BARRIER REEFS OF THE STANTON FORMATION (MISSOURIAN) IN SOUTHEAST KANSAS

by

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INTRODUCTION

An abrupt change of facies has long been recognized in many Missourian formations in the vicinity of the Oklahoma border in southeast Kansas. Moore (1949), pp. 66-122, summarizes the geology of these beds and outlines the problems of correlation connected with the variability of deposition in that area.

Recent engineering geology investigations by the State Highway Commission in southeast Kansas have produced considerable information regarding the stratigraphy of the Stanton Limestone, a typical Missourian formation, where it undergoes transition from limestone to sandstone and shale lithology. Preliminary investigation related to these surveys indicated that all of the limestone members of the Stanton Formation thicken abnormally adjacent to the area of abrupt southward thinning and facies change. Detailed studies near Elk City, Kansas, verified this fact and revealed a number of features in the thickened limestone section which were characteristic of organic reefs.

The purpose of this paper is to describe the stratigraphy of the Stanton Formation and to relate the occurrence of reefs to the physical environment represented by the various phases of Stanton deposition in the area of investigation.

As a large part of this paper is necessarily devoted to a description of the stratigraphy of the reefy deposits, a short introductory discussion of organic reefs and reef types is here included. For a more complete treatment of the subject, refer to an excellent paper by Cloud (1952), pp. 2125-2149, which summarizes much of the existing literature concerning organic reefs and reef deposition. An extensive list of references is also included.

Organic Reefs

Cloud's terminology for reefs is followed by the writer in this paper. According to his definition, (1952), pp. 2126-2127:

> Organic reefs are or were actually or potentially wave-resistant mounds, platforms, or linear or irregular masses that were constructed under organic influence and rise or rose significantly above the sea floor. Where the nature of the structure referred to is clear from context, it may be called simply a "reef" without serious damage to that conventional nautical term.
>
> ----The term "bioherm", originally proposed ---- as a substitute for the general term "reef", may be reserved for reef-like organic masses of uncertain potential or doubtfully wave-resistant nature.

Types of Organic Reefs

Fringing reefs, barrier reefs and atolls are listed by Cloud as the classic and conspicuous types of existing reef complexes.

<u>Fringing Reefs</u>. This form may be expected along shores that are stationary, slowly rising or rapidly subsiding with respect to sea level. They may be expected to show the form of irregular calcareous mantles, veneers, or wedges with abrupt contacts against the sloping substratum on which they grew. Basal unconformities are the rule. The reef front may be separated from the beach by very shallow and narrow bodies of water

known as moats.

Barrier Reefs. Barrier reefs are linear, wave-fronting structures that are essentially similar to fringing reefs except that they lie offshore from the land, being separated from it by a lagoon of varying depths and area. They are characteristically initiated by submergence, but may also grow upward from a pre-existing platform within reach of sea level. A pre-existing platform of organic growth (fringing reef), inorganic construction, or abrasion is considered necessary for initiation of the barrier reef form. Ancient barrier reefs should be an irregular ridge, wedge or mantle of porous but well consolidated and more or less massive rock with a high proportion of clastic debris interstitial in the frame building elements. Seaward, it should pass by interfingering gradation into reef talus, and the talus into offshore sediments. If closely analogous to existing reefs, the old barrier reef should pass lagoonward, with indefinite or complexly interfingering relationship, from the crustose and more sturdily fashioned organic growths of the reef flat, first into limesands that surround abundant irregular small patch reefs, and eventually into lagoonal limesands that may or may not be interspersed with scattered but generally large patch reefs. However, it may pass lagoonward to evaporites or purely clastic sediments.

Atolls. The outer reefs of atolls differ from the above forms mainly in their ring-like disposal about a central lagoon that is devoid of pre-existing land.

METHODS OF INVESTIGATION

Most of the material upon which this paper is based was collected as a part of the routine engineering geology investigations pertaining to nine State and Federal highway projects in Montgomery and adjoining counties. The studies were made at various times between April, 1953 and November, 1956 and constitute a total of approximately twelve months of field work.

The correlation of the stratigraphy between the various projects and additional investigation of significant areas was accomplished by independent study.

General reconnaissance and measurement of typical rock exposures was augmented by structural mapping and numerous core drill and power auger soundings which provided much information not otherwise available.

Beds were measured to the nearest 0.1 foot by tape or with hand level and level rod. Care was taken to minimize the effects of dip.

In several cases it was necessary to use composite or running sections. These instances are indicated in the description of the individual section in the appendix.

The geographic locations of the measured exposures or bore holes were determined to the nearest ¼, ¼, ¼ section by means of aerial photographs and referenced to prominent landmarks where applicable. The significant stratigraphic sections were given distinctive locality names to avoid confusion and to facilitate discussion of the different phases of deposition shown at the various locations.

AREA OF INVESTIGATION

The area of investigation included most of that part of Montgomery County within the outcrop of the Stanton Formation (Plate I). The most intensive study was necessarily restricted to the area adjacent to the above mentioned projects.

GEOLOGIC SETTING

Distribution of Outcrops

The outcrop of the Stanton Formation trends approximately NNE-SSW across the area of investigation. The strike of the abnormally thickened limestone section parallels the outcrop in the northern part of the area but swings abruptly to the west in the vicinity of Independence and Elk City. The thick limestones form prominent escarpments in the north, but southward where limestone is only a minor constituent, the scarps are less well defined and good exposures are less frequently developed.

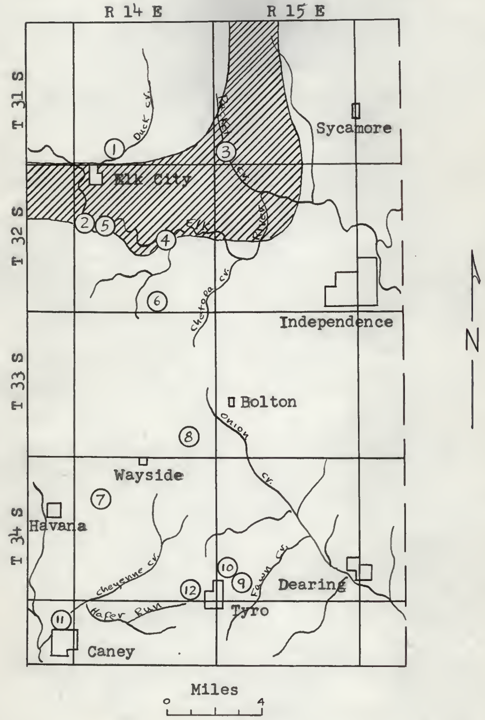
Structure

The average regional dip in the area of investigation is to the northwest at about 25 feet per mile, but is frequently modified by local structure.

EXPLANATION OF PLATE I

An index map of the western part of Montgomery County, Kansas showing the location of the correlation sections, Plate II. The reef area is indicated by cross-hatching.

