THE STRATIGRAPHY AND PHYSICAL CHARACTERISTICS OF THE SIMPSON GROUP

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THE STRATIGRAPHY AND PHYSICAL CHARACTERISTICS OF THE SIMPSON GROUP

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With Descriptions and Illustrations of
Ostracodes and Conodonts
By
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THE STRATIGRAPHY AND PHYSICAL CHARACTERISTICS OF THE SIMPSON GROUP[1]

by

Charles E. Decker

INTRODUCTION

In contrast with the supposed uniformity of the Arbuckle limestone the Simpson has been recognized as an extremely variable formation. It consists not only of many large limestone, sandstone, and shale members, but also of large bodies of rock in which thin limestones and shales alternate in rapid succession, and at some horizons sandstones alternate with shales. Among the limestones a very distinctive type occurs in the eastern and central parts of the Arbuckle Mountains and at the north end of the Criner Hills. The major part of this limestone is dense but contains scattered calcite crystals which give it a birdseye-like appearance. A similar body of limestone does not occur elsewhere in the Arbuckle Mountain section. Below these dense limestones, dolomites occur only in the eastern part of the region. Not only are there very numerous and marked variations in the physical characteristics of the Simpson from bottom to top, but there are also numerous physical changes laterally with gradations from one type of rock into another. Some members are very constant for long distances, while others have only local distribution. In like manner, there are marked faunal changes not only from bottom to top but also laterally. While some of the faunas are widespread others are local in their development. This local distribution seems to represent two different phases of faunal history. First, one in which the fauna in one part of the region grades laterally into another fauna. Second, a type of history in which fauna and formation including it have local distribution, so that a fauna in one part is represented by a hiatus in another part. Also, locally there seems to be a commingling of older and younger faunas. What is true of the irregularity of the distribution of faunas is also true of species. While some species are found practically from one end of the mountains to the other, other species have very limited distribution so far as our present knowledge goes. In fact, a few species have been found in a single limited outcrop, though associated with forms of wider geographic range. Some species occur in small numbers and sparsely scattered, while others occur assembled in countless millions.

1. Named for a former old town near the northern edge of Johnston County at about the present site of Pontotoc.

The economic importance of the Simpson is in marked contrast with that of the Arbuckle. The value of the latter has been limited largely to the production of road metal and until recently in supplying a horizon on which to stop the drill; the value of the former lies in a minor degree in supplying glass sand and asphalt, but primarily in containing in its sand bodies some of the most important oil horizons in the State.

While the Simpson varies greatly in its numerous outcrops, there has been no attempt heretofore to study it in all these outcrops and differentiate the parts in the various regions. In all of its outcropping phases, it has generally been customary to refer to them simply as "Simpson limes", "Simpson sands", or "Simpson shales" without any attempt to separate them in a systematic manner or to correlate the parts represented in the different regions.

Because of the vital and widespread interest in the Simpson, it is the purpose to show the distribution of its outcrops, describe its topography, drainage, and structure;; raise it to the position of a group; divide it into five formations in consonance with the faunal succession and the sedimentary cycles, note their distribution and more important physical changes, horizontally and vertically; note the physical and chemical characteristics of the rocks; list and illustrate a few of its characteristic megascopic and microscopic fossils; show some photo-micropgraphs of rock textures; give the age and correlation of the formations; give the results of the study of a number of detailed sections, and reproduce in a graphic table a number of these sections; note the unconformities and hiatuses below, within, and above the Simpson; and indicate the general direction from which the terrigenous materials were received, hoping thus in as brief compass as possible to show the more salient features of the Simpson in its outcrops.

