but none collected due to difficulty of breaking them out.

COCHRANE MEMBER (total 6 feet)

B. *Lithology*: Gray, glauconitic limestone with .... 6 feet small chert nodules. One rock specimen yielded 3.5% HC*l* insoluble residues.

Remarks: The glauconite content of this rock is lower than is common on the Cochrane. The chert is mostly in small irregular pieces, at places appearing to be "brecciated".

KEEL AND IDEAL QUARRY MEMBERS (total 2 feet)

A. *Lithology*: Brownish-gray, fossiliferous calcarenite with some oolites. In the upper few inches some of the oolites are silicified. .... 2 feet

Remarks: This unit is mostly typical Ideal Quarry lithology; the oolite content is low, oolites becoming common only in the upper few inches.

Covered (probably Sylvan shale)

STRATIGRAPHIC SECTION M18*

West side of Spring Creek

Section described and collected by T. W. Amsden, March 31, April 1, 1958. West side of Spring Creek, SW¼ SE¼ sec. 17, T. 2 S., R. 1 W., Murray County, Okla. The Chimneyhill and lower part of the Henryhouse strata were measured on the west side of the lake, extending down onto the west side of the spill-way; the section was then offset along the Chimneyhill-Henryhouse contact about 500 feet to the west, and the upper part of the Hunton was measured extending south over the Bois d'Arc ridge. Some unusually fine crystalline pyrite concretions are present in the Henryhouse formation.

The strike of the beds throughout the section is about 110 degrees (magnetic), dipping 25 to 30 degrees to the southwest.

Covered (much Woodford float and Woodford shale is exposed within a few feet stratigraphically of the highest exposed Hunton).

HUNTON GROUP (total 379 feet)

BOIS D'ARC FORMATION (total 90 feet, no Fittstown present)

CRAVATT MEMBER: Yellowish-gray, fossiliferous calcilutite with many nodules of brown-weathering, porous chert throughout; beds to 3 or 4 inches. Many Helderbergian fossils observed, but none collected.

	feet above base of member
M18-R	58 to 90
M18-Q	38 to 58
M18-P	0 to 38

HARAGAN FORMATION: Partly covered. Scattered outcrops of yellowish-gray, fossiliferous marlstone. Lithologically similar to the underlying Henryhouse; the Haragan-Henryhouse contact is drawn on the basis of the fossils and can be located within 3 or 4 feet. The following brachiopods collected from units N and O: *Dicoelosia varica, Leptaena acuticuspidata, Levenea subcarinata pumilis, Orthostrophia strophomenoides parva, Strophonella* (*S.*) *bransoni*.

	feet above base of formation
M18-O	21 to 69
M18-N	0 to 21

HENRYHOUSE FORMATION: Partly covered. Scattered outcrops of yellowish-gray, fossiliferous marlstone. Some beds (notably G) have many crystalline pyrite concretions, some of the crystal aggregates being nearly perfect. A few Haragan species collected loose on the surface from M, but the rest of the strata yield a large and typical Henryhouse fauna. The collections include a few snails, some small horn corals, Bryozoa and specimens of *Calymene* sp. and *Eophacops* sp.; also the following brachiopods: *Sieberella roemeri, Lissatrypoidea concentrica, Atrypa tennesseensis, Leptaena oklahomensis, Merista* sp., *Rhipidomelloides henryhousensis, Dicoelosia oklahomensis, Homoeospira* sp., *Lissostrophia* (*L.*) *cooperi,* *Nucleospira raritas, Pseudodicoelosia oklahomensis, Resserella brownsportensis, Strophonella prolongata.*

	feet above base of formation
M18-M (may include some Haragan)	188 to 191
M18-L	186 to 188
M18-K	163 to 186
M18-J	154 to 163
M18-I	116 to 154
M18-H (covered)	17 to 116
M18-G	11 to 17
M18-F	2 to 11
M18-E	1 to 2
M18-D	0 to 1

CHIMNEYHILL FORMATION (total 29 feet, no Keel or Ideal Quarry beds observed)

CLARITA MEMBER: Gray, fossiliferous calcilutite with many pink pelmatozoan plates. Bedding even, up to 8 inches. The lower one foot appears to be more argillaceous. No fossils collected.

	feet above base of member
M18-C	1 to 8
M18-B	0 to 1

COCHRANE MEMBER: Light-gray, glauconitic limestone with irregular nodules of vitreous chert. Bedding highly irregular.

M18-A .... 21 feet

Covered (No Keel or Ideal Quarry beds observed in this area and the Cochrane probably rests directly on the Sylvan).

STRATIGRAPHIC SECTIONS Ma2, Ma3, Ma4

Turkey Creek, Marshall County

Stratigraphic sections Ma2, Ma3, Ma4 (no Ma1) describe a sequence of limestones, dolomitic siltstones and dolomitic cherts exposed in a small Paleozoic inlier on Turkey Creek. The location of this inlier is shown on figure 46 and panel I; a geologic map of the area on figure 47. These strata, which are overlain by Woodford shale and underlain by Sylvan shale, have been correlated with the Hunton by past investigators, but are here considered to be post-Hunton and are informally designated the "*carbonate siltstone sequence*." A discussion of the lithologic and stratigraphic relations is given in the section, TURKEY CREEK INLIER. Several analyses of selected rock specimens from these outcrops are given in the section CHEMICAL ANALYSES; photomicrographs of thin sections are illustrated on plate XVI.

STRATIGRAPHIC SECTION Ma2

Turkey Creek

Section described by T. W. Amsden, April 17, 18, July 9, 1958. It is about a mile and a half south of Mannsville, on the west bank of Turkey Creek, NE¼ NE¼ SE¼ sec. 34, T. 4 S., R. 4 E., Marshall County, Oklahoma (fig. 47). This is the northernmost outcrop of the *carbonate-siltstone sequence* ("Hunton") in this area; it is also the best and most complete exposure in this area (55 feet of the beds in question exposed). The lowest strata exposed on Ma2 are tan, calcareous claystone doubtfully referred to the Sylvan. Below this is a 25 foot (stratigraphic) covered interval and then exposures of Viola limestone (may include some "Fernvale"); this covered interval includes some undoubted Sylvan as there are exposures of dark, graptolitic Sylvan shale in the exposures across the fault, on the east side of the Creek (fig. 47). The Sylvan is overlain by the *carbonate-siltstone sequence* which is completely exposed, including the upper contact with the Cretaceous.

Analyses of rock samples from this section are given in the section on CHEMICAL ANALYSES; photomicrographs are illustrated on plate XVI.

CRETACEOUS LIMESTONE (exposed in contact with unit F)

CARBONATE-SILTSTONE SEQUENCE (total 55 feet)

("Hunton" beds of authors)

F. *Lithology*: Light-colored dolomitic chert and siltstone. The upper 10 feet of this unit has much silica in the form of vitreous chert nodules and lenses, and in the form of spongy silica dispersed through the rock (pl. XVI, fig. 1). Two analyses from the upper 10 feet (Ma2-F(2) and Ma2-F(2a)) are as follows: HC*l* insolubles - 36.4%, $CaCO_3$ - 44.9%, and $MgCO_3$ - 18.4%; HC*l* insolubles - 61.1%, $CaCO_3$ - 26.0%, and $MgCO_3$ - 11.4%. ....20 feet

The lower 10 feet is clearly a dolomitic siltstone (pl. XVI, fig. 2). Two analyses of rock specimens (Ma2-F(1), and Ma2-F (1a)) from this lower part tested as follows: HC*l* insolubles 66.8%, $CaCO_3$ - 25.4%, $MgCO_3$ - 8.1%; HC*l* insolubles - 65.9%. $CaCO_3$ - 25.3%, and $MgCO_3$ - 8.6%.

Remarks: The lower part of unit F is a siltstone similar to unit D, below from which it is separated by a bed of chert (unit E). The upper 10 feet is more difficult to describe; it has a distinct resemblance to parts of the Woodford? cherty carbonate at Oil Creek (J13 to J18). There is no lithologic break within unit F, nor is there one between D, E. F, and all of these strata appear to be part of a closely related stratigraphic sequence. None of the undoubted Hunton strata which I have examined have any close lithologic resemblance to unit F.

Fossils: No fossils observed.

E. *Lithology*: Light-gray, fractured, vitreous chert. ....1 foot

Remarks: This bed is exposed for about 20 to 30 feet along strike and is all solid chert. It resembles some of the chert beds on the Oil Creek outcrops (J13 to J18).

D. *Lithology*: Brown (5YR 6/4) to tan-weathering dolomitic siltstone in beds to 3 or 4 inches. Detritus largely angular to subangular quartz particles (pl. XVI, fig. 3) ranging up to 0.06 mm, averaging around 0.04 (sand size detritus, if present, is rare). Considerable mica and glauconite present. About 30 percent of this rock is carbonate, of which 12 to 13 percent is $MgCO_3$. Two specimens analyzed. Ma2-D (1) from the lower 10 feet tested: HC*l* insolubles - 67.1%, $CaCO_3$ - 18.2%, and $MgCO_3$ - 13.19%: the other specimen, Ma2-D(2) from a zone 10 to 15 feet above the base of D tested: HC*l* insolubles - 69.8%, $CaCO_3$ - 16.6%, and $MgCO_3$ - 12.4%. ....29 feet

Two thin sections of this rock (one illustrated in fig. 3, pl. XVI) show the same texture as the lower part of F (pl. XVI, fig. 2; note the similarity in the analyses of these rocks).

Remarks: This rock is a thin-bedded dolomitic siltstone; its bedding is somewhat irregular in places suggesting a subdued type of cross-bedding. The upper few feet has small chert nodules and seems to be clearly related to the overlying beds (see *Remarks* above). It is lithologically quite unlike any undoubted Hunton which I have seen. The Hunton which most closely resembles this rock would be the Henryhouse or Haragan marlstone but these strata have far less silt (insolubles) and far more fossil material.

Fossils: No fossils observed in the field and the thin sections do not include any recognizable fossil material.

C,B,A. *Lithology*: Light-gray to greenish-gray, fossiliferous calcarenite with much glauconite. Evenly bedded, beds from ½ inch up to 8 inches. The HC*l* insoluble content ranges from 5 to 10 percent (see CHEMICAL ANALYSES): residues ....5 feet mostly light colored, spongy silica, some of which is replacing fossils, and glauconite (minor limonite?) ; the glauconite is mostly a light-green color in small rounded to botryoidal grains; a few polylobate grains like those of the Cochrane. The amount of detritus is small, mostly in the silt and smaller sizes, but locally there are well rounded and frosted quartz grains up to 1.5 mm. Arenaceous Foraminifera not observed.

Several peels and one thin section (pl. XVI, fig. 4) prepared: it is a rock rich in fossil material: considerable pelmatozoan material in addition to brachiopod and snail shells, and probably a number of other types; much of the fossil material appears to be broken and there is also some evidence of recrystallization. The matrix is largely clear, crystalline calcite.

The $MgCO_3$ content is low; 3 different rock specimens all tested less than 1½ percent (see CHEMICAL ANALYSES).
Remarks: There is no lithologic break in this unit, but for sampling it was divided into 3 units: A - 0 to 1½ feet above base; B - 1½ to 3 feet above base; C - 3 to 5 feet above base (see CHEMICAL ANALYSES).

This rock is similar to the Clarita and Cochrane members of the Chimneyhill formation in being a bioclastic limestone. It is like the Cochrane in its high glauconite content although it appears to have considerably more glauconite and the general shape of the grains is slightly different; the bedding is, however, quite different from that of the Cochrane, the latter having an irregular, obscure bedding whereas the Turkey Creek calcarenite is remarkably uniform. In its bedding it is similar to the Clarita member, but it has a far greater glauconite content.

This unit is lithologically distinct from the overlying siltstone and the contact is sharp and well defined.
Fossils: This rock is richly fossiliferous and I have obtained a fairly good collection of megafossils, the groups best represented being the phacopid trilobites, snails and brachiopods. I have not studied these in detail but they appear to be certainly post-Silurian and none is conspecific with known Haragan - Bois d'Arc or Frisco species.

Acetic and formic acid residues yield some conodonts, mostly compound types.

SYLVAN? FORMATION

X,Y,Z. *Lithology*: Yellowish-gray (5Y to 7/2) to............6 feet grayish-orange (10 YR 7/4) calcareous claystone. Parts of this rock are thinly laminated, the individual laminae only a millimeter or so in thickness: none is fissile and some parts show little or no bedding. This rock is uniformly fine textured. Two thin sections (one illustrated on pl. XVI, fig. 5) show a maximum grain size of around 0.03 to 0.04; however, the grains of this size appear to be mostly discrete particles of calcite; the insoluble parts appear to be almost exclusively in the range of very fine silt or clay (probably mostly the latter). There is considerable dark iron mineral, probably hematite or limonite.

Two analyses of this rock were prepared (CHEMICAL ANALYSES). One of these (Ma2-Y), which was of a specimen collected 1 to 2 feet below Ma2-A, tested: HCl insolubles - 59.6%, $CaCO_3$ - 37.7%, $MgCO_3$ - 0.70% the other (Ma2-Z), collected an inch or so below Ma2-A, tested: HCl insolubles - 37.43% $CaCO_3$ - 60.8%, $MgCO_3$ - 1.1%. These analyses indicate that, at least locally, this rock grades into an argillaceous limestone.
Remarks: For sampling purposes this interval was divided into the following units: Ma2-Z, 0 to 6 inches below the Ma2-A contact; Ma2-Y, 1 to 2 feet below the contact; Ma2-X, 4 to 6 feet below the contact.

This unit is probably a part of the Sylvan although it does differ from the typical green clay of that formation. The $CaCO_3$ content of the Turkey Creek rock is relatively high, locally grading into a marlstone (60 percent $CaCO_3$); however, lenses of argillaceous limestone are known to be interbedded with the characteristic Sylvan type shale. For example, at J17 near Oil Creek, a lens of argillaceous limestone (17 percent insolubles) is present in the Sylvan shale about 25 feet below the top; for comparative purposes a photomicrograph of this rock is illustrated in figure 6, plate XVI.

The insoluble portion of Ma2-X, Ma2-Y and Ma2-Z is much finer grained than in any of the overlying rocks.

Fossils: No fossils observed.

Covered (There is 20 feet (stratigraphic thickness) between the base of Ma2-X and the highest exposures of coarse limestone (Viola or "Fernvale"). Assuming this to be a normal, undeformed section, and the geologic mapping in this area indicates that it is (fig. 47), there is only about 26 feet of Sylvan present, including all of Ma2-X, Ma2-Y and Ma2-Z in the Sylvan.

STRATIGRAPHIC SECTION Ma3

Turkey Creek

An outcrop of the *carbonate-siltstone sequence*, described by T. W. Amsden, April 18, July 9, 1958. East side of Turkey Creek, a couple of hundred feet southwest of Ma2 (fig. 47); NW¼ NW¼ SW¼ sec. 35, T. 45., R. 4 E., Marshall County, Oklahoma. This outcrop exposes several feet of rocks, all having the same lithology, being a brown-weathering siltstone in beds up to 3 or 4 inches; there is some minor cross-bedding; no chert or fossils observed. This rock is almost certainly the same unit as the dolomitic siltstone, Ma2-D; the units look alike and both appear to be on strike. One thin section was prepared of Ma3 and it shows a texture and composition which is identical to that of Ma2-D; it is made up largely of angular to subangular silt-size quartz particles ranging up to about 0.06 mm in diameter; glauconite and mica are common; no fossil material observed.