PLATE I


R 14 E
R 15 E
T 31 S
T 32 S
T 33 S
T 34 S
Duck cr.
Sycamore
Elk City
Elk
River
Chetopa cr.
Independence
Bolton
Onion
cr.
Wayside
Havana
Cheyenne cr.
Fawn cr.
Dearing
Hafer Run
Tyro
Caney
1
2
3
4
5
6
7
8
9
10
11
12
N
Miles
0
4

STRATIGRAPHY OF THE STANTON FORMATION

The Stanton Formation is the youngest formation of the Lansing Group, Missourian Series, Pennsylvanian System. It is overlain by the Weston Shale of the Pedee Group and underlain by the Vilas Shale of the Lansing.

Thickness

The formation averages approximately 100 feet in thickness throughout the area studied. Moore (1949), p. 117, reports a minimum thickness of ten feet in an area three miles south of Elk City. This figure is apparently in error. Newell, (Moore, et al., 1937) p. 46, previously reported approximately 90 feet of Stanton strata at this same location. This was verified by the writer who found the thickness of the Stanton Formation to be slightly more than 100 feet in this same general vicinity.

Members

All of the limestone members of the Stanton Formation change to sandstone and the upper shale member is also predominantly sandstone in the southern part of the area of investigation. The formal Kansas stratigraphic names obviously do not apply in that area and the appropriate Oklahoma nomenclature should be utilized. The correlation of many of these beds with their Oklahoma equivalents is at present uncertain. Standard Kansas stratigraphic terms have been used for that reason in this paper, but the lithologic part of the unit name, i. e., limestone, shale, etc., has been dropped where it is not applicable throughout the entire area to be discussed.

LITHOLOGIC DESCRIPTION

Captain Creek Member

The greatest thickness of the Captain Creek Member was measured in a well exposed and easily accessible section along a winding black-top road where Racket Creek cuts through the Stanton escarpment in the NE¼, NE¼, NW¼, Sec. 31, T. 31 S., R. 15 E. (Correlation section 3, Plate II). A total thickness of 57 feet of limestone occurs at that location.

The upper 25 feet of this section is composed of wavy-bedded to slabby, light gray, fine-grained limestone containing thin calcite veinlets and numerous crystal filled vugs. The upper surface is slightly irregular to pitted and contains a number of borings or trails.

The middle part of the exposure is 15 feet of reefy appearing limestone, made up mainly of very coarsely crystalline calcite with a small percentage of fine-grained, gray or reddish gray, interstitial material. Some of the crystal masses exceed two inches in diameter. The limestone is very porous, containing vuggy to cavernous voids partially filled in some cases with soft, orange limonite. Bedding is obscure to absent. A coral-like fossil, similar to the stromatoporoid Actinostroma, was found at several places in this zone. Much of the fossil structure has been destroyed by extensive secondary recrystallization.

EXPLANATION OF PLATE II

Localities

1. Duck Creek
   sw ne ne 32-31-14

2. Elk City Bridge
   sw nw ne 18-32-14

3. Racket Creek
   ne ne nw 31-31-15

4. U. S. 160 Composite
   ne nw sw 14-32-14
   Stoner & Eudora Mbrs.
   sw ne sw 14-32-14
   Captain Creek Mbr.

5. Proposed U. S. 160
   Elk River Bridge
   se se nw 17-32-14

6. Coleman Hill-Chetopa
   Creek Composite
   sw se 28-32-14
   South Bend, Rock Lake
   & Stoner Mbrs.
   nw nw 36-32-14
   Eudora & Captain Creek
   Mbrs.

7. Round Mound
   se sw nw 8-34-14

8. Bolton Composite
   nw nw nw 36-33-14

9. Fawn Creek (After
   unpublished section
   by N. D. Newell
   sw cor. 29 & se cor.
   30-34-15

10. Tyro Quarry
    sw se 30-34-15

11. Caney Mound
    se ne se 1-35-14

12. Tyro
    se se nw 1-35-14

Lithology

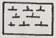
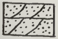
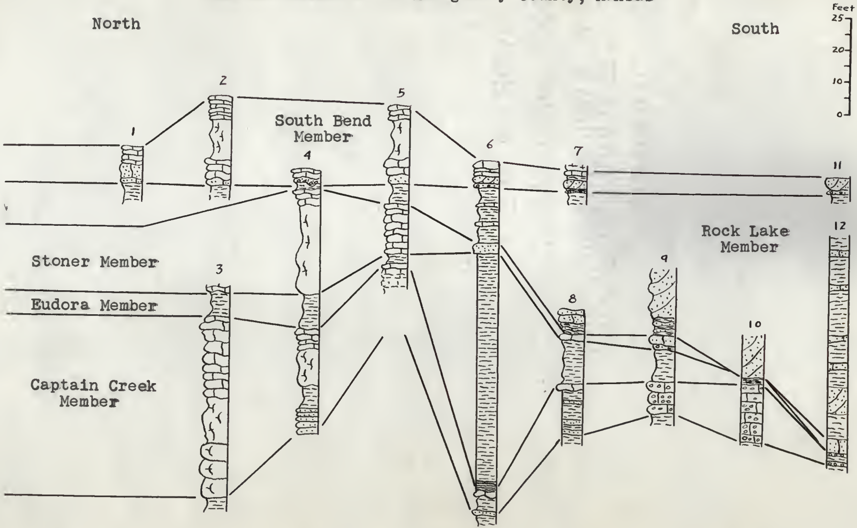
	limestone
	reefy limestone
	oolitic limestone
	sandy limestone
	shale
	limy shale
	carbonaceous shale
	sandstone
	current-bedded sandstone
	conglomerate

PLATE II

Stanton Formation of Montgomery County, Kansas



About 17 feet of limestone, similar to the bed immediately above but with less porosity and crystalline calcite, occurs at the base of the bed. This zone has some bedding or tendency towards the development of horizontal partings.

An outcrop measured below the east abutment of the Elk River bridge on U. S. Highway 160 in the SW¼, NE¼, SW¼, Sec. 14, T. 32 S., R. 14 E., (Correlation section 4, Plate II) exposes five to six feet of upper light gray, wavy-bedded limestone and 12.5 feet of limestone similar to the basal bed of the Racket Creek exposure. Seven feet of limy, gray-green shale and 8+ feet of gray, platy sandstone underlie the limestone. This sandstone is thought to grade laterally into the oolite which occupies the same position in sections to the south. Moore, et al., (1937), p. 46, reports the occurrence of sponges, Enteletes, and Triticites from the Captain Creek Member at this location.

Two miles south of the U. S. 160 section in the vicinity of Chetopa Creek, the Captain Creek Member consists of 1.5 to two feet of dense, blue-gray limestone underlain by four feet of gray, limy shale and three feet of gray, platy sandstone (Correlation section 6, Plate II).

Newell, (Moore, et al., 1937) p. 49, shows a section of the Captain Creek Member measured on the north slope of Walker Mound in the NE Cor. Sec. 5, T. 33 S., R. 15 E. Here a dense, gray oolite occurs at the base of the member. The upper limestone at both locations contains numerous sycon sponges, especially Heterocoelia (?).