ACKNOWLEDGEMENTS

Grateful recognition is given to Dr. E. O. Ulrich for assistance in plans for subdividing the Simpson into formations and for work on its faunas, to Dr. Rudolf Ruedemann for identifying graptolites and for supplying illustrations, and to Dr. August F. Foerste for identifying cephalopods. Much credit is due to Rex McGehee for efficient assistance in measuring sections and collecting fossils, for painstaking work in the identification of fossils, and, especially, for his competent work with the able assistance of Everett Orr in making most of the new geologic map of the Arbuckle Mountains; and to C. L. Cooper for mapping in great detail the Woodford, Welden, and Sycamore formations, and for making the structure sections for the new geologic map. Acknowledgment is also made to Norval Ballard and Ross Maxwell for efficient assistance in the field, to Wayne Beardsley for assistance in mapping, to R. W. Harris for identification and description of ostracodes and conodonts, to L. I. Price for making drawings, to Ray L. Six and J. W. Stovall for taking photographs of fossils, and to Maude McMorris and W. A. Carruth for making the base for the new geologic map, for working out the mechanical details of that map, and for making a stratigraphic section.

EARLIER PUBLICATIONS

The more important previous articles which relate as a whole or in part specifically to the Simpson are listed below.

1. Taff, J. A., U. S. Geol. Survey Geol. Atlas, Atoka folio (No. 79), p. 3, 1902.
2. Taff, J. A., and Ulrich E. O., U. S. Geol. Survey Geol. Atlas, Tishomingo folio (No. 98), p. 3, 1903.
3. Taff, J. A., and Ulrich E. O., U. S. Geol. Survey Prof. Paper 31, pp. 23-25, 1904, (Reprinted as Oklahoma Geol. Survey Bull. 12, 1928).
4. Buttram, Frank, The glass sands of Oklahoma: Oklahoma Geol. Survey, Bull. 10, pp. 43-76, 1913.
5. Trout, L. E., The geology and paleontology of the Simpson formation: Unpublished thesis, University of Oklahoma, 1913.
6. Edson, Fanny C., Notes on the Simpson formation, Oklahoma: Am. Assoc. Petroleum Geologists Bull. vol. 7, pp. 558-564, 1923.
7. White, Luther, Subsurface distribution and correlation of the pre-Chattanooga ("Wilcox" sand) series of northeastern Oklahoma: Oklahoma Geol. Survey Bull. 40, vol. 1, pp. 23-32, 1928.
8. Levorsen, A. L., Geology of Seminole County: Oklahoma Geol. Survey Bull. 40, vol. 3, pp. 307-312, 1928.
9. Cram, Ira H., Early Paleozoic stratigraphy of Wichita Mountain uplift, Oklahoma: Am. Assoc. Petroleum Geologists Bull. vol. 14, pp. 623-626, 1930.
10. Weirich, T. E., The Simpson of central Oklahoma: Am. Assoc. Petroleum Geologists Bull. vol. 14, Dec., 1930.
11. Charles, Homer, H., The Oklahoma City pool: Am. Assoc. Petroleum Geologists Bull. vol. 14, Dec., 1930.
12. Decker, C. E., A preliminary paper on the Simpson group of the Arbuckle and Wichita Mountains, Oklahoma: Am. Assoc. Petroleum Geologists Bull. vol. 14, Dec., 1930.

The chief papers on rocks that outcrop elsewhere in Oklahoma which probably represent some part of the Simpson are given below.

1. Taff, J. A., and Ulrich, E. O., U. S. Geol. Survey Geol. Atlas, Tahlequah folio (No. 122), p. 2, 1905.
2. Dake, C. L, The Problem of the St .Peter sandstone: Missouri Univ. School of Mines and Met., Bull., Tech. ser. vol. 6, No. 1, pp. 1-225, 30 pls., August, 1921.
3. Honess, C. W., Geology of the southern Ouachita Mountains of Oklahoma: Oklahoma Geol. Survey Bull. 32, Pt. 1, pp. 36-87, 1923.
4. Cram, Ira H., Cherokee and Adair Counties, Oklahoma: Oklahoma Geol. Survey Bull. 40, vol. 3, pp. 534-538, 1930.