STRATIGRAPHIC SECTION Ma4

This is a small outcrop of *carbonate-siltstone sequence* described by T. W. Amsden, April 18, July 9, 1958. East side of Turkey Creek, about 500 feet south of Ma3 (fig. 47); NW¼ NW¼ SE¼ sec. 35, T. 4 S., R. 4 E., Marshall County, Okla. It is a light-colored, cherty and dolomitic siltstone ranging into a silty and cherty dolomite. The chert is pale gray to white and with a porcelaneous texture; the rest of the rock is uniform in texture, consisting of silt (and finer) quartz and carbonate. Two analyses of this rock are as follows: Ma4-(1), HC*l* insolubles - 69.9%, $CaCO_3$ - 17.1%, $MgCO_3$ - 22.3%; Ma4-(2), HC*l* insolubles - 41.7%, $CaCO_3$ - 34.7%, $MgCO_3$ - 23.2%. The washed residues consist, in part, of clear, subangular silt size quartz; there is also considerable light-colored, spongy insolubles which might include some clay aggregates. This rock resembles the upper part of Ma2 (Ma2-F) with which it is probably correlative.

STRATIGRAPHIC SECTION P1

Chimneyhill Creek

Described by T. W. Amsden, assisted by J. White, Sept. 28, 29, and Oct. 10, 11, 1958. On the Lawrence uplift, about 2 miles southeast of Lawrence Quarry. The base of this section begins in about the center of the SE¼ sec. 5, on a small tributary approximately 500 feet from its junction with Chimneyhill Creek; it extends to Chimneyhill Creek and then along the creek into the SW¼ of sec. 4; about 1,000 feet east of the 4-5 section line, on a sharp bend in the creek, the section turns north and extends up the scarp face to the top of the ridge capped by the Bois d'Arc cherty beds. For further details on the location of this section see the geologic map, panel II, plate A. A summary of this section given in Amsden 1958A, p. 34; 1958B, p. 37.

The strike of the beds on this section range from 80 to 120 degrees (magnetic), dipping 6 to 8 degrees to the north.

Analyses of the rock from this section are given in the section on CHEMICAL ANALYSES.

HUNTON GROUP

(section carried only to the base of the Bois d'Arc; see P3 for a complete description of the Bois d'Arc formation)

BOIS D'ARC FORMATION

CRAVATT MEMBER

V. *Lithology*: Partly covered; exposures of yellowish-gray marlstone with nodules of porous, brown-weathering chert

Remarks: This unit caps the ridge bordering the north side of Chimneyhill Creek. The rocks are fossiliferous and carry a characteristic Haragan-Bois d'Arc fauna. The Bois d'Arc was not measured on P1, but a detailed description was made at P3, about a half mile to the east.

HARAGAN FORMATION (total 5 feet)

U. *Lithology*: Fossiliferous calcarenite ranging into a calcirudite interbedded with yellowish-gray marlstone. The calcarenite is a pale orange (10YR 8/2) and has a low HCl insoluble content, 2½%. It ranges from 1 to 2 feet in thickness, being overlain and underlain by marlstone. The washed HCl insoluble residues are mostly clear, subangular silt-size particles of quartz with minor glauconite; some arenaceous Foraminifera present. No chert observed. ....5 feet

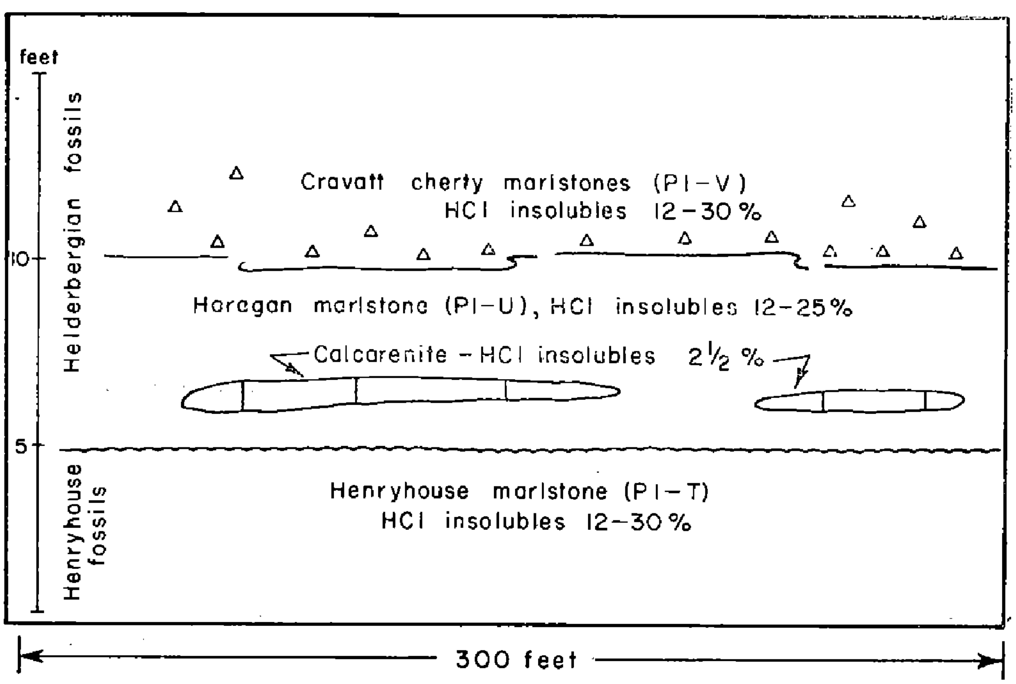

Figure 55. Section showing the relationship of the Haragan calcarenites to the upper Henryhouse and lower Bois d'Arc strata at section P1.

Remarks: The presence of a low insoluble bioclastic calcarenite in the Haragan is interesting and unique. The Haragan-Henryhouse contact can be located within a few inches by means of the fossils (no physical evidence in this area; see P3 and P8); above the contact is a foot or so of marlstone, followed by 1 to 2 feet of calcarenite followed in turn by a foot or so of marlstone; above this are the cherty marlstones of the basal Cravatt member. The calcarenites occur as elongate lenses which can be traced laterally for several hundred feet; followed toward the east they disappear and at P3 there are no calcarenites this low in the section. This is illustrated in figure 55.
Fossils: The calcarenite bed is richly fossiliferous and carries a Haragan-Bois d'Arc fauna quite similar in some respects to that of the Fittstown calcarenites, having large dalmanitid trilobites and a large meristelloid brachiopod, possibly *Meristella* sp. 2 (Amsden 1958B, p. 85-86, pl. IV, figs. 15-19); also *Kozlowskiellina* (*M.*) *velata*, *Leptaena acuticuspidata*? *Meristella atoka*?, *Rhipidomoelloides oblata*, *Strophonella* (*S.*) *bransoni*; one small solitary tetracoral and a fragment of a phacopid trilobite, plus several pieces of some large dalmanitid trilobite. The HC*l* residues yield a few arenaceous Foraminifera.

HENRYHOUSE FORMATION (total thickness 247 feet)

T. *Lithology*: Fossiliferous, yellowish-gray....................36 feet
(5Y 8/4) to pale greenish-gray (10Y 8/4) argillaceous calcilutite (marlstone) with a few scattered beds of calcarenite. Average grain-size of the calcilutite well below 1/16 mm; calcarenites coarser, probably with a slightly reduced insoluble content. One rock sample yielded about 8% HC*l* insolubles; the washed residues consist largely of clear, subangular, silt-size quartz; few arenaceous Foraminifera. Rock is slightly dolomitic, the acid soluble portion having 4.5% $MgCO_3$. Bedding nodular, up to 2 or 3 inches in thickness. No chert observed.
Remarks: There is no lithologic break discernible between unit T, which carries a characteristic Henryhouse fauna, and unit U, which carries a typical Helderbergian fauna.
This interval is lithologically somewhat unusual for the Henryhouse in having some beds of calcarenite. T is similar to the underlying S, from which it is separated for collecting only.
Fossils: This interval carries a large fauna of brachiopods, all being typical Henryhouse species: *Atrypa tennesseensis*, *Stegerhynchus carmelensis*, *Coelospira saffordi*, *Dictyonella gibbosa*, *Dicoelosia oklahomensis*, *Schuchertella attenuata*, *Homoeospira subgibbosa*, *Isorthis arcuaria*, *Leptaena oklahomensis*, *Lissatrypoidea concentrica*, *L. henryhousensis*, *Merista oklahomensis*, *Resserella brownsportensis*, *Ptychopleurella rugiplicata*, *Strixella acutisulcata*, *Rhipidomelloides henryhousensis*, *R. subtriangularis*, *Sieberella roemeri*? In addition to the brachiopods, one specimen of *Pleurodictyum* and a small horn coral were collected; also one snail and a few Bryozoa.

S. *Lithology*: Yellowish-gray (5Y 8/1),....................20 feet
fossiliferous calcilutite with a few beds of calcarenite. A peel of the calcarenite shows over 60% fossil debris, the remainder of the rock being composed of finely divided carbonate; many different kinds of fossils present, but pelmatozoan plates predominate: minor silicification. One speciment tested for HC*l* insolubles yielded about 14%; washed residues largely clear, subangular, silt-size quartz; no Foraminifera observed. Rock is slightly dolomitic. the acid soluble portion with about 3% $MgCO_3$.
Remarks: This unit is like T above from which it is separated for collecting purposes; it grades into the underlying beds from which it differs only in having beds of calcarenite. S has weathered to form a partial glade.

Fossils: All of the fossils collected from this interval are typical Henryhouse species with the exception of a single piece of a *Levenea* which was collected loose on the surface and which probably represents float from the overlying Helderberg strata. Eleven species of brachiopods, *Atrypa tennesseensis, Anastrophia delicata?* (immature specimen), *Dicoelosia oklahomensis, Homoeospira* sp., *H. subgibbosa, Isorthis arcuaria?, Resserella brownsportensis, Ptychopleurella rugiplicata, Rhipidomelloides henryhousensis, R. subtriangularis, Sieberella* sp. In addition several small horn corals, a gastropod and several Bryozoa; one *Pisocrinus* and several fragments of trilobites including *Calymene* sp. and the pygidia of *Eophacops* sp.

R. *Lithology*: Fossiliferous, yellowish-gray..8 feet (5Y 6/1) marlstone. One specimen tested for HC*l* insolubles, about 10%; washed residues almost entirely a clear, silt-size, subangular quartz; no Foraminifera observed. $MgCO_3$ - 1.2%. Bedding nodular, up to 4 inches in thickness.

Remarks: This interval completely exposed in a low bench. It is similar to S but lacks the beds of calcarenite; it is like unit Q although better exposed; separated from the latter primarily for collecting.

The beds, like most of the marlstone exposed in this section, are a yellowish-gray (5Y 8/1) on a fresh surface; this marlstone tends to lose its yellowish cast when weathered, being either a medium gray (N6) to a light olive gray (5Y 6/1).

Fossils: 18 species of brachiopods, all typical Henryhouse species (with the exception of the ?*Orthostrophia*) collected from this interval: *Atrypa tennesseensis, Strophonella prolongata, Anastrophia* sp., *Stegerhynchus altisulcata, ? Delthyris kozlowskii* (immature specimen), *Fardenia reedsi, Homoeospira foerstei, Leptaena oklahomensis, Lissostrophia (L.) cooperi Merista* sp. *Orthostrophia ?* sp. (fragment of a brachial valve) *Resserella brownsportensis, Ptychopleurella rugiplicata, Stixella acutisulcata, Rhipidomelloides henryhousensis, Sieberella* sp., *Schizoramma hami, Strophonella* sp. In addition several corals including different species of *Favosites, Heliolites* and small horn corals; one specimen of *Calymene* sp.; *Pisocrinus quinquelobus and P.* cf. *P. gorbyi*, and *Eucalyptocrinus milliganae*?: one sponge (*Hindia*?), several Bryozoa, and a few gastropods.

Q. *Lithology*: Party covered. Pale, greenish-yellow................................19 feet (10Y 8/2) to yellowish-gray (5Y 8/1), fossiliferous marlstone. Except for the fossils this rock is entirely fine-grained, well below 1/16 mm. Insoluble residue approximately 14%: no arenaceous Foraminifera observed in the residues which are similar to those from the strata above and below. Bedding nodular, up to 3 or 4 inches.

Remarks: This interval is about 60 percent covered: it forms a glade with scattered crops. Q forms the base of the glade along the north side of Chimneyhill Creek; P below makes a cliff going down to the stream. There is no lithologic break between P, Q and R: the separation is for collecting only.

Fossils: A large, representative Henryhouse fauna collected from Q. Eighteen species of brachiopods: *Strophonella loeblichi?, S. prolongata, Atrypa tennesseensis, Coelospira saffordi, "Camarotoechia" filistriata, Delthyris kozlowskii, Dictyonella gibbosa, Fardenia reedsi, Homoeospira foerstei?, Howellella henryhousensis, Isorthis arcuaria, Leptaena oklahomensis, Lissostrophia (L.) cooperi, Resserella brownsportensis, Ptychopleurella rugiplicata, Rhipidomelloides henryhousensis, Pseudodicoelosia oklahomensis, Schizoramma hami.* Several corals including specimens of *Favosites:* the trilobite *Calymene* sp.: a number of specimens of

Piscorinus including specimens of *P. quinquelobus* and *P. gorbyi; Lecanocrinus* sp. and several gastropods and Bryozoa.

P. *Lithology*: Grayish-yellow (5Y 8/4) to........23 feet yellowish-gray (5Y 7/2) fossiliferous marlstone. One sample tested for HC*l* insolubles, 21%; washed residues consist largely of clear, silt-size quartz fragments with some mica; no arenaceous Foraminifera observed.

Remarks: This interval forms a cliff extending from the stream level up to the lowest glade exposure. All of the beds below P were measured in the bed of Chimneyhill Creek extending to the west, and all above were measured in the scarp face going north up to the Bois d'Arc cherty beds which cap the ridge. There is no lithologic break between O, P and Q, the separation being for convenience in measuring and for collecting.

Fossils: All of the fossils from this interval were collected in situ. A moderately large fauna collected, all being characteristic Henryhouse species. Brachiopods: *Strophonella prolongata, Anastrophia delicata, Atrypa tennesseensis, "Camarotoechia"* sp., *Homoeospira foerstei?* (immature specimen), *H. subgibbosa, Leptaena oklahomensis. Resserella brownsportensis, Rhipidomelloides henryhousensis, Schizoramma hami, Sieberella roemeri.* Corals; a few colonial specimens, plus some small horn corals; one *Calymene* sp. and a few specimens of Bryozoa, gastropods and pelecypods.

O. *Lithology*: Covered........16 feet

N. *Lithology*: Pale, greenish-yellow (10Y 8/2)........20 feet to yellowish-gray fossiliferous marlstone. One rock specimen tested for insoluble residues, approximately 13%: $MgCO_3$ - 4.5%. Washed HC*l* residues mostly subangular, silt-size quartz with some mica; no arenaceous Foraminifera observed. Evenly bedded, nodular; beds to 3 inches in thickness.

Remarks: This unit lithologically like the beds above and below, although it may be slightly thinner-bedded; separated mainly for collecting. Measured along the south bank of Chimneyhill Creek.

Fossils: Only a few fossils collected, all in situ. All are typical Henryhouse species. Brachiopods: *Anastrophia delicata, Resserella* sp., *Sieberella romeri?*, Trilobites: *Calymene* sp. Several Bryozoa specimens.

M. *Lithology*: Yellowish-gray (5Y 8/1), fossiliferous........26 feet marlstone in beds up to 6 inches thick. One specimen tested for HC*l* residues gave 22.5%. Rock is dolomitic, one specimen yielding 9.7% $MgCO_3$. Washed HC1 residues mostly clear, subangular, silt-size quartz fragments with some mica.

Remarks: This unit like the beds above and below except for slightly thicker bedding. It was measured along the south side of Chimneyhill Creek.

Fossils: A small fauna was collected in situ from the upper 6 feet of this unit; includes nine species of brachiopods, all typical Henryhouse species: *Strophonella laxiplicata, S. prolongata, Anastrophia delicata, Atrypa tennesseensis. Stegerhynchus carmelensis Lissostrophia* (*L.*) *cooperi, Stropheodonta* (*B.*) *attenuata.* In addition a few small tetracorals, some Bryozoa and a single trilobite pygidium collected.