Both the oolite and the sponge bearing limestone are persistent for some distance parallel to the strike of the thick limestone section. Across the strike of the beds to the southeast, however, the limestone containing sponges dies out and the oolite becomes the only definitely identifiable unit of the Captain Creek Member. The oolitic phase has been traced southward along the outcrop to the Oklahoma line. A mile northeast of Tyro, Kansas, (Correlation section 10, Plate II) the oolite thickens locally to near 20 feet. Bore holes at the east side of Tyro indicate that the oolite has been cut out by erosion at the base of a sandstone in the Rock Lake Member, but it reappears in the hills south of Tyro and is present west of town at a number of places along the course of Hafer Run, where it was traced as far west as the NE Cor. Sec. 4, T. 35 S., R. 14 E.

The foregoing sections illustrate that between Racket Creek and the U. S. 160 locality, the Captain Creek Member has thinned to approximately half of its former thickness and the middle reefy appearing bed is either missing or has undergone a change of lithology. The most striking change occurs between the latter section and the Chetopa Creek area. It is apparent that the Chetopa Creek section represents an entirely different phase of deposition.

Eudora Shale Member

The Eudora Shale Member varies greatly in thickness in the area of investigation. Eight feet of gray to dark gray, silty shale was measured at the Racket Creek exposure, but the member thinned to five feet only a few hundred feet northward. Abundant fusulines, broken brachiopods, bryozoans, and crinoid stems occur in the shale at this outcrop. The interval of the Eudora Shale Member was 11 to 14 feet in the vicinity of the U. S. 160 exposure of the Captain Creek Member.

Two and a half miles southeast of the U. S. 160 outcrop, in the SE¼, NW¼, NW¼, Sec. 36, T. 32 S., R. 14 E., (Correlation section 6, Plate II) a total of 74 feet of Eudora Shale Member was projected from bore holes below the Stoner Member. One to three feet of black, carbonaceous shale occurs at the base of the Eudora Member in the Walker Mound measured section.

Approximately 13 feet of blue-gray, clay shale comprised the Eudora Member two miles southwest of Bolton (Correlation section 8, Plate II). Black shale was not found in that vicinity, but numerous bleached phosphate concretions occur in the gravel of streams which cut this bed, probably indicating that much of the shale was carbonaceous before weathering.

The Eudora Member is thin to absent in some places near Tyro, Kansas, having been eroded during the hiatus represented by the unconformity at the base of the Stoner Member or by downcutting of the channel in the Rock Lake Member. A maximum of 20 feet of black, platy shale underlies the Stoner conglomerate in a gully about 100 yards north of new U. S. 166 in the NW¼, SE¼, NE¼, Sec. 4, T. 33 S., R. 14 E., but the average thickness in this vicinity is only about ten feet.

Stoner Member

A maximum thickness of 37 feet of Stoner Member was measured in the abnormally thickened limestone area. This section is excellently exposed in a cliff north of present U. S. 160 Highway where it crosses the Elk River in the SW¼, NW¼, NE¼, Sec. 18, T. 32 S., R. 14 E. (Correlation section 4, Plate II).

The South Bend and Rock Lake Members overlie the Stoner at the top of this section.

The upper five to six feet of the Stoner Member is gray, crystalline, wavy-bedded limestone, weathering slabby to flaggy. Numerous closely spaced, sinuous lines or veinlets of calcite occur throughout the bed. These veinlets are believed to be of algal origin. This algal (?) limestone occurs persistently at the top of the Stoner in the Elk City area and was used as datum for structural mapping.

The basal bed is a 30 foot, medium soft, light-gray limestone having some masses of free calcite and numerous limonite filled vugs or cavities. This zone appears mottled on fresh surfaces. Joints are widely spaced and horizontal partings absent. The limestone exfoliates parallel to the face of the outcrop exposing successive laminations, each about an inch in thickness. The basal contact of this bed with the Eudora Shale Member is uneven to broadly undulating, probably unconformable. A few hundred yards south, near the highway, most of the Stoner is wavy-bedded to slabby. The member thins rapidly southeastward from this point.

The details of this thinning may be more conveniently observed in a series of exposures along a county road which crosses the Elk River one and a half miles southeast of Elk City, Kansas. Reefy appearing limestone is present in most of the Stoner exposures in the north bank of the river and may be observed just east of the bridge. About one-half mile south of the river in the SW¼, NW¼, NW¼, Sec. 16, T. 32 S., R. 14 E. (Correlation section 5, Plate II), the entire member is exposed in the east backslope of the same road. Two and three-tenths feet of typical algal (?) limestone occurs at the top of the section underlain by 12.1 feet of blue-gray, wavy-bedded limestone containing few fossils other than numerous, partly articulated, crinoid stems occurring on the bedding planes.

The top of the Stoner and the base of the South Bend Member may be observed in a small quarry a few hundred feet southwest of this section. Only two feet of Rock Lake shale separates the two beds. The Stoner dips steeply to the ESE.

Two and a half miles further south, in the SW¼, SE¼, Sec. 28, T. 32 S., R. 14 E., (Correlation section 6, Plate II) the entire Stoner Member consists of 3.5 feet of light gray, fine-grained, calcite cemented sandstone. A thin, yellow, impure limestone occurs above the sandstone bed at a few places in this vicinity and near the school house in the SE¼, SE¼, SE¼, Sec. 35, T. 32 S., R. 14 E., the typical upper algal (?) limestone reappears and is exposed in a small quarry.

In the vicinity of Bolton, Kansas, and southward, the Stoner

Member consists variously of a few inches of algal coated, fossil breccia overlain by platy sandstone and shale of the Rock Lake Member or several feet of fossiliferous conglomerate occurring at the base of a 30 foot current-bedded sandstone also of the Rock Lake Member. The Stoner deposits at most typical locations consist of several feet of coarse clastic limestone or fossil breccia.

The relationship of the above mentioned overlying sandstone is variable. The Stoner conglomerate appears to grade upward into it at some exposures, but at other places the sandstone is distinct from the Stoner deposits and is definitely Rock Lake. This appears to be confirmed at several places near Tyro, where the upper sandstone has cut out the underlying Stoner conglomerate. The base of all definitely identifiable Stoner beds, especially in the south, are unconformable with the underlying strata.

Rock Lake Member

Thickness and lithology of the Rock Lake Member varies considerably in the area of investigation.

In the thickened limestone section north of the Elk River, it varies from a few inches to about five feet of gray-green, silty shale. Abundant fusulines characterize the bed in that vicinity.

A few miles south of the Elk River, (Correlation section 6, Plate II) the thickness is about 15 feet and it is nonfossiliferous.

Two thin concretionary limestone beds occur near the middle and lower part of the member at that exposure.

Near Wayside and Havana, Kansas, the member exceeds 30 feet in thickness. Mapping indicated that nearly 60 feet of Rock Lake strata may be present in the sandstone area northeast of Wayside.

A current-bedded sandstone comprises much of the strata where the Rock Lake Member is thickest. The position of this bed within the member is variable, and in some cases two or more relatively thick beds are present. These beds grade laterally into a series of alternating shales and thin, fine-grained, ripple-marked sandstones. The distribution of the thick sandstones of the Rock Lake indicates that they are channel or deltaic deposits. At a number of places, as near Wayside and Tyro, the sandstone exceeds 30 feet in thickness and is easily mistaken for the Tonganoxie Sandstone of Virgilian age.

South Bend Member

The upper member of the Stanton Formation undergoes a southward sequence of facies variation very similar to that of the Captain Creek Member.