DISTRIBUTION

As the Simpson is exposed for only a few square rods in two of the hills south of Gotebo at the north edge of the Wichita Mountains, its outcrops are limited almost wholly to the Arbuckle Mountains and the neighboring Criner Hills to the south (Pl. I).

In the Arbuckle Mountains the Simpson outcrops from a point two miles east of Tatums southeastwardly for 35 miles nearly to the town of Ravia, occupying a narrow strip varying from two-fifths of a mile to a mile in width. A narrow faulted strip extends for 12 miles northwest from Dougherty. A small outcrop occurs 5 miles southeast of Davis, and a small area occurs on the north side of the West Timbered Hills. About five square miles outcrop around the Nebo store; large areas south and east of Sulphur, at Hickory, and a small area east of Hickory on the Arbuckle plateau; a long strip in the vicinity of Roff and eastward to a point a short distance south of Franks; a large area east of Pontotoc and Connerville, and small areas southeast and west of the site of the old town of Viola, which was about 4 miles southwest of Bromide; at the north end and at Rock Crossing of Hickory Creek in the Criner Hills. Along the northern edge of the Wichita Mountains about 86 feet of the Simpson are exposed near the base of two of the monadnocks about six miles south of Gotebo. (See base, Pl. I).

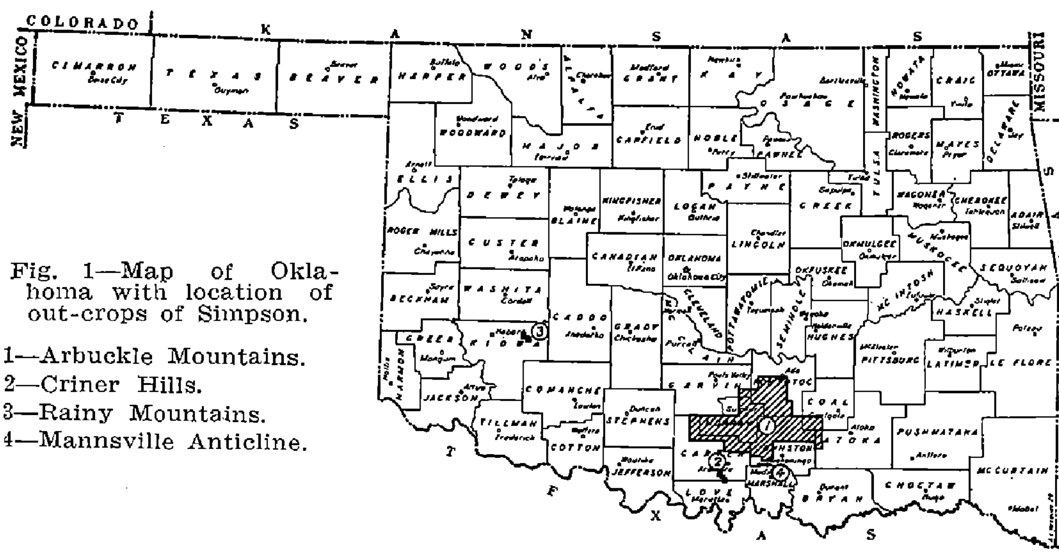


Fig. 1—Map of Oklahoma with location of out-crops of Simpson.

1—Arbuckle Mountains.
2—Criner Hills.
3—Rainy Mountains.
4—Mannsville Anticline.