L. *Lithology*: Covered........17 feet

K. *Lithology*: Yellowish-gray marlstone........2 feet

Remarks: Like beds below; separated for collecting.

Fossils: Small fauna collected in situ; all species typical of the Henryhouse. *Strophonella laxiplicata, S. loeblichi, Anastrophia delicata; Calymene* sp.; few Bryozoa.

J. *Lithology*: Yellowish-gray (5Y 7/2 to 5Y 8/1), ...15 **feet**
fossiliferous marlstone with nodular beds up to 3 inches in thickness. One specimen tested for HC*l* residues, 31%; washed residues almost entirely clear, subangular quartz (silt-size) with some mica; no arenaceous Foraminifera observed. Dolomitic, one specimen with 11.6% $MgCO_3$ Acetic acid residues did not yield conodonts.
Remarks: This unit like the beds above and below, being separated for collecting. It was measured along the north bank of Chimneyhill Creek.
Fossils: A small fauna collected in situ. Typical Henryhouse collection: *Atrypa* sp., *Strophonella prolongata, Dicoelosia oklahomensis, Lissatrypoidea decaturensis, Merista* sp., *Ptychopleurella rugiplicata, Sieberella roemeri?*; *Calymene* sp., *Eophacops* sp., and a few Bryozoa.

I. *Lithology*: partly covered. Some exposures of ....14 **feet**
yellowish-gray fossiliferous marlstone. One specimen tested for HC*l* residues, 14%; washed residues mostly subangular, silt-size quartz fragments with some mica. Beds nodular, less than 3 inches in thickness.
Remarks: Some 50 to 70% of this interval is covered; it is similar to the beds above and below from which it was separated because it is partly covered, and for collecting.
Fossils: A small Henryhouse fauna collected in situ; this consists of a couple of incomplete specimens of *Calymene* sp., one snail, a few Bryozoa, and the following 7 species of brachiopods: *Atrypa tennesseensis, Stropheodonta (B.) attenuata, Delthyris?* sp., *Dictyonella gibbosa, Leptaena oklahomensis, Sieberella roemeri? Strophonella prolongata.*

H. *Lithology*: Pale greenish-yellow (10Y 8/2) to ....19 **feet**
yellowish-gray fossiliferous marlstone with nodular beds up to 2 inches. One specimen yielded 12.8% HC*l* residues; washed residues mostly clear, subangular, silt-size quartz fragments with some mica; no arenaceous Foraminifera observed.
Remarks: Similar to beds above and below although the bedding may be somewhat more nodular than below; measured in the bed of Chimneyhill Creek.
Fossils: This interval contains *Resserella brownsportensis, Dicoelosia oklahomensis, Sieberella* sp., *Anastrophia delicata* and *Fardenia* sp.; also a few trilobite fragments, including *Calymene?* sp.

G. *Lithology*: Yellowish-gray (5Y 7/2 to 5Y 8/1) ....12 **feet**
fossiliferous marlstone. One HC*l* residue calculated, 14.5%; washed residues entirely silt-size, clear subangular quartz fragments with a few pieces of mica; acetic residues similar to HC1, no conodonts or arenaceous Foraminifera observed. One peel prepared which shows a rock composed of finely divided (silt and smaller) carbonate with silt and clay size insoluble fragments. Scattered through this matrix are larger fossil fragments, some being concentrated into irregular seams or beds; however, in general the fossil material seems to be somewhat randomly dispersed through the rock. Bedding nodular, up to 4 inches in thickness.
Remarks: This unit is faunally and lithologically similar to H from which it is separated for collecting purposes only. G is both lithologically and faunally distinct from F; see under *Remarks* for F. G. measured on the south bank of Chimneyhill Creek.
Fossils: Typical Henryhouse fauna: includes a few ....12 **feet**
small, horn corals, gastropods, Bryozoa, *Calymene* sp., and a fragment of a dalmanitid cranidium. The folowing brachiopod fauna collected in situ: *Strophonella laxiplicata, S. prolongata, Atrypa tennesseensis, Isorthis arcuaria, Leptaena oklahomensis, Lissatrypoidea henryhousensis, Nanospira parvula, Rhipidomelloides henryhousensis, Sieberella roemeri?.*

CHIMNEYHILL FORMATION (total thickness 63 feet)
CLARITA MEMBER (total thickness 36 feet)

F. *Lithology*: Pale orange (10YR 8/2), richly fossiliferous calcilutite with scattered pink pelmatozoan plates Peel shows fossil fragments irregularly set in a fine-grained matrix (below 1/16 mm); rock predominantly composed of fossil material, being a bioclastic limestone. One HC*l* residue - 4½%; washed residues largely silt-sized, subangular quartz; some dark minerals present including a dark mica; arenaceous Foraminifera common in the HC*l* residues and in the acetic residues; no conodonts observed in the latter. Dolomite content low, $MgCO_3$ content less than 1%. ....2 feet

Remarks: This unit is exposed in the bed of Chimneyhill Creek some 200 feet east of the road; it may be observed in contact with the beds above and below. The upper contact is an abrupt one, and unit F is lithologically distinct from G: (1) insoluble residue much lower, less than one-half of the lowest Henryhouse residue recorded from section P1; (2) presence of pink pelmatozoan fragments (3) arenaceous Foraminifera common in the HC1 and acetic acid residues; also probably a higher percentage of dark minerals in residues; (4) fossil content of rock is higher. In addition to these lithologic differences the fauna is entirely different (see below), thus F is sharply marked off from G. This unit is like the underlying beds in its low insoluble content, high fossil content, pink pelmatozoan plates; the fauna of F is somewhat different from E (see below), but this is probably only a minor biofacies of the Clarita member. This particular bed and fauna has not been found at the top of the Clarita member elsewhere.

Fossils: A moderate megafauna broken out of F, being composed predominantly of brachiopods and trilobites with some snails and a few cephalopods. I have not yet studied this fauna in detail, but a preliminary check indicates none of the brachiopods are conspecific with those of the Henryhouse, but does show a resemblance to the St. Clair (Arkansas) brachiopod fauna. Provisional identifications show species similar to (perhaps identical with) *Triplesia praecipta* Ulrich and Cooper; "*Spirifer* (*Delthyris*) *sulcatus*" of Thomas (not Hisinger): "*Camarotoechia*" *arkansana* Thomas; "*Camarotoechia*" *marginata* Thomas; also a fragment of a *Dictyonella* (almost certainly not *D. gibbosa*), and specimens of *Meristella*? sp. The *Eospirifer* which is present in the underlying unit E not observed in F.

Arenaceous Foraminifera are common in the acetic and HC*l* residues, most being elongate tube-like types or irregular subspherical types. No conodonts observed in the acetic residues, but presumably they could be recovered by the use of heavy liquids.

E. *Lithology*: Orange pink (10R 7/4) fossiliferous calcarenite with many pink (actually orange pink) pelmatozoan fragments. Fragments average 1 to 2 mm in diameter, but some parts quite coarse-grained and range into a calcirudite, whereas other parts are finer and grade into a calcilutite. Peel shows much fossil debris, commonly set in clear calcite; some of the fossil pieces are incomplete, due either to breakage or to recrystallization (or a combination thereof). One HC*l* residue calculated - less than 1%; washed residues with clear, subangular silt-size quartz, and some opaque white to yellowish mineral, perhaps a type of chert or the result of incomplete silicification; also some glauconite, dark mica and pyrite; arenaceous Foraminifera common, the most numerous type being elongate, tube-like forms. Acetic residues with conodonts, which appear to be of the common Clarita types. ....15 feet

This unit is evenly bedded with the beds ranging up to 6 or 8 inches in thickness.

Remarks: E is well exposed in the bed of Chimneyhill Creek. Its upper contact with F is marked by a change in color and in texture; however, both units are bioclastic limestones. The lower contact with D is not conspicuous, being principally a change in texture.

Fossils: A small fauna was broken out of the lower 10 feet. It is composed predominantly of trilobites with some brachiopods and snails; I have not studied the fauna in detail but one of the brachiopods is an *Eospirifer* similar to (or perhaps identical with) one from the St. Clair of Arkansas. This brachiopod not observed from beds F, and most, if not all, of the brachiopds from F have not been identified from E.

Arenaceous Foraminifera common in the HC*l* and acetic residues, and conodonts abundant in the acetic residues.

D. *Lithology*: Fossiliferous calcilutite with....................19 feet scattered pink pelmatozoan fragments. Fresh surface yellowish-gray (5Y 7/2) with many pelmatozoan plates, most being a moderate-orange (10R 7/4) to moderate-reddish-orange (10R 6/6); these plates are commonly a millimeter or two in diameter. The texture of this rock, excluding the fossil fragments, is well below 1/16 mm. It is evenly bedded, the beds generally ranging from 1 to 6 inches in thickness. One specimen tested for HC*l* insoluble residue gave 3%; washed residues largely clear, silt-size subangular quartz fragments with some glauconite and other dark minerals; arenaceous Foraminifera common. The acetic acid residues are composed largely of arenaceous Foraminifera, conodonts and inarticulate brachiopods.

Remarks: D is well exposed in the bed of a small stream which enters Chimneyhill Creek from the south; the top D is near the junction of this stream with Chimneyhill Creek. It is separated from E on the basis of texture, D being a finer-grained rock than E. The base of D is marked by a small indentation probably indicating a slightly more shaly zone; this argillaceous zone at the base of the Clarita is common in many areas and is everywhere included in the Clarita.

Fossils: The rock is richly fossiliferous, a bioclastic calcarenite, but it is almost impossible to break out specimens due to its fine texture.

COCHRANE MEMBER (total thickness 18 feet)

C. *Lithology*: Fine to medium-grained calcarenite....................18 feet with many grains of glauconite. The texture is variable, but averages 1 to 2 mm in diameter. Weathered color is a medium gray (N6), and the fresh surface is a light gray (N7 to N8); scattered through this rock are orange-colored fragments, some of which can be demonstrated to be pelmatozoan plates. Peels show that this rock has a fragmental texture, many of the fragments being pelmatozoan plates; there appears to have been some recrystallization as the boundaries of the plates are commonly obscure. This rock yields less than 1% insoluble residues; washed residues largely glauconite grains, most being less than a millimeter in diameter; the glauconite grains are commonly rounded, many botryoidal; some are clearly the filling or steinkerns of shells, mostly snails or ostracods; some are in the form of sponge spicules which may be the filling of a hollow spicule, or may be replacement (pl. XVII); along with the glauconite are some clear, subangular, silt-size quartz fragments; also minor pyrite and limonite. The acetic acid residue is considerable, much being in the form of pelmatozoan plates (the $MgCO_3$ content is low, slightly over 1%).

Bedding irregular, commonly obscure, in beds to 2 or 3 feet. A few, irregular nodules of chert present.
Remarks: This unit is easily distinguished from the overlying Clarita by its thicker, more irregular beds; much higher glauconite content; gray color. It is also sharply marked off from the underlying Keel oolite.
Fossils: C is highly fossiliferous but its dense texture makes it difficult to impossible to collect satisfactory specimens.

KEEL MEMBER (total thickness 4 feet)

B. *Lithology*: Light-gray (N6 to N7) oolitic limestone. Peels show that the oolites are mostly spherical, ranging up to 1.5 mm in diameter. They are packed closely together, the matrix filling the interstices being largely a translucent calcite. Many of the oolites have a core, some of clear transparent material, and some a fossil fragment (commonly a pelmatozoan plate). The shape of the oolites is variable, the larger ones being circular in cross section, but the smaller ones are generally irregular. This irregular shape is generally controlled by the shape of the core and some appear to be nothing more than some fragment, fossil or otherwise, with a thin coating of the granular "oolite" material; with increased size the shape tends to become more spherical. Some fossil debris present. *HCl* insoluble content low, less than 1%: the washed residues mostly irregular knots of incipient silicification. $MgCO_3$ content low, about 1%. .... 4 feet
Remarks: Unit B is easily distinguised by its oolitic character.
Fossils: There are fossils present in B, but it is practically impossible to collect satisfactory specimens due to the dense texture.

IDEAL QUARRY MEMBER (total thickness 5 feet)

A. *Lithology*: Brown-weathering bioclastic calcarenite grading upwards into an oolitic limestone. Thin sections show much fossil debris, mostly pelmatozoan plates, set in a matrix which is partly clear calcite, partly brownish, finely divided carbonate. Color on a weathered surface is an olive gray (5Y 6/1) mottled with light-brown (5Y 6/4), which on a fresh surface becomes a light-brown (5YR 4/4 to 5YR 5/6). One insoluble residue, 1.3%; residue mostly a rusty brown, spongy material, possibly limonite, with some silicified fossil debris. Dolomite content low, less than 1%. .... 5 feet
Remarks: Most of unit A is lithologically distinct from the overlying B, but in its upper part it grades into that member so the contact between the two is obscure. Covered below.
The type section of Maxwell's Hawkins member is in the NE¼ sec. 8, T. 2 N., R. 6 E., which is about ¼ mile south of P1-A.
Fossils: A small fauna was collected from A, some specimens being broken out of the rock and some being obtained by etching (the silicification is not very complete). This fauna has not been studied in detail, but provisional identifications indicate *Clorinda* cf. *C. thebesensis*, *Dictyonella* sp., *Modiolopsis?* sp., plus a few snails.

Covered (probably SYLVAN SHALE)

STRATIGRAPHIC SECTION P2

South of Fittstown

Described by T. W. Amsden, Dec. 16, 1955; collection made from this section by T. W. Amsden and W. E. Ham, Oct. 14, 1955. This section covers the strata exposed in a small quarry located about 200 feet east of Oklahoma Highway 99, about 3 miles south of Fittstown, Pontotoc County, Oklahoma: NE¼ NW¼ sec. 12, T. 1 N., R. 6 E., approximately 1,000 feet south of the junction of Oklahoma Highways 99 and 61. (Amsden 1958A, p. 34; 1958B, p. 38).

This is an important location because a large fauna has been obtained by etching from the basal few feet of the Cravatt member (P2-B).

HUNTON GROUP

BOIS D'ARC FORMATION —Cravatt member: yellowish-gray, fossiliferous marlstone with some beds of calcarenite; nodules of brown-weathering porous chert; silicified fossil present.

P2-B ....

HARAGAN FORMATION: yellowish-gray, fossiliferous marlstone.

P2-A ....

Covered.

STRATIGRAPHIC SECTION P3

Cedar Hill

Described by T. W. Amsden, April 11-14, 1956. On the Lawrence uplift, about 3 miles southeast of Lawrence Quarry. It begins in the NE¼ NW¼ sec. 9, T. 2 N., R. 6 E., on a small NE flowing tributary of Chimneyhill Creek; it extends NE along this stream to the road (boundary of secs. 9 and 4), and then north up the scarp face to the top of Cedar Hill (SE¼ of sec. 4), a hill capped by basal Bois d'Arc strata (unit Y which is the same as the basal part of unit AA); at this point the section was offset along the Bois d'Arc-Haragan contact to stream level, the section then extending N along Chimneyhill Creek to the Woodford contact (NE¼ sec. 4, T. 2 N., R. 6 E.). For further details on the location of this section see the geologic map, panel II, plate A. Henryhouse-Haragan contact shown in figure 56.

The entire stratigraphic section from the Cochrane member to the Woodford was collected and described in detail, but only the part covering the Bois d'Arc formation is here repeated in detail; only a summary of the Henryhouse stratigraphy is included because the lithologic and faunal characters of these strata are almost identical to those at P1, located about a half mile west of P3 (see description under P1); the total thickness of the Henryhouse formation is similar on the two sections, 233 feet being measured at P3 and 247 at P1.