The greatest measured thickness of the South Bend Member was 27.3 feet at the Elk River bridge southwest of Elk City (Correlation section 2, Plate II). The above exposure, in the SW¼, NW¼, NE¼, Sec. 18, T. 32 S., R. 14 E., is typical of the South Bend Member in the thick limestone phase. The upper 7.5 feet is slightly oolitic, crystalline limestone, wavy-bedded, but weathering slabby to flaggy. Broken crinoid stems are the most abundant fossil.

This zone is underlain by 13 feet of medium soft, light gray, porous limestone. Joints and partings are nearly absent. Large spherical masses some six to eight feet in diameter stand out from the outcrop face. The limestone exfoliates in concentric inch-thick layers parallel to the surface of the outcrop. The contact between this bed and the underlying fine-grained limestone is abrupt and uneven, possibly diastemic.

The next lower bed is made up of seven to eight feet of gray, dense, wavy-bedded, very finely crystalline limestone. A zone of fusulines and stromatoporoids (?) occur on bedding planes near the top. A brachiopod, Meekella, is abundant near the base. Large articulated crinoid stems were found on bedding planes throughout this part of the South Bend Member. One, having a diameter of nearly an inch and a length of nearly two feet, was found at this outcrop.

The lower part of the member occurs below slumped material at the river bed. A current-bedded sandstone occurs at the base at nearby exposures.

The South Bend Member thins abruptly to the south. A typical exposure measured in a little-used public road in the SW¼, SW¼, NE¼, Sec. 28, T. 32 S., R. 14 E., (Correlation section 6, Plate II) consists of three feet of blue-gray, fine-grained, wavy-bedded to slabby limestone containing numerous broken crinoid stems and several varieties of sponges, among them Heterocoelia (?). This limestone grades downward into a pure, fine-grained, current-bedded sandstone; well cemented with calcite. A thin conglomerate occurs at the base. The lime cementation shows whorls and patterns suggestive of an algal origin. Numerous crystalline calcite casts of the small brachiopod, Dielasma, and broken crinoid stems occur throughout the sandstone. The conglomerate contains pebblesor small nodules of impure concretionary limestone presumably from the underlying Rock Lake Member. Total thickness of the sandstone and conglomerate is about five feet.

The thickness and lithology of the member in its thin phase is remarkable constant parallel to the strike of the beds, but undergoes gradational changes to the south very similar to those of the Captain Creek Member.

The upper sponge bearing limestone is a single, dense bed near Wayside and Havana (Correlation section 7, Plate II), but southward, in the vicinity of Caney, it changes to a zone of impure, nodular limestone and disappears. The basal lime-cemented sandstone and conglomerate remain essentially the same and were traced for some distance southwest into Oklahoma. The conglomerate is surprisingly persistent. It has been noted by the writer as far north as Garnett, in Anderson County. The unconformity at the base of the South Bend did not cut below the Rock Lake Member at any place observed by the writer, but the presence of coal fragments in the basal conglomerate near Wayside and

Havana implies destruction of a well indurated part of the previously deposited strata and suggests that the vertical extent of the unconformity was greater than the present evidence indicates.

STANTON DEPOSITIONAL ENVIRONMENT

Correlation

Plate II summarizes graphically the foregoing description of the various members of the Stanton Formation and their relationships. If the illustrated correlations are essentially correct, several interrelated facies are represented by Stanton deposits in the area of investigation.

Offshore Environment

The South Bend is the only member exposed at the surface in the area of essentially normal offshore deposition. An outcrop of this member was measured one and a half miles northeast of Elk City in the SW¼, NE¼, NE¼, Sec. 32, T. 31 S., R. 14 E. (Correlation section 1, Plate II). The section shows 3.3 feet of light gray, wavy-bedded, fossiliferous limestone at the top, grading downward into a 1.9 foot, blue, sandy limestone containing crinoid and echinoid fragments. A 5.4+ foot, lime-cemented, quartzose sandstone occurs at the base.

Reef Environment

Fore-reef Phase. Typical fore-reef deposits are not exposed at the surface in the area of investigation. Bore holes along the top of the formation northeast of Elk City indicate that these beds dip rather steeply to the northwest away from the reef. In this area the Stanton Formation forms a topographic dip slope upon which only the upper surface of the beds are occasionally exposed.

Reef Proper. The Racket Creek section of the Captain Creek Member (Correlation section 3, Plate II) is typical of deposition on and within the reef itself. The top of the member may be the true upper surface of the Captain Creek reef preserved by muds of the Eudora shale which presumably buried the structure, stopping growth. The upper surface is uneven to pitted and borings or trails are abundant in the upper few inches.

The very porous, coarsely crystalline limestone which occurs near the middle of the exposure is apparently part of the reef core. An unidentified coral or stromatoporoid, very similar in appearance to *Actinostroma*, was found at several places in this part of the outcrop.

The massive appearing limestone which makes up a large part of the Captain Creek, Stoner, and South Bend Members in the area immediately north of the Elk River represents a similar but slightly different phase of reef development. The rock appears to be devoid of horizontal bedding, but the limestone exfoliates in thin layers parallel to the face of the outcrop. The resulting concentric laminations strongly suggest progressive colonial growth. Large, dome-like masses weathered out from the face of the outcrop at a number of places (Figs. 1 and 2, Plate III). These structures and the limestone itself are believed to be of organic origin, but the responsible organism could not be identified by the writer. Algal material was observed to occur both above and below the rounded masses in the South Bend Member and it was thought probable that the structures were of similar origin. Well preserved stromatoporoids (?) occur below the reefy limestone in the South Bend Member, but seem to be confined to a single zone and do not make up any appreciable part of the rock.

Back-reef Phase. Immediately adjacent to the shoreward disappearance of the reefy limestone in the Stoner Member, the limestone thins abruptly and is made up entirely of relatively fine-grained, dense, wavy-bedded rock (Fig. 4, Plate III). Articulated or semi-articulated crinoid stems occur abundantly on the bedding planes. This material was deposited as limy mud and fine reef debris in the sheltered water immediately behind the reef proper and was considered to be evidence that the reefs were at that time truly wave resistant masses.

The top of the back-reef limestone dips steeply away from the reef proper. Borings to the top of the South Bend Member about one and a half miles southeast of Elk City, revealed an apparent dip to the south of approximately 11 degrees. True dip

EXPLANATION OF PLATE III

Fig. 1. & Fig. 2. Two views of the rounded organic (?) masses in the reefy limestone of the South Bend Member at the Elk River bridge one and a half miles southwest of Elk City, Kansas. Note the peculiar exfoliation of the seemingly structureless limestone.

Fig. 3. A close-up of a part of the lower left center, Fig. 2, showing the contact between the overlying reefy limestone and the basal fine-grained limestone.

Fig. 4. Back-reef strata of the Stoner Member in the SW¼, NW¼, NW¼, Sec. 16, T. 32 S., R. 14 E., Montgomery County.

PLATE III

Fig. 1

Fig. 2

Fig. 3

Fig. 4

is to the southeast, indicating that the observed component is considerably less than the total or true dip. A steep dip to the east-southeast has been previously mentioned at the top of the Stoner Member in this same area. The inclination of the beds was caused initially by the slope of the back-reef which was subsequently increased by compaction of the deposits during burial and finally slightly lessened by regional tilting to the northwest.