TOPOGRAPHY AND DRAINAGE

The rocks of the Simpson are in general less resistant than the Arbuckle limestone below or the Viola limestone above, due to the presence of large amounts of shale and poorly indurated sandstones and, in most localities, the Simpson limestones have not proved to be very resistant to weathering. Accordingly, the Simpson generally forms either a flat featureless plain, often largely covered by loose sand or thin slabs of limestone, or a relatively low area between the more resistant Viola and Arbuckle limestones. Usually the gradation from the basal Simpson into the Arbuckle is a very gentle one with only a few feet of escarpment at most between them. On the other hand the Viola hills generally rise abruptly above the upper part of the Simpson, though in many localities the resistant upper Simpson limestones are included in the slopes with the Viola. Locally some of the major sandstones of the Simpson have become more completely indurated and as a result rise as rather abrupt ridges above the adjacent weaker rocks. Particularly is this true of the sandstone at the base of the McLish in the western part of the Arbuckle Mountains east of Pooleville, and at the extreme southeast on the east side of the Robertson ranch south of Bromide. Locally, also, the limestones of the Oil Creek formation form a low rounded ridge which is well developed half a mile west of Highway 77, two and one-half miles north of Springer. A different type of topography may be seen in the eastern part of the mountains two miles southwest of the town of Franks and on the east side of Delaware Creek northwest of Bromide. There high hills of Simpson occur with steep westward slopes with local development of abrupt scarps of heavy bedded birdseye-like limestone and in some places of resistant dolomites. On the west side of Delaware Creek four beautiful monadnocks in an almost east-west alignment extend several miles westward to the vicinity of the Coatsworth School. These monadnocks are capped, in one case with heavy beds of birdseye-like limestone, and in the others with resistant massive dolomites. These monadnocks together with the line of hills to the east doubtless represent the eastward extension of the peneplain which is so markedly developed at about 1,000 feet above sea level in the western part of the Arbuckle Mountains.

No special type of drainage is characteristic of the Simpson other than that it is drained largely by streams which rise in other formations and cross its numerous outcrops in various places. Even most of the permanent small tributary streams which may flow for several miles across Simpson rocks, as a rule find their head waters in adjacent formations. Delaware Creek and some of its upper tributaries are exceptions, as they rise within the Simpson plain east of Pontotoc, thousands of acres of which are covered by the birdseye-like limestone of the Simpson instead of the Viola which is shown on the state geological map.

STRUCTURE

In general the Simpson is structurally related to the major uplifts of the Arbuckle and Wichita Mountains. In the Arbuckles elevation and extensive erosion have exposed a large area of coarsely crystalline granite in the eastern part of the mountains and two much smaller areas of quartz-porphyry at the northwest portion in the East Timbered Hills and West Timbered Hills. Granitic rocks constitute the main mass of the Wichita Mountains though a minor amount of porphyry is present. As a rule the Simpson dips away from the older rocks surrounding these igneous masses. However, a number of major folds occur in which no igneous rocks are exposed, and these, generally, together with a number of large faults, control the dips in several of the outcrops of the Simpson.

The major folds in the Arbuckle Mountains are the Arbuckle[2], Tishomingo, Belton, Hunton, and Lawrence anticlines, and Washita, Mill Creek, Franks, and Wapanucka synclines, and and Dougherty Basin.

Besides the major structures several folds of a second order have been developed. At the north edge of Woodford, a sharp asymmetrical anticline, which is slightly overturned, has been eroded so that the Simpson has been shifted southward in the outcrop in its crest for about half a mile. To the northeast of this fold another larger transverse fold called the Plateau anticline[3] also affects the Simpson by shifting the Arbuckle contact southward into it for half a mile. In a northward plunging anticline one and three-fourths miles northwest of Dougherty and one and one-fourth miles south of Falls Creek, the Simpson has been exposed in an area generally mapped as Viola. In a similar still larger anticline the Simpson is exposed between Viola ridges on the north side of Lick Creek about 5 miles southwest of Davis. On the east side of the Washita River, about 5 miles southeast of Davis, the Simpson is exposed in an elongate area on the eroded crest of an anticline. About 8 miles southeast of Sulphur and 5 miles northeast of Nebo the base of the Simpson is very much folded and complexly faulted in its contact with the Arbuckle. The Simpson is exposed at the north edge of Bromide in the crest of an eroded anticline.