I have calculated the HC*l* residues for a number of Bois d'Arc rock specimens (fig. 40), but no rock samples have been tested for $CaCO_3$ and $MgCO_3$. However, a channel sample from the Henryhouse was collected along Chimneyhill Creek by W. E. Ham, and a rather complete chemical analysis made by A. L. Burwell. This channel sample covered 40 feet of Henryhouse strata taken from approximately the position of P3, and probably covered about the same strata as those herein described as P3-Q to P3-U. This sample yielded 21.3% HC*l* insolubles, 66.7% $CaCO_3$ and 9.5% $MgCO_3$; for a complete analysis see Oklahoma Geological Survey, Mineral Report 28, 1955.

A summary of section P3 is given in Amsden 1958A (p. 35-36); see also Amsden 1958B, fig. 2, p. 38-39.

WOODFORD FORMATION (contact with Hunton exposed)

HUNTON GROUP (total thickness 390 feet using the the Chimneyhill thickness of 63 feet obtained at P1)

BOIS D'ARC FORMATION (total thickness 90 feet)

FITTSTOWN MEMBER (total thickness 58 feet)

JJ. *Lithology*: Yellowish-gray (5Y 8/1) to ....5 feet grayish-orange (10R 7/4) fossiliferous calcarenite. HC*l* insoluble residue 3%. Rock dominantly a bioclastic calcarenite, the average grain-size ranging from 0.5 to 1 mm, with much larger fossil fragments. Considerable limonite (after pyrite) scattered through the rock.

Remarks: This unit is exposed in a small stream entering Chimneyhill from the west. The contact with the Woodford is well exposed; the basal Woodford consists of a couple of inches of conglomerate with subangular to subrounded pebbles up to an inch; the uppermost Bois d'Arc is slightly darker than below and with more pyrite.

Fossils: This interval carries a fairly typical Haragan brachiopod fauna. The following species collected in situ: *Orthostrophia strophomenoides parva, Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptostrophia beckii tennesseensis, L.* sp. 2, *Leptaena* cf. *L. rhomboidalis, Schellwienella marcidula, Sphaerirhynchia lindenensis, Camarotoechia* sp., *Howellella cycloptera, Meristella atoka.*

II. *Lithology*: Gray calcarenite like beds below............2 feet

HH. *Lithology*: Yellowish-gray (5Y 8/1), fossiliferous calcarenite. Beds range from 2 to 6 inches in thickness. Average grain-size about 1 mm, with larger fossil fragments............11 feet

Remarks: This unit exposed along the west bank of Chimneyhill Creek. There is no lithologic break above or below, the separation being entirely for collecting purposes.

Fossils: The following brachiopods collected in situ: *Rhipidomelloides oblata, Platyorthis angusta, Sphaerirhynchia lindenensis, Obturamentella wadei, Howellella cycloptera, Meristella atoka, Trematospira* sp.

GG. *Lithology*: Fossiliferous calcarenite............13 feet
HC*l* insoluble residue 5%.

Remarks: This unit is similar to the rocks above from which it was separated for collecting purposes.

Fossils: The following brachiopods collected in situ: *Platyorthis angusta, Strophonella (S.) bransoni, Leptostrophia beckii tennesseensis, Leptostrophia* sp. 2, *Leptaena* cf. *L. rhomboidalis, Schellwienella marcidula, Obturamentella wadei, Camarotoechia* sp., *Costellirostra singularis, Meristella atoka, Meristella* sp. 2, *Atrypa oklahomensis, Howellella cycloptera.*

FF. *Lithology*: Fossiliferous, argillaceous calcilutite. HC*l* insolubles estimated to be about 20%. Fresh color is a yellowish-gray (5Y 8/1) to grayish-yellow (5Y 8/4)............4 feet

Remarks: This unit is exposed on the north bank of a small tributary entering Chimneyhill Creek from the west. It is fairly typical marlstone lithology and is well marked from the beds above and below by its more argillaceous character.

EE. *Lithology*: Fossiliferous, gray calcarenite which is similar to unit GG. There are a few argillaceous calcilutite partings, but most of this rock is a low-insoluble calcarenite............5 feet

Remarks: This is exposed in the small tributary mentioned above.

Fossils: The following brachiopods, all typical Helderbergian species, collected in situ: *Rhipidomelloides oblata, Platyorthis angusta, Strophonella (S.) bransoni, Stropheodonta (B.) gibbera?, Lissostrophia (L.) lindenensis, Leptostrophia beckii tennesseensis, Leptostrophia* sp. 2, *Leptaena* cf. *L. rhomboidalis, Schellwienella marcidula, Sphaerirhynchia lindenensis, Obturamentella wadei, Costellirostra singularis, Howellella cycloptera, Meristella atoka, Meristella* sp. 2

DD. *Lithology*: Covered............3 feet

CC. *Lithology*: Yellowish-gray (5Y 8/1), fossiliferous calcarenite with a few beds of argillaceous calcilutite; beds from 2 to 8 inches. Grain size generally less than 1 mm with much larger fossil fragments. Color, fresh surface, yellow gray (5Y 8/1)............15 feet

Remarks: This unit is exposed along the east bank of Chimneyhill Creek: the lower part is well exposed but the upper part has some cover. It differs from the underlying beds in its reduced insoluble content; it is also somewhat thicker-bedded and coarser-grained (pl. VII, fig. 2).

Fossils: Typical Helderbergian fauna collected in situ: *Rhipidomelloides oblata*, *Gypidula* sp., *Leptostrophia beckii tennesseensis*, *Schellwienella marcidula*, *Sphaerirhynchia lindenensis*, *Obturamentella wadei*, *Kozlowskiellina* (*M.*) *velata*, *Howellella cycloptera*.

CRAVATT MEMBER (total 32 feet)

BB. *Lithology*: Fossiliferous, argillaceous calcilutite with some beds of calcarenite, the latter with a reduced insoluble residue. One specimen yielded 28% HCl insoluble residues. Richly fossiliferous; one peel shows well over 70% fossil debris. ....20 feet

Remarks: This unit is exposed in a cliff face on the east bank of Chimneyhill Creek. It differs from the overlying beds in being predominantly an argillaceous calcilutite or marlstone whereas the beds above are largely calcarenites with a reduced insoluble content. It is very much like AA below, differing only in the absence of chert. From BB to the Woodford contact there is little or no chert present.

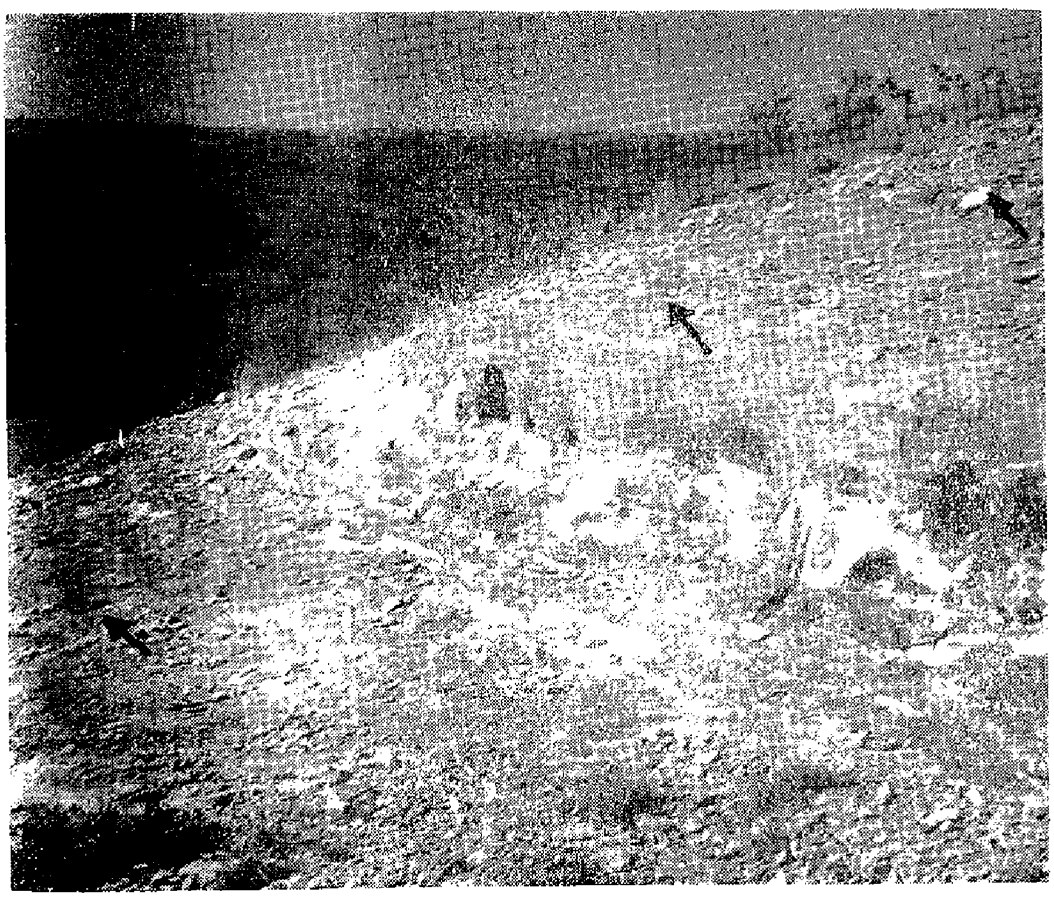

Figure 56. Henryhouse-Haragan contact on section P3, near the top of Cedar Hill. The contact (P3-W with P3-X) lies near the base of the small, pitted scarp face. The lower arrow points to a compass resting on the bed from which Henryhouse fossils (P3-W) were collected; the middle arrow points to a 6 foot tape case resting on the bed from which Haragan fossils (P3-X) were collected. The upper arrow points to a pencil resting on the basal cherty beds of the Bois d'Arc formation (P3-AA; illustrated on plate VI, figure 2).

Fossils: *Scyphocrinites* bulbs (*Camarocrinus*) common. Also a number of brachiopods, all similar to those from the Haragan. *Rhipidomelloides oblata*, *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *S. glomerosa*, *Atrypa oklahomensis*, *Kozlowskiellina* (*M.*) *velata*, *Meristella atoka*.

AA. *Lithology*: Yellowish-gray (5Y 8/1) to grayish-yellow (5Y 8/4) argillaceous calcilutite or marlstone with many nodules of brown-weathering, porous chert; chert in the form of irregular nodules, elongate in the bedding plane (pl. VI, fig. 2). ....12 **feet**

Remarks: This unit is distinguished from the underlying Haragan strata solely on the basis of chert. Unit AA is completely exposed in contact with the Haragan strata on the west bank of Chimneyhill Creek. The lower 5 or 6 feet of AA (equals Y) is also exposed at the top of Cedar Hill, including the contact with the Haragan. Section P3 was measured up the scarp face (i.e. the south face) of Cedar Hill, and was then offset along the Haragan-Bois d'Arc contact to the west bank of Chimneyhill Creek, continuing north along the Creek bed.

Note: The uppermost Henryhouse strata, all of the Haragan, and the lower part of the Bois d'Arc beds are completely exposed, both at the top of Cedar Hill and along Chimneyhill Creek (Amsden 1957, p. 30). The Haragan-Bois d'Arc contact (i.e. contact of units X and AA) is drawn at the lowest chert bed (pl VI, fig. 2); however, the Henryhouse-Haragan contact cannot be determined on the basis of lithology, but faunally this contact is well marked and can be located within a foot or so; see figure 56.

Fossils: The following brachiopods collected in situ: *Levenea subcarinata pumilis*, *Rhipidomelloides oblata*, *Dicoelosia varica*, *Platyorthis angusta*, *Strophonella* (*S.*) *bransoni*, *Leptaena* cf. *rhomboidalis*, *Eatonia exserta*, *Meristella atoka*.

HARAGAN FORMATION (total 4 feet)

X. *Lithology*: Yellowish-gray, fossiliferous, argillaceous calcilutite or marlstone. No chert present. ....4 **feet**

Remarks: This unit separated from the beds above because it has no chert. Lithologically it is like the underlying Henryhouse beds from which it is separated on the basis of its fossils. See *Remarks* under AA; figure 56.

Fossils: A small Haragan fauna collected in situ: *Levenea subcarinata pumilis*, *Schuchertella haraganensis*, *Leptaena acuticuspidata?*, *Meristella atoka*.

HENRYHOUSE FORMATION (total thickness 233 feet)

W. *Lithology*: Yellowish-gray, fossiliferous argillaceous calcilutite. ....3 **feet**

Remarks: Lithologically like the overlying strata but carries a Henryhouse fauna; similar to beds below from which it was separated for collecting purposes. Measured at top of Cedar Hill. See *Remarks* under AA: figure 56.

Fossils: A small fauna collected in situ; all appear to be typical Henryhouse species. *Isorthis arcuaria* (a dozen specimens, several being complete well-preserved shells; these are typical representatives of this species in all respects, including size). *Leptaena* sp., *Chilidiopsis* sp., *Rhipidomelloides* sp., *Coelospira saffordi*.

V. *Lithology*: Yellowish-gray (5Y 8/1) argillaceous calcilutite. ....10 **feet**

Remarks: This is typical marlstone lithology, being similar to the beds above and below; separated for collecting only.

Fossils: Small Henryhouse fauna collected in situ. *Atrypa* sp., *Dictyonella gibbosa*, *Isorthis arcuaria*, *Lissatrypoidea concentrica*, *Leptaena* sp., *Resserella brownsportensis*, *Strixella acutisulcata*. Also a few snails and some small, horn corals.

The remainder of the Henryhouse formation, included under units P3-U to P3-D, is composed of yellowish-gray marlstone like the beds above. For purposes of description and collecting a number of separate units were recognized, but as these are all essentially the same no additional lithologic description is given (a detailed description of the Henryhouse is given under P1, located about a mile west of P3). A large fauna, predominantly brachiopods, was collected from this part of the Henryhouse. The following brachiopods were found in units P3-U to P3-D: *Anastrophia delicata, Atrypa tennesseensis, "Camarotoechia" oklahomensis, Delthyris kozlowskii, Dictyonella gibbosa, Dicoelosia oklahomensis, Fardenia reedsi, Isorthis arcuaria, Homoeospira subgibbosa, Leptaena oklahomensis, Lissostrophia* (*L.*) *cooperi, Lissatrypoidea henryhousensis, L. concentrica, Meristina? roemeri, Merista oklahomensis, Resserella brownsportensis, Rhipidomelloides subtriangularis, R. henryhousensis, Sieberella roemeri, Strixella acutisulcata, Strophonella laxiplicata, S. prolongata, Stegerhynchus altisulcata.* Also some corals, Bryozoa and trilobites.

	feet above base of formation
P3-U	214-220
P3-T	204-214
P3-S	187-204
P3-R	181-187
P3-Q	168-181
P3-P	155-168
P3-O	119-155
P3-N	113-119
P3-M	103-113
P3-L	83-103
P3-K	81-83
P3-J	52-81
P3-I	49-52
P3-H	45-49
P3-G (see plate IV, fig. 2)	24-45
P3-F	19-24
P3-E	12-19
P3-D	0-12

CHIMNEYHILL FORMATION

CLARITA MEMBER (total 47 feet)

C. *Lithology*: Pinkish-gray (5Y 8/1) to pale orange (10YR 8/2) calcilutite and calcarenite with scattered pink pelmatozoan plates. Evenly bedded, beds, from 2 inches to 8 inches (pl.III, figs. 1, 2). The lower 15 feet is all calcilutite, the upper 30 feet a mixture of calcilutite and calcarenite. ....45 feet
Fossils: This rock is highly fossiliferous but it is difficult to break out specimens. A few specimens of *Eospirifer* and one questionable *Onychotreta* sp. collected; also a few snails and trilobites.

B. *Lithology*: Covered. ....2 feet
Remarks: This probably represents the shaly zone at the base of the Clarita.

COCHRANE MEMBER

A. *Lithology*: Pale-orange (10YR 8/2) to yellowish-gray (5Y 8/1) fossiliferous calcarenite. Grain-size averages 0.5 to 1 mm. with much larger fossil fragments. Dark-green glauconite dispersed through the rock, mostly in rounded nodules up to 0.5 mm. Pink pelmatozoans common in parts of the rock. Bedding variable, up to 6 inches or so in thickness.
Remarks: The base of the Cochrane is not exposed in the vicinity of section P3. At P1 this member is 18 feet thick.