Lagoonal Environment

The back-reef sediments wedge in a shoreward direction into the thin, dense, sponge bearing limestones which were observed at the top of the Captain Creek and South Bend Members (Correlation sections 6, 7, and 8, Plate II). These beds are shallow water, lagoonal deposits. The abnormal thickening of the Eudora shale near Chetopa Creek (Correlation section 6, Plate II) was thought to be largely the result of lagoon filling.

Neritic and Terrestrial Environments

Southward thinning of the Eudora Shale Member resulting from pre-Stoner and Rock Lake erosion, together with the marked thickening of the Rock Lake Member and the presence in it of deltaic or channel sandstones indicates the proximity of a positive area near the Oklahoma border. Similar features of Kansas Citian sedimentation in this vicinity were related by Moore (1949), p. 80, to successive uplift in the area of the Chautauqua

Arch, a pre-Mississippian extension of the Ozark uplift in Southeastern Kansas.

Both the Eudora and the Rock Lake Members represent the seaward flood of clastic sediments initiated by uplift in that area. Pre-Stoner erosion of the Eudora Member may indicate the actual emergence of these beds at the close of Eudora time. Further erosion of the Eudora and Captain Creek Members was accomplished by channeling during the deposition of the Rock Lake sequence. The presence of coal fragments in the basal conglomerate of the South Bend Member near Havana indicates erosion of older sediments and signifies another period of emergence prior to the deposition of the South Bend Member.

Interfingered with the Eudora and Rock Lake deposits are near-shore transgressive sediments of the Captain Creek, Stoner, and South Bend Members. Basal conglomerates characterize the upper two members. Reworked clastic material, firmly cemented by calcium carbonate, comprises the rest of these beds and makes up all of the Captain Creek Member. Subrounded calcitic or quartzose sand grains form the nuclei of the calcareous ooliths of which the Captain Creek is composed and subrounded relatively pure quartzose sand, also indicative of considerable reworking, is a conspicuous constituent of both the Stoner and the South Bend Members.

These sediments were deposited marginally to the area of uplift during periods of relative quiescence or submergence contemporaneous to the development of the reefs in the offshore environment.

A DISCUSSION OF STANTON REEFING

Areal Extent

The distance between definitely non-reefy offshore deposits and back-reef sediments of the South Bend Member, measured across the strike of the reef near Elk City, is about three miles, indicating that the width of the South Bend reef was probably only one and a half to two miles in that area. This was thought to be typical of the other Stanton reefs in the thesis area.

The occurrence of the reefs within a narrow band over a relatively long period of geologic time suggests that the land area to the southeast must have been very stable during periods of quiescence.

The reefy deposition extends northward for a considerable distance along the outcrop of the Stanton Formation. It has been observed to occur continuously from the Elk City area northward to beyond the town of Buffalo, in northeast Wilson County, a distance of more than 35 miles.

Wagner and Harris (1953), and Wagner (1954), describe a sequence of deposition in the Stanton Formation near Fredonia, Kansas, which the writer believes to be typical of the seaward facing elements of the reef complex.

They report the Captain Creek Member in the Fredonia quadrangle to be a fossiliferous, locally coquinoid, and generally massive appearing, thick bedded, vuggy, algal limestone. It commonly forms escarpments that characteristically weather whitish and very cavernous.

The Eudora Member consists of about five feet of greenish gray, fossiliferous shale.

The Stoner limestone Member is described by Wagner and Harris as being a fine-grained, blotchy appearing limestone with coarsely crystalline bodies of nondescript shape appearing on the weathered surface as irregular seams. Medium to coarse crystalline coquinoid limestone, made up entirely of fenestellid bryozoans, crinoid columnals and plates, or pelecypod and brachiopod fragments, comprises thin beds within the Stoner.

The Rock Lake Shale Member consists of about a foot of dark yellowish orange shale which is locally very fossiliferous and calcareous, overlain by a foot of olive gray, unfossiliferous shale.

Wagner and Harris found that the South Bend Limestone Member in the Fredonia quadrangle is a predominantly sandy oolitic limestone. A well developed conglomerate containing limestone and ironstone gravel, and subangular fragments of underlying Rock Lake shale, occurs at the base in some places.

It will be noted that the Captain Creek and Stoner Members in the Fredonia quadrangle are very similar to the same deposits in the area of investigation except for the beds of coquinoid limestone which are not present in the latter area. It should also be noted that Wagner and Harris definitely identify the Captain Creek as being an algal limestone.

Wagner and Harris report a maximum of over 80 feet of

Stanton sediments near the southeast corner of the Fredonia quadrangle. The formation thins to the northwest, and along a line of steep west dip at the northeast corner of the city of Fredonia, the Captain Creek is absent and the thickness of the Stoner and South Bend Members is only five and three feet respectively. West and north of this point the entire Stanton is missing, but it reappears farther west in the subsurface and at the surface to the north. Wagner and Harris attribute the absence of the Stanton to non-deposition resulting from a local contemporaneous structural rise of the basin floor.

The reported abrupt thinning of the limestones along a steep westerly dip is probably due to wedging out of the formation at the reef front. Sharp flanking synclines are a feature of the Stanton reef structure everywhere it was studied. They were present not only at Fredonia, but also at both Elk City and Buffalo, where the synclines were partially mapped by the writer. Pettijohn (1949), pp. 296-299, in his discussion of reefs and reef structures, describes a peripheral sag adjacent to large reefs. This sag is bounded on the side opposite the reef by a reversal of dip which he interprets as the response of the strata to sinking of the heavy reef structure and compensatory upbulging of the surrounding sediments. The contemporaneous structural uplift described by Wagner and Harris may be related to this phenomenon.

The Stanton reef complex may have formed an effective barrier to the seaward distribution of certain fossil forms.

Newell (1937), p. 101, in describing a new species of pelecypod from the cement plant quarry at Fredonia makes the following significant statement:

> A curious fauna occurs in the Stanton limestone (Stoner Member) at Fredonia, Kan. This fauna is unlike that of the same or other formations elsewhere in Kansas in that many of the species and a few genera of invertebrates are unlike those found elsewhere in the Kansas section. It appears likely that this fauna is an exotic one, incorporating elements from some basin that was not ordinarily in free communication with the Kansas area.

It seems probable that this restricted basin may have been the lagoonal basin behind the Stanton reef.

Reef Type

The linear disposition of the reefy sediments within the Stanton Formation and the presence of lagoonal deposits between the reef and the shore indicates that in their final form, and probably during much of their existence as growing structures, the reefs were of the barrier type.

The initial form is not known, however, sandy deposits are present at the base of the South Bend Member throughout the Elk City area and it is possible that reefing, in that member at least, was initiated upon this mantle of clastic sediments.

Fine-grained, wavy-bedded limestone occurs below the coarsely crystalline organic strata at the outcrop of the South Bend Member at the Elk River bridge southwest of Elk City. The contact between the two beds is abrupt and uneven, probably indicating a diastem or unconformity (Fig. 3, Plate III). The lower, fine-grained limestone contains large, articulated, crinoid stems, and was thought to be a back-reef deposit. Apparently the reef formed to seaward and later migrated across its own back-reef sediments as subsidence continued relative to sea level.