Covered.

STRATIGRAPHIC SECTION P4*

Small quarry southeast of Cedar Hill

Section described by T. W. Amsden, April 19, 1956. Located in a small quarry on the southeast side of the road, SW¼ SW¼ sec. 3, T. 2 N., R. 6 E., Pontotoc County, Okla.; panel II, plate A (Amsden 1958A, p. 39; 1958B, p. 33).

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray, argillaceous, fossiliferous calcilutite with nodules of brown-weathering, tripolitic chert. This rock is highly fossiliferous and some snails, trilobites and the following brachiopods were collected: *Orthostrophia strophomenoides parva, Meristella* sp. 2, *Rhipidomelloides oblata, Leptostrophia beckii tennesseensis, Strophonella (S.) bransoni*
P4-C ....

HARAGAN AND **HENRYHOUSE FORMATION**: covered.
P4-B .... 14 feet

HENRYHOUSE FORMATION: Yellowish-gray to pale, greenish-gray, fossiliferous marlstone. Two snails, a specimen of *Calymene* sp. and the following brachiopods collected: *Dictyonella gibbosa, Homoeospira subgibbosa, Isorthis arcuaria, Lissatrypoidea concentrica, L. henryhousensis, Leptaena oklahomensis, Merista oklahomensis, Meristina roemeri, Resserella brownsportensis, Strixella acutisculata, R. subtriangularis.* Also a few small horn corals.
P4-A .... 0 to 15 feet above base of section

COLLECTION P5

Southeast of Lawrence

Henryhouse collection made by T. W. Amsden from a glade about 1½ miles southeast of Lawrence: NW¼ NW¼ sec. 5, T. 2 N., R. 6 E., Pontotoc County, Okla. (panel II; plate A). This glade partially exposes about 30 feet of Henryhouse strata consisting of yellowish-gray marlstone in beds to 2 to 3 inches. The base of this exposure lies 40 feet (stratigraphically) above the Henryhouse-Chimneyhill contact. A typical Henryhouse fauna collected here, including 2 snails, 2 trilobites, several small horn corals, a number of Bryozoa, and the following brachiopods: *Strophonella laxiplicata, Atrypa tennesseensis, Dicoelosia oklahomensis, Howellella henryhousensis, Leptaena oklahomensis, Lissostrophia (L.) cooperi, Resserella brownsportensis, Pseudodicoelosia oklahomensis.*

COLLECTION P6

Southwest of Cedar Hill

This is a Henryhouse glade located just south of the road: SE¼ SW¼ sec. 4, T. 2 N., R. 6 E., Pontotoc County, Oklahoma (panel II, pl. A). The glade partially exposed 10 to 12 feet of highly fossiliferous, yellowish-gray marlstone. The base of the glade lies 15 feet (stratigraphically) above the Henryhouse-Chimneyhill contact (Amsden 1958A, p. 36).

A large Henryhouse fauna was collected by T. W. Amsden, C. C. Branson and W. E. Ham; these fossils were collected loose on the surface, but the relation of topography to geology are such that it is certain these specimens are, for all practical purposes, in situ. This collection is important because it is one of the few places where the lower part of the Henryhouse yields numerous fossils; it clearly shows that many of the characteristic Henryhouse brachiopod species range throughout the formation (compare to the fauna collected from the uppermost Henryhouse strata, sections P1 and P3).

The collection includes many Bryozoa, a few horn corals, 2 species of *Pisocrinus*, 2 or 3 snails, and specimens of "*Dalmanites*" and *Encrinurus*. The brachiopods are represented by the following species: *Strophonella* *laxiplicata, S. prolongata, Anastrophia delicata, Atrypa tennesseensis, Stropheodonta (Brachyprion) attenuata, Stegerhynchus carnelensis, Delthyris kozlowskii, Dicoelosia oklahomensis, Dictyonella gibbosa, Fardenia reedsi, Homoeospira foerstei, Isorthis arenaria, Leptaena oklahomensis, Lissostrophia (L.) cooperi, Merista oklahomensis, Resserella brownsportensis, Ptychopleurella rugiplicata, Sieberella roemeri.*

COLLECTION P7

Northwest of Cedar Hill

Small road side outcrop of Henryhouse: NE¼ SE¼ sec. 32, T. 3 N., R. 6 E., Pontotoc County, Oklahoma (panel II, pl. A). This exposes 6 to 8 feet of yellowish-gray, fossiliferous marlstone (pl. V, fig. 2), the uppermost bed being 10 feet (stratigraphically) below the base of the Bois d'Arc (Amsden 1958A, p. 36). A small collection of Henryhouse fossils made by T. W. Amsden. This collection consists of several Bryozoa, 2 snails, and the following brachiopods: *Dictyonella gibbosa, Schuchertella attenuata, Homocospira subgibbosa, Isorthis arenaria, Leptaena oklahomensis, Lissatrypoidea henryhousensis, Merista oklahomensis, Resserella brownsportensis, Strixella acutisulcata, Rhipidomelloides subtriangularis.*

STRATIGRAPHIC SECTION P8

North side of Bois d'Arc Creek

Section described by T. W. Amsden, April 24, 25, 1956. It is located on the north side of Bois d'Arc Creek, starting in the bed of the creek (Henryhouse formation), about 100 feet east of a bend in the stream, and extending north to the top of the ridge (Frisco formation): SW¼ NW¼ sec. 11, T. 2 N., R. 6 E. (see geologic map, panel II, pl. A).

This section is significant because it is one of the few places where there is physical evidence for an unconformity between the Henryhouse and overlying Devonian strata. These stratigraphic relations are discussed and illustrated in my 1957 paper (pp. 30-31, text fig. 6, pl. II, figs. A, B; see also Amsden 1958B, p. 40).

The Frisco formation is well exposed on this section, but it disappears a short distance to the west, being cut out under the Woodford unconformity (see pl. A, panel II). The Frisco-Bois d'Arc-Haragan, and Haragan-Henryhouse contact in this area are illustrated in Amsden 1957, plates A, B, C.

Analyses of the rocks from this section are given in the section on CHEMICAL ANALYSES.

FRISCO FORMATION (upper contact covered)

H. *Lithology*: Light-gray (N8) to pale orange ....
(10YR 8/2) medium-to coarse-grained calcarenite. Bedding slightly irregular, up to 2 feet in thickness; bedding surfaces weather with a pitted or "pot-holed" texture. No chert observed.

Three specimens tested for HCl insoluble residues, all less than 1%; washed residues mostly subangular, clear, silt-sized quartz fragments. Peels show this rock to be a calcarenite composed of about 50% or slightly more fossil material; fossils mostly fragmentary, scattered through a matrix of clear calcite; the fragmentary character of much of the fossil debris is in part due to breakage, but at least some is probably due to recrystallization; average grain size between 0.5 and 1 mm with much larger fossil pieces. $MgCO_3$ content less than 1%.

Remarks: The Frisco formation caps the ridge on the north side of Bois d'Arc Creek. The lower part is well exposed (top covered) and the contact with the underlying Bois d'Arc can be followed for several hundred feet. This contact is distinct, the Frisco being thicker-bedded and almost free of argillaceous material.

Fossils: The lower part of H is richly fossiliferous and a large collection made here. It carries the distinctive "*Dendropora*" sp., and many large snails: brachiopods predominate with such species as *Leptostrophia magnifica*, *Rhipidomelloides musculosa*, *Costellirostra peculiaris*, *Rensselaeria* sp. and many others (see SECTION P11 for a complete list). This is a Deerparkian fauna and quite distinct from that of the underlying Bois d'Arc (Helderbergian).

BOIS D'ARC FORMATION (total 68 feet)

FITTSTOWN MEMBER (total 41 feet)

G. *Lithology*: Light-gray (N8) to pale-orange.......14 feet
(10YR 8/2) fossiliferous calcarenite. Bedding irregular, up to 8 inches in thickness. Two insoluble residues prepared, 2% and 2.6%; washed residues mostly silt-size, clear, subangular quartz. One peel shows this rock to be well over 80% fossil debris, much of this being pelmatozoan plates; fossil material set in a matrix of clear calcite. $MgCO_3$ content low, less than 1%.
Remarks: the upper contact of G with the Frisco is well defined (see above), but the lower contact is arbitrary, for collecting purposes only. No conodonts or Foraminifera seen in the acetic acid residues.
Fossils: This unit carries a Helderbergian fauna. The following brachiopods collected in situ: *Leptostrophia beckii tennesseensis*, *L.* sp. 2, *Leptaena* cf. *L. rhomboidalis*, *Sphaerirhynchia lindenensis*, *Obturamentella wadei*, *Howellella cycloptera*, *Meristella atoka*.

F. *Lithology*: Partly covered. Scattered outcrops of.......21 feet
fosiliferous calcarenite like above.
Remarks: The upper contact with G is arbitrary; lower contact is gradational and poorly marked, F being separated from E because of its slightly reduced clay content.
Fossils: The following brachiopods collected in situ: *Rhipidomelloides oblata*, *Platyorthis angusta*, *Leptostrophia beckii tennesseensis*, *L.* sp. 2, *Schellwienella marcidula*, *Sphaerirhynchia lindenensis*, *Coelospira virginia*, *Kozlowskiellina* (*M.*) *velata*, *Howellella cycloptera*, *Meristella atoka*, *Meristella* sp. 2.

E. *Lithology*: Interbedded argillaceous calcilutite.......6 feet
(5Y 8/1) and calcarenite, the latter with a much reduced clay content. No chert observed.
Remarks: This unit is transitional between the underlying marlstones and the overlying calcarenites. It is arbitrarily assigned to the Fittstown member. ....
Fossils: None collected.

CRAVATT MEMBER (total 27 feet)

D. *Lithology*: Yellowish-gray argillaceous calcilutite.......4 feet
or marlstone. No chert.
Remarks: This is like C but lacks chert; gradational above.
Fossils: The following brachiopods collected in situ: *Rhipidomelloides oblata*, *Strophonella* (*S.*) *bransoni*, *Leptaena* cf. *L. rhomboidalis*, *Meristella atoka*.

C. *Lithology*: Yellowish-gray (5Y 8/4) to.......13 feet
grayish-yellow (5Y 8/1) marlstone with irregular nodules of brown-weathering, porous chert.
Remarks: C is separated from the beds above and below on the presence of chert. C has the lowest chert in the marlstone sequence and is therefore arbitrarily assigned to the Bois d'Arc. It is faunally and lithologically like the underlying strata except for the presence of the porous chert; an illustration of this contact is given on plate II of Amsden 1957.
Fossils: The following brachiopods collected in situ: *Orthostrophia strophomenoides parva*, *Levenea subcarinata pumilis*, *Rhipidomelloides oblata*, *Dicoelosia varica*, *Leptaena acuticuspidata*, *Coelospira virginia*, *Kozlowskiellina* (*M.*) *velata*.

HARAGAN FORMATION (total 5 feet)

B. *Lithology*: Fossiliferous, yellowish-gray marlstone. ....5 feet

Remarks: This unit is lithologically and faunally like C above except for the absence of chert. Lithologically it is like the underlying Henryhouse from which it is separated solely on a faunal basis, B carrying a Helderbergian fauna and A a Brownsportian fauna. See Amsden 1957, pp. 30-31, text fig. 6, plate II for illustrations and discussion of the contact.

Fossils: The following brachiopods collected in situ: *Dicoelosia varica, Levenea subcarinata pumilis, Kozlowskiellina (M.) velata, Leptaena* sp.

HENRYHOUSE FORMATION

A. *Lithology*: Fossiliferous, yellowish-gray marlstone. ....

Remarks: For a discussion of the Henryhouse-Haragan contact see above and also Amsden 1957, p. 30-31, text fig. 6, pl. III. The Henryhouse strata are well exposed in the stream bed going west from the line of section P8. There is a strong component of dip to the east so these beds pass beneath the stream bed a short distance east of this section. See map, panel II, plate A.

Fossils: The following fossils collected in situ: *Calymene* sp. *Dictyonella gibbosa. Resserella brownsportensis, Isorthis arcuaria, Pseudodicoelosia oklahomensis.*

STRATIGRAPHIC SECTION P9

Coal Creek

Section described by T. W. Amsden, May 16, 17, 18, 1916. North side of Coal Creek, NW¼ NW¼ sec. 22, T. 1 N., R. 7 E., Pontotoc County, Oklahoma. This begins at the base of the Chimneyhill (Ideal Quarry member), which is exposed near stream level, and extends in northwest direction up the scarp to the top of the hill (Frisco formation). The strike of the beds ranges from 120 to 125 degrees (magnetic) dipping 18 to 25 degrees to the NE. A summary given in Amsden 1958A, p. 37, and Amsden 1958B, p. 41.

FRISCO FORMATION (upper contact covered)

R. *Lithology*: Fossiliferous calcarenite with nodules of vitreous chert. Beds to 2 feet. Chert distribution variable: it is a fossiliferous chert ranging in color from a light-gray (N8) to a bluish-white (5B 9/1). Calcarenite texture varies, ranging from fine (locally a calcilutite) to very coarse (locally a calcilutite). HCl residues low; washed residue mostly clear, silt-size quartz, with some glauconite. ....

Remarks: This formation is easily distinguished from the Bois d'Arc by its thicker bedding (pl. VIII, fig. 2) and reduced clay content. Faunally it is distinct, carrying a Deerparkian fauna.

Fossils: This unit is richly fossiliferous and a number of fossils were broken out. These include "*Dendropora*" sp., many large snails and brachiopods such as *Leptostrophia magnifica*. See Ventress 1958, section 4, p. 33-37.

BOIS D'ARC FORMATION (total 137 feet)

FITTSTOWN ? MEMBER (total 54 feet)

Q. *Lithology*: Partly covered. Scattered outcrops of fossiliferous argillaceous calcilutite and calcarenite. No chert observed. Color ranges from a yellowish-gray (5Y 8/1) to grayish-orange (10YR 7/4). ....42 feet

Remarks: This unit is lithologically intermediate between typical Cravatt marlstone and typical Fittstown calcarenite. P9 contains no solid beds of calcarenite, all this rock type being interbedded with marlstone; therefore the reference of units P and Q to the Fittstown rather than the Cravatt is arbitrary; Q is separated from P because the latter has chert whereas none was seen in Q.

Fossils: Small fauna of brachiopods collected: *Levenea subcarinata pumilis, Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptaena* cf. *L. rhomboidalis, Sphaerirhynchia lindenensis, Obturamentalla wadei, Camarotoechia?* sp., *Kozlowskiellina (Megakozlowskiella velata, Meristella atoka, Cyrtina dalmani nana.*

P. *Lithology*: Yellowish-gray, argillaceous calcilutite with beds of calcarenite. Nodules and lenses of chert: some porous, brown-weathering chert present, but mostly a light-colored, vitreous type. ..... 12 feet

Remarks: See remarks above for a discussion of the stratigraphic position of P and Q. P grades into the underlying O from which it differs in having scattered beds of calcarenite.

Fossils: Small fauna of brachiopods collected: *Levenea subcarinata pumilis, Rhipidomelliodes oblata, Leptaenisca concava, Leptaena* cf. *L. rhomboidalis, Schellwienella marcidula, Sphaerirhynchia lindenensis, Eatonia medialis, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Howellella cycloptera, Cyrtina dalmani nana.*

CRAVATT MEMBER

O. *Lithology*: Yellowish-gray, argillaceous calcilutite with many nodules of brown-weathering, porous chert, rare beds of calcarenite. ..... 27 feet

Remarks: Like unit below except for the presence of chert; see discussion above.

Fossils: Small fauna of brachiopods collected: *Levenea subcarinata pumilis, Rhipidomelloides oblata, Anastrophia grossa, Gypidula* sp., *Leptaenisca concava, Leptaena* cf. *L. rhomboidalis, Sphaerirhynchia lindenensis, Atrypa oklahomensis.*

N. *Lithology*: Partly covered. Outcrops of yellowish-gray marlstone with a few nodules of brown-weathering, porous chert. ..... 22 feet

Remarks: No well defined lithologic break between unit N and the beds above and below.

Fossils: The following brachiopods collected: *Levenea subcarinata pumilis, Rhipidomelloides oblata, Anastrophia grossa, Strophonella (S.) bransoni, Stropheodonta (B.) gibbera, S. (B.) arata, Leptaena acuticuspidata, Schellwienella, marcidula, Sphaerirhynchia lindenensis, Atrypina hami, Atrypa oklahomensis, Meristella atoka, Cyrtina dalmani nana, Rhynchospirina maxwelli, Rensselaerina haraganana.*

M. *Lithology*: Covered ..... 20 feet

Remarks: This unit located on the top of a small topographic bench; dirt road located here.

L. *Lithology*: Fossiliferous, yellowish-gray marlstone with many nodules of brown-weathering porous chert. ..... 14 feet

Remarks: This is the lowest zone with any appreciable quantities of chert on section P9 and accordingly the base of the Bois d'Arc is placed at the base of L. A few nodules found in unit I but it is extremely rare.

Fossils: The following fossils collected loose on the surface of units L and M: *Orthostrophia strophomenoides parva, Leptostrophia beckii tennesseensis, Schuchertella haraganensis, Levenea subcarinata pumilis, Rhipidomelloides oblata, Dicoelosia varica, Anastrophia grossa, Stropheodonta (B.) arata, Leptaenisca concava, Leptaena acuticuspidata, Sphaerirhynchia lindenensis, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Meristella atoka, Cyrtina dalmani nana, Rhynchospirina maxwelli, Rensselaerina haraganana.*

HARAGAN FORMATION (total 92 feet)

K. *Lithology*: Yellowish-gray marlstone in beds to 8 inches. No chert observed. ..... 26 feet

Remarks: The Haragan-Bois d'Arc contact is placed between K and L, its position being determined by the lowest appearances of abundant chert; however, there is a trace of chert in unit I, but the amount is so small that it can only be found with difficulty.
Fossils: A *Scyphocrinites* calyx, several snails and Bryozoa plus the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Rhipidomelloides oblata, Strophedonta (B.) gibbera, Leptaenisca concava, Leptaena acuticuspidata, Schuchertella haraganensis, Sphaerirhynchia glomerosa, S. lindenensis, Coelospira virginia, Atrypa oklahomensis, Kozlowskiellina (M.) velata.*

J. *Lithology*: Yellowish-gray, fossiliferous marlstone; partly covered. No chert observed. ......27 feet
Fossils: *Scyphocrinites (Camarocrinus)* bulbs; *Favosites* sp., *Pleurodictyum* sp., and horn corals; several gastropods and the following brachiopods: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Leptaenisca concava, Leptaena acuticuspidata, Sphaerirhynchia glomerosa, S. lindenensis, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Meristella atoka.*

I. *Lithology*: Yellowish-gray fossiliferous marlstone with rare chert nodules. ......12 feet
Fossils: Many *Scyphocrinites (Camarocrinus)* bulbs; few corals and snails plus *Orthostrophia strophomenoides parva, Rhipidomelloides oblata, Meristella atoka.*

H. *Lithology*: Covered ......16 feet

G. *Lithology*: Yellowish-gray marlstone ......2 feet
Fossils: *Kozlowskiella (M.) velata* and *Orthostrophia strophomenoides parva* and *Levenea subcarinata pumilis* collected in situ.

F. *Lithology*: Partly covered. Scattered crops of yellowish-gray marlstone. ......7 feet
Remarks: This is the lowest exposure of marlstone; it is lithologically like the beds above, but stands in marked contrast to the relatively pure calcilutites of the Clarita. A number of fossils collected here and on the covered interval below (E); all of these are typical Haragan species, no Henryhouse fossils being found and it is therefore reasonably certain that Haragan rests directly upon the Chimneyhill formation.
Fossils: *Rhipidomelloides oblata, Leptaena acuticuspidata, Meristella atoka.*

E. *Lithology*: Covered ......2 feet
Fossils: *Dicoelosia varica, Stropheodonta (B.) gibbera, Leptaena acuticuspidata, Atrypa oklahomensis, Kozlowskiellina (M.) velata, Meristella atoka.*

CHIMNEYHILL FORMATION (total 36 feet)

CLARITA MEMBER (total 10 feet)

D. *Lithology*: Pale-orange (10YR 8/2) to yellowish-gray (5Y 8/1) calcilutite with many pink pelmatozoan plates. Richly fossiliferous, locally grading into a trilobite coquina. HCl insoluble content low; probably around 5 %. Most of this rock is a calcilutite texture, locally grading into a calcarenite. ......10 feet
Remarks: The thickness of the Clarita is variable in this area, being entirely absent a short distance south of here. The Clarita-Cochrane contact is exposed, the two being lithologically distinct with no shale on, or near, the boundary.
Fossils: Highly fossiliferous; few trilobites collected.

COCHRANE MEMBER (total 12 feet)

C. *Lithology*: Pale-orange (10YR 8/2) to greenish-yellow (10YR 8/2) fossiliferous calcarenite. Nodules and elongate lenses of vitreous chert; color mostly a tan to light-brown, locally becoming almost black. ......12 feet

KEEL MEMBER

(3 submembers with a total thickness of 14 feet)

Upper Oolite

B. *Lithology*: Oolitic limestone; most of the oolites less than 1 mm in diameter. .... 1 foot
Remarks: Sharply marked off from the beds above and below.

Middle Laminated Submember

A. *Lithology*: Yellowish-gray, thinly laminated (less than 1 in.) argillaceous calcilutite. HC1 insoluble residues 7.8%; washed residues largely subrounded, silt-size clear quartz. Peel shows this rock to be mostly finely-divided carbonate, most grains falling between 0.05 and 0.01 mm, with scattered silt-size particles; only minor fossil debris. No oolites observed. .... 5 feet
Remarks: This unit is quite unlike the typical Keel oolite, but is overlain and underlain by the characteristic oolite rock; see Amsden 1957, p. 12-14, text fig. 5 for a discussion of the Keel submembers. This unit illustrated, plate IV, fig. 1.
Fossils: A few colonial tetracorals collected.

Lower Oolite

A1. *Lithology*: Oolitic limestone, oolites ranging up to 3 mm in diameter. .... 5 feet
Remarks: The contact with the overlying laminated rock is sharply defined. Lower contact gradational.

IDEAL QUARRY MEMBER (total 3 feet)

Lithology: Brown-weathering, pelmatozoan limestone. Irregular nodules of brown-weathering chert. .... 3 feet
Remarks: The upper part of this unit is oolitic and grades into the overlying Keel member. The Ideal Quarry member is exposed only a few feet above stream level (Coal Creek) on the line of section.

SYLVAN SHALE (exposed within a foot or so of the basal Hunton strata)

STRATIGRAPHIC SECTION P10*

Southeast of Fittstown

Section described by T. W. Amsden, May 18, 19, 23, 1956. About 3 miles southeast of Fittstown, and 2 miles east of Oklahoma Highway 99, ½ mile south of Highway 61; NE¼ SE¼ sec. 7, T. 1 N., R. 7 E., Pontotoc County. The section begins in the bed of a small stream (Keel member), and extends NE up the scarp face to the top of the ridge, and down the dip slope to the Frisco limestone. See Amsden 1958A, p. 37-38; 1958B, p. 42.

HUNTON GROUP (total thickness approximately 350 feet)

FRISCO FORMATION: gray, medium-to coarse-grained, fossiliferous calcarenite with nodules of vitreous chert; beds range from 1 to 3 feet in thickness. Thickness not precisely determined as the upper part is poorly exposed, but estimated at 10 feet. Small Deerparkian fauna collected from the lower 2 to 3 feet.
P10-V ....

BOIS D'ARC FORMATION (total 108 feet)
FITTSTOWN MEMBER?: gray, fossiliferous calcarenite with much yellowish-gray, fossiliferous calcilutite. Not typical Fittstown lithology because of the high percentage of marlstone; grades into the underlying strata. Small Helderbergian fauna collected.

	feet above base of member
P10-U	6 to 54
P10-T	0 to 6

CRAVATT MEMBER: yellowish-gray, fossiliferous, argillaceous calcilutite with nodules of brown-weathering porous chert. Helderbergian fauna like that of the underlying Haragan collected.

	feet above base of member
P10-S	43 to 54
R	35 to 43
Q	12 to 35
P	8 to 12
O	0 to 8

HARAGAN FORMATION: yellowish-gray, fossiliferous marlstone; some beds with red mottling. Like beds above except for absence of chert. The following brachiopods collected from units H and L: *Orthostrophia strophomenoides parva, Levenea subcarinata pumilis, Dicoelosia varica, Rhipidomelloides oblata, Strophonella (S.) bransoni, Stropheodonta (B.) arata, Leptaenisca concava, Leptaena acuticuspidata, Schuchertella haraganensis, Sphaerirhynchia glomerosa, Coelospira virginia, Kozlowskiellina (M.) velata, Meristella atoka, Rhynchospirina maxwelli.*

	feet above base of formation
P10-N	150 to 154
M	137 to 150
L (red mottling)	117 to 137
K	109 to 117
J	99 to 109
I	45 to 99
H	0 to 45

HARAGAN and/or **HENRYHOUSE FORMATION**

P10-G (covered) .... 27 feet

HENRYHOUSE FORMATION: Yellowish-gray, fossiliferous marlstone partly covered). Small Henryhouse fauna collected, consisting of 1 small horn coral and the following brachiopods: *Atrypa tennesseensis, Coelospira saffordi?, Isorthis arcuaria, Lissatrypoidea concentrica, Resserella brownsportensis.*

P10-F .... 16 feet

CHIMNEYHILL FORMATION: (total 32 feet)

CLARITA MEMBER: light-gray to pinkish-gray, fossiliferous calcilutite with some beds of calcarenite; pink pelmatozoan fragments. Evenly bedded, beds to 8 inches.

P10-E .... 18 feet

COCHRANE MEMBER: light-gray to pale-greenish-gray, fossilifer ous calcarenite; scattered grains of glauconite up to 3 mm in diameter.

P10-D .... 4 feet

KEEL MEMBER (divided into 3 submembers, totaling 10 feet)

Upper oolite: gray, oolitic limestone, oolites to 1 mm.

P10-C .... 1 foot

Middle laminated submember: thinly laminated, brown, argillaceous calcilutite.

P-10-B .... 3 feet

Lower oolite: oolitic limestone with much pelmatozoan debris in lower part; lower part weathers brown, resembles Ideal Quarry lithology.

P-10-A .... 6 feet

Covered (probably SYLVAN SHALE).

STRATIGRAPHIC SECTION P11

Bois d'Arc Creek

That part of this section included under the Frisco formation was described and collected by William Ventress (1958; as his stratigraphic Section 1, described on p. 138) in the spring of 1958; the part included in the Bois d'Arc formation was described and collected by T. W. Amsden, June 7, 8, 1956. It is located in the bed of Bois d'Arc Creek, most of it falling within the NE¼ sec. 11, T. 2 N., R. 6 E. (see panel II, pl. A); it begins in the upper part of the Bois d'Arc formation (NW¼ NE¼ sec. 11) and covers all of the Frisco, extending along the creek to Oklahoma Highway 99 and a short distance into the NW¼ of sec. 12. Frisco-Bois d'Arc contact illustrated in Amsden, 1957, plate III-A; the Fittstown member illustrated on plate VII of this report. (see also Amsden 1958A, p. 38; 1958B, p. 43).

The dip is very gentle, but there is a slight component to the west. This is the type section of the Frisco formation (Amsden 1957, p. 47).

Analyses of the rocks from this section given in the section on CHEMICAL ANALYSES.

WOODFORD FORMATION (faulted against the Frisco)

HUNTON GROUP

FRISCO FORMATION (total 60 feet)

Lithology: Light-gray, coarse-grained calcarenite........20 feet with much crinoidal debris; bedding thick, ranging from 5 to 10 feet. HC*l* insoluble residue 1.2%.

Fossils: *Kozlowskiellina* (*Megakozlowskiella*) sp. and *Oriskania sinuata*.

Lithology: fine- to medium-grained........20 feet fossiliferous calcarenite. Much crinoidal material; beds range up to 10 feet in thickness.

Fossils: *Rhipidomelloides musculosa*, *Leptaena* cf. *L. ventricosa*, *Anoplia nucleata*, *Ambocoelia* sp., *Acrosprifer murchisoni*, *Cyrtina* cf. *C. rostrata*, *Platyceras* (*Platyostoma*) cf. *P. gebhardi*, *P.* (*P.*) cf. *P. reflexum*.

Lithology: Light-gray to yellowish-gray,........5 feet coarse-grained calcarenite. Bedding ranges from 6 inches to 2 feet.

Fossilss *Costellirostra peculiaris*, *Acrospirifer murchisoni*, *Trachypora* sp.

Lithology: Light-gray to white, fine-grained........5 feet calcarenite; bedding 10 inches to 3 feet. HC*l* insoluble residue 0.8%.

Lithology: Dark-brown, fine-grained, oil-stained........5 feet calcarenite. Bedding 1 to 2 inches. HC*l* insoluble residues 1.3%.

Fossils: Large colonies of *Favosites* cf. *F. schriveri* and *Trachypora* sp.; *Lindstroemia?* sp., *Levenea* sp., *Rhipidomelloides musculosa*, *Platyorthis* cf. *P. planoconvexa*, *Anoplia nucleata*, *Acrospirifer murchisoni*, *Meristella?* sp., *Platyceras* (*Platyostoma*) cf. *P. gebhardi*, *P.* (*P.*) *cf. P. reflexum*, *P.* (*Orthonychia*) cf. *tortuosa*

Lithology: (This equals unit P11-C of Amsden 1958A, p. 38)........5 feet Yellowish-gray to gray, medium- to coarse-grained, highly fossiliferous calcarenite. HC*l* insoluble residues, 0.8%.

Fossils: *Trachypora* sp., *Lindstroemia?* sp., *Stereolasma* sp., *Favosites* cf. *F. shriveri*, *Levenea* sp., *Platyorthis* cf. *P. planoconvexa*, *Rhipidomelloides musculosa*, *Leptaena* cf. *L. ventricosa*, *Leptostrophia magnifica*, *Costellirostra peculiaris*, *Plethorhynchia* cf. *P. speciosa*, *Uncinulus?* cf. *U. welleri*, *Ambocoelia* sp., *Acrospirifer murchisoni*, *Costispirifer arenosus*, *Meristella?* sp., *Trematospira* sp. indet., *Cyrtina* cf. *C. rostrata*, *Prionothyris perovalis*, *Rensselaerina* sp., *Etymothyris gaspensis*, *Cypricardinia* sp., *Strophostylus* cf. *S. allani*, *Platyceras* (*Orthonychia*) cf. *P. tortuosa*, *Platyceras* (*P.*) cf. *P. reflexum*, *Platyceras* (*P.*) cf. *P. gebhardi*.

BOIS D'ARC FORMATION

FITTSTOWN MEMBER

B. *Lithology*: Gray to yellowish-gray fossiliferous........3 feet calcarenite with a few beds of yellowish-gray, argillaceous calcilutite. HC*l* insoluble residues 4.2%.