Regional Distribution

Reefing in the Stanton Formation may have had very wide distribution. Page (1955), p. 451, in his study of the subsurface geology of Noble County, Oklahoma, describes a limestone which occurs in the stratigraphic position of the Stanton Formation of Kansas.

> This limestone is separated from the overlying Tonkawa sandstone by a shale interval that is usually about 180 feet thick. It is a gray to buff, finely crystalline, dolomitic and sometimes oolitic limestone. This limestone exhibits lateral and vertical changes; for example, in the Otoe City field it is 175 feet thick but is absent immediately west of the producing area. The occurrence of this limestone is very unpredictable and is not believed to be related to structure.

The Tonganoxie Sandstone of Kansas is correlated with the Tonkawa Sandstone of Oklahoma and the underlying 180 feet of shale is apparently the Weston Formation of the Kansas section which immediately overlies the Stanton Formation. The area described is adjacent to the Nemaha Ridge in north central Oklahoma.

Grimes (1955), p. 129, describes an abrupt facies change from limestone to shale along the shelf area adjacent to the Anadarko basin in the Oklahoma Panhandle and suggests that ideal reef-building conditions prevailed in that area throughout middle Pennsylvanian time.

These widespread occurrences may be merely coincidental, or they may be indicative of contemporaneous reefing adjacent to more or less stable land areas throughout the middle Pennsylvanian. If future study should prove the latter condition to be true, the possible economic significance of the reefs as potential petroleum reservoirs is readily apparent.

SUMMARY AND CONCLUSIONS

A positive area, probably a low land mass, existed in the vicinity of the Oklahoma border in southeast Kansas during all of Stanton time. This emergent area occupied the same general position as the older Chautauqua Arch, a pre-Mississippian extension of the Ozark Uplift.

At the beginning of Stanton deposition, this land area was quiescent to gently subsiding. A linear reef formed a few miles off shore and subsequently built upward to sea level, forming a true barrier reef. Sponges flourished in the shallow lagoon behind the reef. As the circulation of the lagoon became more restricted and the water more highly charged with calcium carbonate, oolite was deposited in the shallow, agitated zone near the shore. Captain Creek deposition ended as the source area became moderately positive causing a flood of muddy sediment which overflowed the lagoon and eventually buried the reef itself.

As uplift continued much of the area became emergent and part of the previously deposited Eudora shale was eroded before the Stanton seas again encroached on the land area and Stoner deposition began.

A Stoner organic reef developed in approximately the same vicinity as the preceding Captain Creek reef and probably again became a true barrier. A fossiliferous conglomerate and organic breccia was deposited in the zone between the reef and the shore.

This period of relative quiescence was ended by a sharp uplift, apparently of greater magnitude than that marking Eudora time. A considerable thickness of Rock Lake sediments were laid down in the area adjacent to the Oklahoma border during the middle part of the Rock Lake deposition but erosion again became the dominant process as the entire area was lifted above sea level before the end of Rock Lake time.

The shore line again receded to the south as the source area became quiet and sandy deposits were reworked and redeposited as basal South Bend sediments. Reef-building organisms once again became established as conditions of depth, temperature and clarity of water became favorable and a barrier reef developed in much the same area and fashion as the preceding Captain Creek and Stoner reefs.

Stanton deposition ceased in this vicinity with the gradual uplift of the source area and the washing of muddy sediments into the lagoon and eventually over the reef itself.

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APPENDIX

LOCAL STRATIGRAPHIC SECTIONS

Section 1

Measured in a feed lot and stream bank north of a shallow abandoned quarry in the SW¼, NE¼, NE¼, Sec. 32, T. 31 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	<u>South Bend Member</u> (10.6+ ft.)	
3.	Limestone; light gray; wavy-bedded. Contains calcite veinlets and limonite filled vugs. Brachiopods, bryozoans, horn corals and crinoid fragments...	3.3
2.	Limestone, sandy; blue-gray. Crinoid columnals and echinoid spines	1.9
1.	Sandstone, quartzose, medium-grained, calcite cemented; blue-gray, weathers red-brown. Upper part contains algal whorls and shows some trails or burrows. The sandstone is massive, no current bedding apparent	5.4

Base covered in stream. Nearly complete section measured.

Section 2

Measured in a running section along the west backslope of a winding county road near Racket Creek in the NE¼, NE¼, NW¼, Sec. 31, T. 31 S., R. 15 E., Montgomery County.

Bed	Description	Thickness (feet)
	<u>Stoner Member</u> (incomplete)	
6.	Limestone, crystalline; wavy-bedded. Very fossiliferous. Base may be slumped.................	3.0

Section 2 (Continued)

Bed	Description	Thickness (feet)
	Eudora Shale Member (5.4 to 8.2 ft.)	
5.	Shale, silty; gray to dark gray. Abundant brachiopods, crinoid stems and bryozoans. Thickness variable. Thins to 5.4 ft. about 1,000 ft. northwest..	8.2
	Captain Creek Member (57.1 ft.)	
4.	Limestone; light gray; mostly fine grained with fine calcite veinlets and crystalline masses. Upper surface rough to pitted, shows numerous borings or trails. A zone of fusulines about o.5 ft. below base and another about 1.0 ft. above base. The rest of the rock is sparsely fossiliferous, contains broken crinoid stems and echinoid spines....................................	24.9
3.	Limestone; mainly very coarsely crystalline calcite (some crystal masses exceeding 2 inches) with some finer grained gray or reddish gray matrix. Very porous with abundant voids filled with soft orange limonite. Bedding obscure to absent. A few broken crinoid stems and large Stromatoporoids(?)	15.0
2.	Limestone, similar in appearance to above except more dense. Bedding present but obscure. Makes good outcrop. Base slumps badly. Fossiliferous....	17.2
	Lane-Vilas Shale	
1.	Shale, gray. Mostly covered.	

Section 3

Measured 20 ft. east of Elk River Bridge about one mile southwest of Elk City, Kansas, in the SW¼, NW¼, NE¼, Sec. 18, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	South Bend Member (27.3+ ft.)	
3.	Limestone, crystalline; light gray; wavy-bedded to slabby. Slightly oolitic. Numerous crinoid columnals..	7.4

Section 3 (Continued)

Bed	Description	Thickness (feet)
2.	Limestone, crystalline; soft, porous; massive, exfoliates in thin layers parallel to face of exposure. Large 6 to 8 ft. knobs or masses protrude several feet from the face of the outcrop......	13.0
1.	Limestone, fine-grained, dense; medium gray; wavy-bedded. Numerous large articulated crinoid stems on bedding planes. A zone of fusulines and Stromatoporoids (?) near top. Meekella striata-costata abundant in middle..........................	6.9
	Base below water level. Pipes from Corps of Engineer measuring station probably extend from underlying shale in stream bed.	