Remarks: This unit is sharply marked off from the beds above by its thinner bedding and greater clay content. An illustration of this contact is given on plate III-A, of Amsden 1957. Unit B grades into the underlying unit A. No conodonts observed in the acetic acid residues.
Fossils: The following fossils collected in situ: *Rhipidomelloides oblata, Strophonella (S.) bransoni, Leptostrophia beckii tennesseensis, Leptostrophia* sp. 2, *Kozlowskiellina (M.) velata.*

A. *Lithology*: Interbedded calcarenite and ....10 feet
yellowish-gray argillaceous calcilutite. Thin-bedded, beds up to 6 inches. Some shaly partings. One specimen tested for HCl insoluble residue, 2.8%. The $MgCO_3$ content of both A and B, less than 1%. This rock is highly fossiliferous.
Remarks: Similar to unit B although may have somewhat more marlstone: separated mainly for collecting. Only the upper 10 feet, which is completely exposed, was studied and collected; for a complete description of the Bois d'Arc formation in this area see stratigraphic section P8 (illustrated pl. VII, fig. 1).
Fossils: The following fossils collected in situ: *Rhipidomelloides oblata, Platyorthis angusta, Strophonella (S.) bransoni, Lepstrophia beckii tennesseensis, L.* sp. 2, *Leptaena* cf. L. *rhomboidalis, Schellwienella marcidula, Sphaerirhynchia lindenensis, Obturamentella wadei, Kozlowskiellina (M.) velata, Howellella cycloptera, Meristella atoka.*

STRATIGRAPHIC SECTIONS P12 and P15*

North of Chimneyhill Creek

Small hill-top glades located on the east and west sides of the section line road; NW¼ sec. 33 and NE¼ sec. 32, T. 3 N., R. 6 E., Pontotoc County, Oklahoma. See stratigraphic section P12 (Henryhouse glade), Amsden 1958A, p. 39, and stratigraphic section P15 (Bois d'Arc glade), Amsden 1958B, p. 44.

The stratigraphic relations are shown on the geologic map of the Lawrence Uplift, panel II, plate A. The small outcrop of Bois d'Arc which caps a knob in the NW¼ sec. 33 (P15) is not well exposed and most collectors have not been aware of its presence, assigning all of the strata in this area to the Henryhouse formation. There are, however, cherty marlstones with Helderbergian fossils present in this small hill. West of the road is an outcrop of highly fossiliferous Henryhouse strata from which a large collection (P12) was made by T. W. Amsden, Richard Alexander and Styron Douthit, July 12, 1956.

BOIS D'ARC FORMATION

CRAVATT MEMBER: yellowish-gray marlstone with nodules of brown-weathering, porous chert. Only the basal part of the Cravatt is present, the upper part being removed by erosion. Collection P15 from these beds.
P15 ....

HARAGAN and HENRYHOUSE FORMATION

Covered .... 10 feet

HENRYHOUSE FORMATION: yellowish-gray, fossiliferous marlstone. A few feet of this formation is exposed on the west side of the road, NE¼ sec. 32. Collection P12 made here.
P12 ....

COLLECTION P13

Southeast of Fittstown

This outcrop is located in a small quarry on the north side of Oklahoma Highway 61, about 2½ miles southeast of Fittstown; SW¼ SE¼ sec. 1, T. 1 N., R. 6 E., Pontotoc County, Oklahoma. See Amsden 1958A, p. 39; 1958B, p. 43.

Covered

BOIS D'ARC FORMATION

CRAVATT MEMBER: Yellowish-gray to gray, fossiliferous, argillaceous calcilutite (marlstone) with some beds of calcarenite: nodules of chert. Collection P13 taken from about 20 feet of strata exposed in the quarry.

Covered.

COLLECTION P14

Henryhouse collection made by T. W. Amsden and W. E. Ham, Sept. 7, 1955. This was made from a small outcrop of Henryhouse strata, located on the north side of the road, about the center of sec. 29, T. 3 N., R. 6 E., Pontotoc County, Okla. (panel II, pl. A).

STRATIGRAPHIC SECTION P15 (see P12)

COLLECTION P16

Collection made by T. W. Amsden and William Ventress, May 13, 1958, from the Fittstown member of the Bois d'Arc formation. It is located in the NE¼ SW¼ sec. 35, T. 2 N., R. 6 E., Pontotoc County. This collection was broken out of a calcarenite, being taken from the upper 2 to 3 feet of exposed Fittstown (probably very near the top of this member). The collection is unusual in that it contains a number of dalmanitid trilobites of large size.

STRATIGRAPHIC SECTION P17*

Goose Creek

This section described and collected by T. W. Amsden and W. Ventress, April 8, 1958. It is located on the east side of Goose Creek, NW¼ SE¼ sec. 26, T. 1 N., R. 7 E., Pontotoc County, Okla.

This section covers the upper part of the Bois d'Arc formation and the lower part of the Frisco formation, the contact between these two being well exposed. It was made primarily to stratigraphically place the fossils collected from P17-D, a prolific collection of extremely well preserved Bois d'Arc fossils, including specimens of *Troostocrinus*. The Frisco is also fossiliferous. See Amsden 1958B, p. 44, and figure 42 of the present report.

FRISCO FORMATION: Light-gray, fossiliferous calcarenite in beds to 2 or 3 feet; weathers with a "pot-holed" appearance. Carries a Deerparkian fauna.

P17-A ....

BOIS D'ARC FORMATION

FITTSTOWN MEMBER: Light-gray, fossiliferous calcarenite with marlstone partings; beds to 6 to 8 inches. Contact with Frisco well exposed.

P17-B .... 0 to 5 feet below Frisco contact.

CRAVATT MEMBER: Yellowish-gray, fossiliferous marlstone with a few thin beds of calcarenite; no chert observed.

P17-C .... 5 to 8 feet below Frisco contact

P17-D .... 8 to 12 feet below Frisco contact

Several specimens of *Troosticrinus* n. sp. and the following brachiopods collected from P17-D: *Atrypa* sp., *Cyrtina dalmani nana*, *Howellella cycloptera*, *Kozlowskiellina (M.) velata*, *Leptaena* sp., *Meristella atoka?*, *Nucleospira ventricosa*, *Obturamentella wadei*, *Rhipidomelloides oblata*, *Rhynchospirina* sp., *Sphaerirhynchia lindenensis*, *Stropheodonta (B.) arata*, *Trematospira* sp.

CHEMICAL ANALYSES

The chemical analyses listed on the following pages were made in the Chemical Laboratory of the Oklahoma Geological Survey. A few of these were made by Thomas Hamm, but the most were prepared by John A. Schleicher.

Almost all of these analyses were made from chert-free rock specimens (not channel samples) collected by me from the stratigraphic sections described in the chapter on STRATIGRAPHIC SECTIONS (locations given on fig. 48, and panel I). However, the analyses do include one channel sample (M9-A) and the 4 Frisco rock samples whose analyses are found at the end of this section were not taken from measured sections.

All samples were prepared as follows: The rock was first pulverized and then digested in warm (not boiling), dilute HC*l* . The insoluble residue was calculated, and the CaO and MgO determined for the acid soluble part; these data were then converted to $CaCO_3$ and $MgCO_3$ A few observations should be made on this procedure. *First*, the pulverizing of the rock in a pestle and mortar appears to give maximum solubility. I have calculated a number of HC*l* insoluble residues from crushed samples, broken to pea-size and smaller, and found that these generally give an insoluble residue which is slightly higher than that of the pulverized samples. All of the analytical data cited in this report were calculated from pulverized samples and thus all have the same relative value. *Second*, in studying the physical and biological characteristics of the residues I used only those prepared by myself as described above and not the pulverized samples.

The analyses of approximately 260 rock samples are given on the following pages. These data are presented stratigraphically, with the following sections represented by partial or complete analyses:

A2	Ca9	J1	J14	Ma4	M10	P1
Ca1	Ca10	J4	J16	M1	M12A	P8
Ca1(2)	Ca12	J6	J17	M2	M14	P9
Ca2	Ca13	J11	J18	M3	M15	P11
Ca3	C1	J12	L2	M5	M16	Frisco samples
Ca4	C2	J13	Ma2	M9	M17	

The analyses from each of these stratigraphic sections are grouped according to formations and members. These data are discussed in the text under the appropriate formation or member, and the $MgCO_3$ and HC*l* insoluble residues are presented by means of frequency diagrams; some distribution maps are included along with a few graphs of selected stratigraphic sections. A general discussion of Hunton $MgCO_3$, $CaCO_3$ and insoluble residues is given in the introductory part of the text (HUNTON GROUP).

Note: All of the following data are expressed as percentages. The plate and figure number is given for all specimens illustrated by photomicrographs (J1-C [XI-4]; pl. XI, fig. 4).

STRATIGRAPHIC SECTION A2

Southeast of Wapanucka

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
A2-C	8.09	90.09	1.73	99.91
	Chimneyhill formation - Cochrane member			
A2-A	2.22	97.35	0.71	100.28

STRATIGRAPHIC SECTION Ca1

Henryhouse Creek (samples collected from the glade exposures)

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
Ca1-M	15.60	82.77	0.92	99.29
Ca1-L	32.52	64.36	1.54	98.83
Ca1-K	29.38	68.45	1.67	99.51
Ca1-J	30.74	67.61	0.75	99.10
Ca1-I	49.30	48.90	0.91	99.11
Ca1-H	40.35	58.64	0.71	99.70

STRATIGRAPHIC SECTION Ca1(2)

Henryhouse Creek (samples collected in the Creek bed; see fig. 5)

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
Cal-V(2)	3.34	95.51	0.68	99.53
	Bois d'Arc formation - Cravatt member			
Cal-U(2) [XIII-5]	15.34	83.69	1.57	100.58
Cal-S(2)	8.74	87.47	3.65	99.86
	Haragan formation			
Cal-R(2)	6.95	90.55	3.40	100.90
Cal-Q(2)	16.11	77.75	5.55	99.41
	Haragan formation?			
Cal-P(2)	24.10	64.60	11.00	99.74
	Henryhouse formation			
Ca1-O(2)	9.78	87.48	2.57	99.83
Ca1-N(2)	23.51	68.01	8.21	99.79
Ca1-L(2)	23.11	72.81	4.52	100.44
Ca1-K(2)	22.78	75.62	1.97	100.37
Ca1-J(2)	16.19	79.58	3.52	99.29
Ca1-I(2)	31.47	64.18	4.32	99.88
Ca1-G(2)	13.42	83.51	2.46	99.39
	Chimneyhill formation - Clarita member			
Ca1-E	3.88	96.05	0.42	100.35
	Chimneyhill formation - Cochrane member			
Ca1-C	1.22	98.28	1.13	100.63
Ca1-B	1.00	98.49	0.94	100.43
	Chimneyhill formation - Keel member			
Ca1-A	2.66	96.56	0.50	99.72

STRATIGRAPHIC SECTION Ca2

Tulip Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
Ca2-Q	12.36	86.64	1.40	100.40
	Haragan formation			
Ca2-P	7.35	91.38	0.64	99.37
Ca2-O	9.72	88.97	1.28	99.97
	Henryhouse formation			
Ca2-N	23.57	73.94	1.13	98.64
Ca2-M	10.08	88.39	0.45	98.92
Ca2-K	26.21	71.59	0.45	98.25
Ca2-J	15.48	82.87	0.30	98.65
Ca2-I	28.53	69.78	0.72	99.03
Ca2-G	23.00	75.71	1.10	99.80
	Chimneyhill formation - Clarita member			
Ca2-E	10.73	87.68	2.08	100.49
Ca2-D	4.09	95.90	0.49	100.48
	Chimneyhill formation - Cochrane member			
Ca2-B	2.01	97.78	0.45	100.24
	Chimneyhill formation - Ideal Quarry member			
Ca2-A	10.12	88.71	0.45	99.32

STRATIGRAPHIC SECTION Ca3

Northeastern Carter County

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
Ca3-H	22.60	76.20	1.09	99.89
Ca3-G	29.75	59.52	10.43	99.70
Ca3-F	42.65	55.56	0.34	98.55
	Chimneyhill formation - Clarita member			
Ca3-E	11.56	88.44	0.41	100.21
Ca3-D	3.19	96.28	0.87	100.34
	Chimneyhill formation - Cochrane member			
Ca3-B	5.58	93.34	0.45	99.37
	Chimneyhill formation - Keel and Ideal Quarry members			
Ca3-A	3.40	96.18	0.57	100.15

STRATIGRAPHIC SECTION Ca4

Northeastern Carter County

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
Ca4-C	35.41	37.72	24.10	97.23
	Chimneyhill formation - Cochrane member			
Ca4-A	1.27	98.06	0.30	99.63

STRATIGRAPHIC SECTION Ca9

Westernmost Hunton outcrop

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
Ca9-O	2.69	96.24	0.94	99.87
	Bois d'Arc formation - Cravatt member			
Ca9-N	5.21	94.97	0.72	100.40
Ca9-M	8.74	90.54	1.10	100.38
Ca9-L	15.21	83.45	1.31	99.97
	Haragan and/or *Henryhouse formation*			
Ca9-K	12.17	86.64	1.55	100.36
	Henryhouse formation			
Ca9-J	12.76	85.84	0.83	99.43
Ca9-H	14.52	83.71	1.25	99.48
Ca9-G	7.42	91.26	1.51	100.01
Ca9-F	9.99	88.86	1.24	100.09
Ca9-E	19.04	78.65	1.28	98.97
Ca9-D	15.02	82.80	1.51	99.33
Ca9-B	7.86	90.55	1.36	99.77
Ca9-A	14.73	84.07	1.09	99.89

STRATIGRAPHIC SECTION Ca10

Westernmost Hunton outcrop

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Chimneyhill formation - Clarita member			
Ca10-D	3.38	95.72	0.72	99.82
	Chimneyhill formation - Cochrane member			
Ca10-C	0.67	98.67	0.95	100.29
Ca10-B	0.37	99.23	0.68	100.28
	Chimneyhill formation - Keel member			
Ca10-A	1.10	98.90	0.53	100.53

STRATIGRAPHIC SECTION Ca12

Criner Hills

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
Ca12-F	10.01	88.50	1.06	99.57
Ca12-E	16.78	81.17	1.81	99.76

	Chimneyhill formation - Clarita member			
Ca12-D	5.54	93.88	0.90	100.32
	Chimneyhill formation - Cochrane member			
Ca12-C[XII-6]	1.47	98.09	0.81	100.37
Ca12-B	0.96	98.53	0.93	100.43
	Chimneyhill formation - Keel member			
Ca12-A(3)*	2.67	96.41	1.07	100.15
Ca12-A(2)*	2.24	96.87	0.98	100.09
Ca12-A(1)*	1.85	97.47	1.04	100.36

STRATIGRAPHIC SECTION Ca 13

Northern end of Criner Hills

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
Ca13-D	32.83	64.83	0.68	98.34
Ca13-C	15.25	83.05	0.94	99.24
	Chimneyhill formation - Clarita member			
Ca13-B	3.18	96.18	0.78	100.18
	Chimneyhill formation - Cochrane member			
Ca13-A	0.83	98.65	0.72	100.20

STRATIGRAPHIC SECTION C1

Old Hunton townsite

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total	
	Bois d'Arc formation - Fittstown member				
C1-Q[XIV-6]	1.80	94.93	2.05	99.59	(R_2O_3 0.81)
	Bois d'Arc formation - Cravatt member				
C1-P	8.58	87.90	2.38	100.11	(" 1.25)
	Haragan formation				
C1-H	15.35	77.32	1.51	97.11	(" 2.93)
	Chimneyhill formation - Clarita member				
C1-F	1-68	96.02	0.75	99.39	(" 0.94)
	Chimneyhill formation - Cochrane member				
C1-C	0.98	95.83	1.61	100.31	(" 1.89)
	Chimneyhill formation - Keel member				
C1-B	0.44	97.34	0.75	99.69	(" 1.16)