Section 4

Measured in cliff section in west valley wall of the Elk River on Linn farm in the NE¼, NW¼, SW¼, Sec. 14, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	South Bend Member (incomplete)	
6.	Limestone; platy to slabby; sandy in lower part......	2.0
5.	Sandstone; conglomeritic at base....................	1.0
	Rock Lake Member (0.3 ft.)	
4.	Shale, gray. Absent nearby..........................	0.3
	Stoner Member (33.0 ft.)	
3.	Limestone, crystalline; gray; slabby to flaggy. Contains abundant algal (?) veinlets................	6.0
2.	Limestone, coarsely crystalline; light gray; very porous with much limonitic material in vugs. Joints widely spaced, no horizontal partings. Exfoliates in thin layers parallel to the face of the outcrop...	27.0

Section 4 (Continued)

Bed	Description	Thickness (feet)
	Eudora Shale Member (11.0 to 14.0 ft.)	
1.	Shale, limy; gray. Mostly covered. Maximum interval..	14.0

Section 5

Measured below east abutment of the Elk River Bridge on U. S. 160 Highway in the SW¼, NE¼, SW¼, Sec. 14, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Captain Creek Member (33.3+ ft.)	
4.	Limestone, crystalline; light gray; slabby.........	5.8
3.	Limestone, coarsely crystalline; light gray; bedding present but obscure......................	12.5
2.	Shale, limy; gray-green; partly covered...........	7.0
1.	Sandstone, gray, platy............................	8.0+
	Base occurs below stream bed.	

Section 6

Measured in the east backslope of a county road in the SW¼, NW¼, NW¼, Sec. 16, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Rock Lake Member (incomplete)	
4.	Shale, gray, weathered............................	1.0+
	Stoner Member (14.3 ft.)	
3.	Limestone, crystalline; gray. Contains algal (?) striations or veinlets...........................	2.3

Section 6 (Continued)

Bed	Description	Thickness (feet)
2.	Limestone, crystalline; wavy-bedded. Abundant semi-articulated crinoid columnals on bedding planes..	12.1
	Eudora Shale Member (incomplete)	
1.	Shale, limy; gray. Brachiopods (Derbyia), abundant fusulines and crinoid stems...............	5.3+
	Base covered.	

Section 7

Measured in east backslope of a little used public road in the SW¼, SW¼, NE¼, Sec. 28, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Weston Shale (incomplete)	
4.	Shale, clayey; gray-green. Contains large, flat limonite concretions................................	2.0+
	Stanton Formation South Bend Member (7.5 ft.)	
3.	Limestone, dense, finely crystalline; blue-gray; wavy-bedded, weathers slabby. Contains numerous broken crinoid columnals and sponges in the upper part....	3.0
2.	Sandstone, quartzose, calcite cemented in upper part, lower part current-bedded; blue-gray, weathers reddish-brown. Conglomeritic at base. Conglomerate contains pebble and nodules of yellow, impure limestone and numerous broken crinoid stems. The sandstone contains calcite filled casts of the brachiopod Dielasma...........	4.5
	Rock Lake Member (incomplete)	
1.	Shale, clayey; gray-green........................	3.0+
	Base covered.	

Section 8

Measured in the south wall of the Elk Valley in the SE¼, SE¼, NW¼, Sec. 17, T. 32 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	<u>South Bend Member</u> (25.5 ft.)	
6.	Limestone, slabby to platy	4.5
5.	Limestone, coarsely crystalline; joints and bedding absent or widely spaced. Exfoliates parallel to exposure face	12.5
4.	Limestone, sandy near base; massive, weathers wavy-bedded. A current-bedded sandstone occurs at the base nearby	8.5
	<u>Rock Lake Member</u> (5.2 ft.)	
3.	Shale; gray-green (dug out)	5.2
	<u>Stoner Member</u> (16.0 ft.)	
2.	Limestone; gray; wavy-bedded. Crinoid stems on bedding planes. Nearly entire section exposed	16.0
	<u>Eudora Shale Member</u> (incomplete)	
1.	Shale, limy; gray-green. Exposed in north bank of the Elk River north of this section	4.0+

Base covered.

Section 9

Measured in a running section along a township road in the SW¼, SE¼, Sec. 28, T. 32 S., R. 14 E., Montgomery County.

Section 9 (Continued)

Bed	Description	Thickness (feet)
	South Bend Member (6.9 ft.)	
9.	Limestone, dense; wavy-bedded; blue-gray. Crinoid stems, brachiopods and echinoid spines. Sandy in lower part, grades downward into bed 8..............	3.7
8.	Sandstone, coarse grained, upper part limy, lower part limonite cemented. Ripple marked. Conglomeritic at base................................	3.2
	Rock Lake Member (17.0 ft.)	
7.	Shale, silty; gray-green............................	7.3
6.	Limestone, nodular, impure..........................	0.4
5.	Shale, gray-green; conchoidal fracture..............	5.6
4.	Limestone, nodular, impure..........................	0.8
3.	Shale, gray-green...................................	2.9
	Stoner Member (3.5 ft.)	
2.	Sandstone, calcite cemented; very dense; light tan-gray, weathers tan..............................	3.5
	Eudora Shale Member (60+ ft.)	
1.	Shale, dark gray to gray, blocky....................	10.0+
	Rest covered, interval exceeds 60 ft.	

Section 10

Projected from bore holes on the Hellwig farm in the NW¼, NW¼, Sec. 36, T. 32 S., R. 14 E., Montgomery County.

	Stoner Member (2.0+ ft.)	
3.	Sandstone, fine grained, tan........................	2.0

Section 10 (Continued)

Bed	Description	Thickness (feet)
	Eudora Shale Member (74.0 ft.)	
2.	Shale, silty; gray	71.5
1.	Shale, carbonaceous; black; platy	2.5
	Stopped on the top of the Captain Creek Member.	

Section 11

Measured along the south backslope of a county road in the SE¼, NE¼, NW¼, Sec. 36, T. 32 S., R. 14 E., Montgomery County.

	Captain Creek Member (9.0 ft.)	
3.	Limestone, dense, blue-gray	2.0
2.	Shale, limy, gray	4.0
1.	Sandstone, platy, gray	3.0
	Underlain by Lane-Vilas Shale.	

Section 12

An unpublished section by N. D. Newell from the files of the Kansas Geological Survey at Lawrence. Only the Stanton portion of the section is given. Measured in the SW Cor. Sec. 29 and the SE Cor. Sec. 30, T. 34 S., R. 15 E., Montgomery County.

	(Rock Lake Member, incomplete)	
6.	Cross-bedded sandstone	15.0+
5.	Whitish papery sandy shale and thin sandy oolite with *Myalina* and *Worthenia*	5.5

Section 12 (Continued)

Bed	Description	Thickness (feet)
	(Stoner Member, 5 ft.)	
4.	Sandy limestone, interbedded with coarse sandstone (conglomeritic at base). Molluscs............	5.0
	(Eudora Shale Member, 10 ft.)	
3.	Dark gray clay (shale) with large phosphate concretions....................................	10.0
	(Captain Creek Member, 3 to 10 ft.)	
2.	Dark gray, cross-bedded oolitic limestone with *Enteletes*.....................................	3 to 10
	(Lane-Vilas Shale, incomplete)	
1.	Clay shale, covered.	

Note: The parenthetical notations are the present writer's.

Section 13

A core drill sounding drilled by Joseph Martin at a proposed quarry site in the SW¼, SE¼, Sec. 30, T. 34 S., R. 15 E., Montgomery County.

	Rock Lake Member (incomplete)	
4.	Sandstone, poorly cemented with limonite; brown. A few thin shaly partings..........................	16.9
	Eudora Shale Member (2.0 ft.)	
3.	Shale, clayey, gray..............................	2.0
	Captain Creek Member (17.9 ft.)	
2.	Limestone, oolitic; calcite cemented; very hard; light tan to gray; fossiliferous. Shale particles in lower 3 ft. become more numerous near base (conglomeritic)....................................	17.9

Section 13 (Continued)

Bed	Description	Thickness (feet)
	Lane-Vilas Shale (incomplete)	
1.	Shale, silty, gray....................................	2.1
	Stopped in same.	

Section 14

Measured in the banks and stream bed of Hafer Run in the NW¼, NE¼, Sec. 4, T. 33 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Rock Lake Member (incomplete)	
5.	Sandstone, fine-grained, subangular, soft limonite cementation; orangish white. Current-bedded. Some fossil fragments................................	10.0+
	Stoner Member (1.0 ft.)	
4.	Conglomerate and fossil breccia. Contains large orthocone cephlapod, Chonetes, Bryozoa, and crinoid stems..	1.0
	Eudora Shale Member (12.3 ft.)	
3.	Shale, carbonaceous; black; fissile. Numerous phosphate concretions..................................	2.3
2.	Shale, silty; gray. Numerous sponges (Heterocoelia)...	10.0
	Captain Creek Member (incomplete)	
1.	Oolite, forms stream bed upstream from section.	

Section 15

A core drill sounding drilled in the SE¼, SE¼, NW¼, Sec. 1, T. 35 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Rock Lake Member (incomplete)	
8.	Shale, gray, with thin, calcite cemented, sandstone lenses throughout..............................	52.1
7.	Sandstone, stained................................	8.1
6.	Shale, gray..	7.5
	Stoner Member (4.1 ft.)	
5.	Sandstone, gray, fossiliferous....................	4.1
	Captain Creek Member (3.9 ft.)	
4.	Oolite...	0.5
3.	Shale, gray..	1.7
2.	Oolite...	1.7
	Lane-Vilas Shale (incomplete)	
1.	Shale, gray..	4.3
	Stopped in same.	

Section 16

Measured in a small quarry about a half mile north of Round Mound in the SE¼, SW¼, NW¼, Sec. 8, T. 34 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Weston Shale (incomplete)	
7.	Shale, limy; tan to green.........................	3.0+

Section 16 (Continued)

Bed	Description	Thickness (feet)
	Stanton Formation South Bend Member (5.0 ft.)	
6.	Limestone; gray, weathers yellow. Unit bedded, some tendency to weather flaggy in lower 0.6 ft. Contains abundant sponges, some brachiopods (Dielasma), and broken crinoid stems................	1.1
5.	Shale, limy; tan..................................	0.6
4.	Limestone, sandy or sandstone, lime cemented; gray to blue-gray; unit bedded but develops partings after weathering..................................	2.4
3.	Shale parting....................................	0.2
2.	Sandstone, conglomeritic, well cemented; gray weathers brown. The conglomerate contains limonite concretions and some coal particles. Fossils include molluscs, bryozoans and much broken fossil material, especially crinoid stems..................	0.7
	Rock Lake Member (incomplete)	
1.	Shale, silty; gray-green............................	1+

Section 17

Measured in a small quarry about 60 ft. west of a culvert on a county road in the SE¼, NE¼, SE¼, Sec. 1, T. 35 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	Weston Shale (incomplete)	
3.	Shale, limy; gray. Contains numerous crinoid stems and several varieties of gastropods.................	5.0+

Section 17 (Continued)

Bed	Description	Thickness (feet)
	<u>Stanton Formation</u> <u>South Bend Member</u> (4.9 ft.)	
2.	Sandstone, lime-cemented, current bedded. Conglomeritic at base. Fossiliferous..................	4.9
	<u>Rock Lake Member</u> (incomplete)	
1.	Shale, gray....................................	3.0+
	Rest covered.	

Section 18

A composite section from outcrops and bore holes in the NW¼, NW¼, NW¼, Sec. 36, T. 33 S., R. 14 E., Montgomery County.

Bed	Description	Thickness (feet)
	<u>Rock Lake Member</u> (incomplete)	
6.	Sandstone, red-brown; slightly conglomeritic........	1.5+
5.	Shale, gray, with several thin sandstone zones......	1.1
	<u>Stoner Member</u> (2.2 ft.)	
4.	Fossil breccia, lime-cemented. Contains brachiopods, bryozoans, and crinoid fragments..............	2.2
	<u>Eudora Shale Member</u> (13.0 ft.)	
3.	Shale, clayey; dark blue-gray; numerous bleached phosphate nodules.................................	13.0
	<u>Captain Creek Member</u> (incomplete)	
2.	Limestone, impure; yellow. Contains numerous sponges, especially <u>Heterocoelia</u> (?)................	1.0
1.	Shale, gray. Contains numerous thin calcite cemented sandstone zones..........................	15.0+
	Stopped in same.	

BARRIER REEFS OF THE STANTON FORMATION (MISSOURIAN)
IN SOUTHEAST KANSAS

by

FRANK WARREN WILSON

B. S., Kansas State College
of Agriculture and Applied Science, 1951

AN ABSTRACT OF A THESIS

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An abrupt change of facies from limestone to sandstone and shale lithology occurs in many Missourian formations near the Oklahoma border in Southeast Kansas.

The Stanton limestone, a typical Missourian formation, was studied in this area in an attempt to correlate the various phases of deposition.

During the progress of the investigation, reefy deposits were recognized in all of the limestone members of the Stanton in the vicinity of Elk City, Kansas.

The purpose of this paper is to describe the stratigraphy of the Stanton Formation and to relate the occurrence of the reefs to the other phases of Stanton deposition in the area of investigation.

General reconnaissance and measurement of typical rock exposures were augmented by structural mapping and numerous shallow power auger and core drill soundings.

These studies revealed that the limestone members of the Stanton changed abruptly in a southward direction from a maximum total thickness of more than 100 feet of reefy limestone to a minimum total thickness of less than 15 feet of sponge-bearing limestone, lime-cemented sandstone or oolite and fossil breccia or conglomerate. The Eudora Shale Member thickened abruptly from five feet in the reefy area to near 75 feet only a few miles behind the reefy deposits and then thinned southward due to erosion at the base of overlying Stoner and Rock Lake strata. The Rock Lake Member was found to thicken from only a few inches in the reef area to more than 60 feet near the Oklahoma line. A thick deltaic or channel sandstone is present in the Rock Lake of that vicinity.

The Stanton deposits in the area of investigation were believed to represent four sedimentary environments: offshore, reef, lagoonal and neritic-terrestrial. The reefs were found to extend at least 35 miles to the northeast from the area of study and were shown to be of the barrier type.

The various phases of deposition including the reefs, can be related to the existence of a previously described positive area which occupied the same general position as the Chautauqua Arch, a pre-Mississippian extension of the Ozark uplift in southeast Kansas.