STRATIGRAPHIC SECTION C2

North of Bromide

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
C2-K	7.41	91.64	1.39	100.44
	Haragan formation			
C2-J	9.57	88.95	1.14	99.66
C2-I	9.47	89.18	1.28	99.93
C2-H	7.93	90.43	1.21	99.57
	Henryhouse formation			
C2-E	18.97	73.87	6.39	99.23
C2-D	14.27	80.10	5.00	99.37
	Chimneyhill formation - Clarita member			
C2-C	8.45	90.83	0.64	99.47
C2-B	19.36	78.71	0.95	99.02
	Chimneyhill formation - Cochrane member			
C2-A	2.11	97.52	0.51	100.41

*Three different Keel specimens analyzed from unit Ca12-A

STRATIGRAPHIC SECTION J1

Southwest of Wapanucka

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Chimneyhill formation - Keel member			
	upper oolite			
J1-D	0.20	99.14	0.47	99.81
	middle laminated calcilutite			
J1-C[XI-4]	5.53	93.01	1.22	99.76

STRATIGRAPHIC SECTION J4

Southwest of Wapanucka

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
J4-J	14.39	84.16	1.27	99.82
	Haragan formation			
J4-I	7.38	91.82	0.72	99.92
	Henryhouse formation?			
J4-G	19.63	78.83	1.29	99.75
J4-F	17.19	80.86	0.85	98.90
	Chimneyhill formation - Clarita member			
J4-E	5.16	94.24	0.77	100.17
	Chimneyhill formation - Cochrane member			
J4-B	2.05	96.79	1.40	100.24
	Chimneyhill formation - Keel member			
J4-A	2.35	60.72	36.38	99.45

STRATIGRAPHIC SECTION J6

West of Wapanucka

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
J6-D	9.63	87.60	2.80	100.03
	Chimneyhill formation - Cochrane member			
J6-C	2.73	97.27	0.26	100.26
	Chimneyhill formation - Keel member			
J6-B*	2.42	97.59	0.15	100.16
J6-B(1)*	0.56	97.56	1.73	99.85
J6-B(2)*	1.79	97.67	0.62	100.08
	Chimneyhill formation - Ideal Quarry member			
J6-A	5.66	75.30	15.16	96.63

STRATIGRAPHIC SECTION J11

West of Mill Creek town

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
J11-L	2.09	97.63	0.49	100.19
J11-K	14.54	84.86	1.06	100.46
J11-J	5.51	94.32	0.45	100.17
J11-H	4.96	94.59	0.53	100.08
J11-G	4.78	95.21	0.23	100.22
	Bois d'Arc formation - Cravatt member			
J11-F	17.10	82.52	0.34	99.96
J11-E	9.50	90.39	0.34	100.43
	Chimneyhill formation - Cochrane member			
J11-C	2.76	97.56	0.11	100.43
	Chimneyhill formation - Keel member			
J11-B	1.47	98.58	0.42	100.47
	Chimneyhill formation - Ideal Quarry member			
J11-A	2.97	96.98	0.41	100.36

*Analyses of 3 different rock specimens from the same unit.

STRATIGRAPHIC SECTION J12

Near Ravia

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
J-12-F	13.60	85.41	0.79	99.80
	Haragan formation			
J12-D	16.36	82.06	0.98	99.40
	Henryhouse formation			
J12-C	36.42	61.13	1.17	98.72
	Chimneyhill formation - Clarita member			
J12-B	4.21	94.74	0.87	99.82
	Chimneyhill formation - Cochrane member			
J12-A	2.95	95.78	0.04	98.77

STRATIGRAPHIC SECTION J13

Oil Creek area

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford? brown carbonate			
J13-B(1) [XV-5]	9.49	87.12	1.66	98.27
J13-B(2) [XV-6]	9.97	80.14	9.77	99.88

STRATIGRAPHIC SECTION J14

Oil Creek area

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford? brown carbonate			
J14-B	11.33	74.64	13.24	100.07

STRATIGRAPHIC SECTION J16

Oil Creek area

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford formation			
J16-B	28.68	41.85	25.85	98.91

STRATIGRAPHIC SECTION J17

Oil Creek area

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Sylvan formation (lens of silty dolomite)			
J17[XVI-6]	18.10	44.74	26.15	88.99

STRATIGRAPHIC SECTION J18

Oil Creek area

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford? brown carbonate			
J18-D(1) [XV-1]	9.15	53.84	33.32	98.81
J18-D(2)	6.00	66.90	24.61	98.66
J18-D(3) [XV-2]	16.73	79.50	2.42	98.65
J18-E(1)	4.01	56.52	36.25	99.06
J18-E(2) [XV-3]	4.54	56.45	36.64	97.63

STRATIGRAPHIC SECTION L2

Criner Hills

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
L2-G	13.94	84.23	0.82	98.99
	Haragan formation			
L2-F	11.55	88.29	0.42	100.38
L2-D	18.79	79.08	0.79	98.66
	Henryhouse and/or *Haragan formation*			
L2-C	22.39	76.62	0.67	99.76
	Henryhouse formation			
L2-B	17.69	81.46	1.09	100.32

STRATIGRAPHIC SECTION M1

Vines Dome

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
M1-O(1) [XIII-6]	10.12	86.42	3.97	100.51
M1-O(2)*	8.53	68.54	21.08	99.79
M1-O(3)*	3.13	95.30	1.29	99.72
M1-M	10.13	92.49	1.46	104.08
	Haragan formation			
M1-K	17.42	80.21	3.94	101.57
M1-J [XIII-4]	17.65	75.18	5.92	98.75
M1-I	11.73	83.35	3.33	98.41
M1-H	16.85	81.24	1.30	99.39
M1-G	21.89	78.74	0.83	101.46
	Henryhouse formation			
M1-F	26.84	70.83	0.92	98.79
M1-E	8.19	89.23	0.71	98.13
M1-D	29.02	70.24	0.33	99.59
M1-B	25.96	73.02	1.15	100.13
	Chimneyhill formation - Clarita member			
M1-A	5.74	93.86	0.61	100.21

STRATIGRAPHIC SECTION M2

Near White Mound

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Cravatt member			
M2-O	11.78	87.85	0.75	100.38
	Haragan formation			
M2-M	17.65	75.54	5.54	98.73
M2-L	26.89	66.12	5.72	98.73
M2-K	13.42	82.49	3.63	99.54
M2-J	14.99	83.53	0.41	98.93
M2-H	17.34	80.34	0.94	98.62
	Henryhouse? formation			
M2-F	10.82	88.20	0.79	99.81
	Henryhouse formation			
M2-E	15.97	82.63	0.60	99.20
M2-D	21.02	76.90	1.70	99.62
	Chimneyhill formation - Clarita member			
M2-B	4.33	95.12	0.23	99.68
	Chimneyhill formation - Cochrane member			
M2-A	1.44	98.32	0.45	100.21

STRATIGRAPHIC SECTION M3

White Mound area - Haragan Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
M3-F	7.56	81.31	11.25	100.12
M3-E	3.70	95.12	1.97	100.48
M3-D	7.81	88.84	3.23	99.88
M3-C(1)**	5.52	88.98	5.83	100.33
M3-C(2)**	9.66	88.69	1.36	99.71

*Samples from the upper 3 to 4 feet of the Cravatt, just below the Woodford.

** Two different samples from the same interval.

	Bois d'Arc formation - Cravatt member			
M3-B	11.04	86.94	2.69	100.57
M3-A(3)	11.13	82.22	7.08	100.43
M3-A(2)	16.12	79.03	5.25	100.49
M3-A(1)	8.75	88.56	2.98	100.29

STRATIGRAPHIC SECTION M5

Road to Price's Falls

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford formation (basal cherty carbonate)			
M5	76.15	16.65	6.38	99.18

STRATIGRAPHIC SECTION M9

North of Dougherty

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Haragan formation			
M9-A (6 ft. channel sample)	28.03	66.43	4.50	98.96

STRATIGRAPHIC SECTION M10

Buckhorn Ranch, northeast of Dougherty

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
M10-P	3.79	95.62	0.57	99.98
	Bois d'Arc formation - Cravatt member			
M10-O	5.17	93.71	1.66	100.54
M10-N	22.65	76.47	0.26	99.38
	Haragan formation			
M10-M	23.00	75.20	0.76	98.96
M10-L	24.89	72.92	0.87	98.68
M10-K	12.56	86.31	0.30	99.17
M10-J	20.22	78.81	0.30	99.33
M10-I	29.05	67.97	1.62	98.64
	Henryhouse formation			
M10-H	12.34	86.54	1.17	100.05
M10-G	19.63	79.06	0.68	99.37
M10-F	16.09	82.52	1.02	99.63
	Chimneyhill formation - Clarita member			
M10-E	9.40	89.01	1.51	99.92
M10-D	11.57	87.62	1.17	100.36
M10-C	6.45	93.08	0.26	99.79
	Chimneyhill formation - Cochrane member			
M10-A	2.20	97.18	0.68	100.09

STRATIGRAPHIC SECTION M12A

Price's Falls

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Chimneyhill formation - Keel member			
M12A-B[X-4]	0.78	99.13	0.11	100.02
	Chimneyhill formation - Ideal Quarry member			
M12A-A[X-1]	2.56	95.30	0.94	98.80

STRATIGRAPHIC SECTION M14

West of Oklahoma Highway 18

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
M14-L(2)	0.91	98.71	0.04	99.66
M14-L(1)	2.81	96.62	0.45	99.88
	Bois d'Arc formation - Cravatt member			
M14-K	11.32	88.16	1.06	100.54
M14-J	14.14	84.64	0.98	99.76

STRATIGRAPHIC SECTION M15

North of Camp Classen

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Henryhouse formation			
M15-E	22.17	75.54	1.17	98.88
M15-D	27.09	71.00	0.53	98.62
	Chimneyhill formation - Clarita member			
M15-B	3.51	95.23	0.23	98.97
	Chimneyhill formation - Cochrane member			
M15-A	1.92	96.75	0.11	98.78

STRATIGRAPHIC SECTION M16

Southeastern Murray County

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Bois d'Arc formation - Fittstown member			
M16-F	6.37	93.66	0.45	100.48

STRATIGRAPHIC SECTION M17

U. S. Highway 77

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Haragan formation			
M17-K	20.75	77.42	0.94	99.11
M17-J	30.73	67.05	0.76	98.54
	Haragan and/or *Henryhouse formations*			
M17-I	26.20	69.40	4.71	100.31
	Henryhouse formation			
M17-H	23.01	76.55	0.45	100.01
M17-G	32.13	65.90	1.10	99.13
M17-F	19.53	77.92	1.36	98.81
M17-E	17.41	80.39	1.17	98.97
M17-D	31.91	65.65	0.94	98.50
	Chimneyhill formation - Clarita member			
M17-C	8.91	89.36	0.79	99.06
	Chimneyhill formation - Cochrane member			
M17-B	3.50	95.00	0.34	98.84
	Chimneyhill formation - Keel and Ideal Quarry members			
M17-A	5.30	93.22	1.17	99.69

STRATIGRAPHIC SECTION Ma2

Turkey Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	carbonate-siltstone sequence			
	cherty carbonate			
Ma2-F(2) (upper 10')	36.47	44.91	18.45	99.83
Ma2-F(2a)[XVI-1] (upper 10')	61.16	26.00	11.47	98.63
Ma2-F(1)[XVI-2] (lower 10')	66.86	25.48	8.14	100.50
Ma2-F(1a) (lower 10')	65.95	25.33	8.65	99.93
	dolomitic siltstone			
Ma2-D(2) (10' to 15' above base)	69.81	16.64	12.41	99.61
Ma2-D(1)[XVI-3] (lower 10')	67.14	18.21	13.19	99.23
	glauconitic limestone			
Ma2-C	5.03	95.01	0.38	100.62
Ma2-B	6.63	91.02	1.44	99.09
Ma2-A[XVI-4]	10.19	87.81	0.57	98.57
	Sylvan? formation			
Ma2-Y[XVI-5]	59.62	37.71	0.70	98.03
Ma2-Z	37.43	60.89	1.17	99.49

STRATIGRAPHIC SECTION Ma4

Turkey Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Woodford? cherty carbonate			
Ma4-(1)	69.94	17.07	22.26	98.93
Ma4-(2)	41.72	34.68	23.18	99.58

STRATIGRAPHIC SECTION P1

Chimneyhill Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Haragan formation			
P1-U (calcarenite)	2.43	96.42	1.53	100.48
	Henryhouse formation			
P1-T	8.04	86.55	4.50	99.09
P1-S[XII-4]	14.77	81.55	2.97	99.29
P1-R	10.32	88.44	1.26	100.02
P1-Q	14.42	83.89	1.15	99.46
P1-P	21.01	74.98	3.73	99.72
P1-N	13.12	82.68	4.52	100.32
P1-M	22.52	66.79	9.79	101.10
P1-J	31.80	53.67	11.61	97.08
P1-I	14.17	80.87	5.38	100.42
P1-G	13.69	80.98	4.62	99.29
	Chimneyhill formation - Clarita member			
P1-F	4.40	94.67	0.65	99.72
P1-E[XII-3]	0.42	99.47	0.69	100.58
P1-D	3.03	95.67	1.26	99.96
	Chimneyhill formation - Cochrane member			
P1-C	0.79	98.99	1.11	100.89
	Chimneyhill formation - Keel member			
P1-B	0.89	99.75	0.79	101.43
	Chimneyhill formation - Ideal Quarry member			
P1-A	1.39	99.72	0.57	101.68

STRATIGRAPHIC SECTION P8

North side of Bois d'Arc Creek (fig. 4)

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Frisco formation			
P8-H(2)	0.59	100.64	0.51	101.74
P8-H(1)[XIV-2]	0.51	99.62	0.38	100.51
	Bois d'Arc formation - Fittstown member			
P8-G	2.55	97.16	0.88	100.59
P8-F	3.76	95.79	0.71	100.26
P8-E	2.73	95.29	1.11	99.13
	Bois d'Arc formation - Cravatt member			
P8-D*	63.11	31.36	5.15	99.62
P8-C	14.40	77.75	7.87	100.02
	Haragan formation			
P8-B	12.12	76.82	10.39	99.33
	Henryhouse formation			
P8-A	17.60	68.87	13.87	99.34

STRATIGRAPHIC SECTION P9

Coal Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Frisco formation			
P9-R	0.26	99.18	0.79	100.23

*Sample probably included some chert.

	Bois d'Arc formation - Fittstown member			
P9-Q	4.18	94.60	1.01	99.79
P9-P	5.20	93.27	1.02	99.49
	Bois d'Arc formation - Cravatt member			
P9-O	7.04	90.48	1.39	98.91
P9-N	14.97	83.79	0.68	99.41
P9-L	13.79	85.57	1.05	100.41
	Haragan formation			
P9-K	15.91	83.36	0.91	100.18
P9-I	33.04	65.66	1.02	99.72
P9-F	16.29	82.25	0.90	100.16
	Chimneyhill formation - Keel member			
P9-B	0.34	99.25	0.75	100.34

STRATIGRAPHIC SECTION P11

Bois d'Arc Creek

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
	Frisco formation			
P11-C	0.86	101.23	0.54	102.63
	Bois d'Arc formation - Fittstown member			
P11-B	4.20	94.99	0.63	99.82
P11-A	2.82	97.81	0.17	101.34

FRISCO FORMATION

Miscellaneous rock samples

Rock sample	Insoluble residue	$CaCO_3$	$MgCO_3$	Total
Frisco formation - NE¼ SE¼ sec. 10, T. 2 N., R. 6 E. (pl. XIV, fig. 1)				
	3.56	97.48	0.39	101.43
	Frisco formation - NE¼ NE¼ sec. 16, T. 1 S., R. 8 E.			
A	4.94	94.54	0.45	99.93
B	2.20	96.72	0.41	99.33
	Frisco formation - SE¼ SW¼ sec. 9, T. 1 S., R. 8 E.			
	0.61	99.18	0.60	100.39

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An asterisk (*) indicates the page where a subject is discussed or described; references to stratigraphic sections are placed in parenthesis (J6) and follow the page number; a small c following the page reference indicates a chemical analysis.