Still smaller folds of the third order, intraformational in character, are to be found within the Simpson, especially in the thin limestones about 2 miles northeast of Woodford and about half a mile south of Big Canyon, or Crusher, on the east side of the Washita River. These small folds give a graphic index of

2. Reeds, C. A., Oklahoma Geol. Survey Bull. 3, pp 43-44, 1910.
3. Decker, C. E., Pan-American Geologist, vol 46, p 191, Oct. 1926

the type of movements in the relatively incompetent Simpson with its alternating thin limestones and shale between the more competent Arbuckle and Viola limestones below and above it. Some small, more open folds occur in the heavy bedded birdseye-like limestone of the McLish formation about 3 miles east and northeast of Pontotoc.

The larger faults, which in general have a northwest-southeast trace for 15 or 20 miles, affect the outcrops of the Simpson in many localities. Smaller faults cut the Simpson about 5 miles northeast of Woodford;; at the north edge of the West Timbered Hills; about 4 miles southwest of Davis; about 2 to 7 miles south and southeast of Sulphur; 4 miles east of Pontotoc; and in the Criner Hills. Still smaller faults with offsets of only a few feet affect the Simpson in many localities, but one of the most noteworthy is in the lower limestones on the west side of Henryhouse Creek about 5 miles northeast of Woodford.

The dip of the Simpson varies greatly in the different regions. Generally in the eastern, northern, and central parts of the Arbuckle Mountains the dips are low, where over wide areas they are 12 degrees or less, but locally they reach 30 degrees. On the south side of the mountains from Ravia westward to a point about 5 miles west of the Washita River, the dip varies from about 70 to almost 90 degrees; at Highway 77 the dip is 55 and it decreases westward to about 25 and 30 degrees. Northwest of Dougherty the dips are high, where locally the Simpson is slightly overturned. At the north side of the West Timbered Hills the dip varies from 32 to 68 degrees; at the north end of the Criner Hills, 70 degrees; and at the south end, 45 degrees. At the north side of the Wichita Mountains, south of Gotebo, the dip is 18 degrees.

Jointing does not seem to be as well developed in the Simpson as it is in the Arbuckle below or in the Viola above, though locally joints are well developed in the heavy bedded limestones in the eastern part of the Arbuckle Mountains and in the well indurated parts of the sandstone. Locally joints may be seen well developed in the thin limestones as at the south end of the Criner Hills (Pl. XII A).

STRATIGRAPHY

As indicated above, the Simpson is here raised to the position of a group and divided into five formations representing five more or less complete sedimentary cycles with a basal sand at the bottom of each of the four upper ones and a conglomerate at the base of the lowest one. The names of these formations, beginning with the oldest, are as follows: Joins, Oil Creek, McLish, Tulip Creek, and Bromide. (See Table II). A seven-partate division has been used during part of this study and the two additional formation names temporarily used are Falls Creek and Criner. Briefly, these two formation names were used and later discarded for the following reasons: the McLish has a distinctive though rather limited fauna the major part of which has been traced to the region a short distance south of Sulphur, and it was then thought that the McLish was not represented in the western part of the mountains, and the name Falls Creek was used for the formation in this western region, between the Oil Creek and Tulip Creek formations. But, because the marked lower cystid zone, which occurs a short distance above the second sandstone called "Burgen" along Highway 77, extends eastward and ties in with the McLish fauna at Roff, in the region east of Sulphur, and at the Bell School house two and one-half miles northwest of Connerville, it is thought that the body of rocks temporarily named Falls Creek is approximately equivalent to the McLish to the east. Further confirmation of this view is found at the north edge of the Criner Hills, where, beneath the lower cystid zone, occur 85 feet of birdseye-like limestone which is so characteristic of the McLish of the eastern part of the mountains, and in it are found ostracodes and gastropods which occur in the birdseye-like beds of the eastern region. Furthermore, this birdseye-like rock of the Criner Hills lies above a bryozoan fauna which occurs a short distance below the sandstone called "Burgen" along the southwest edge of the Arbuckle Mountains. Heretofore Bromide, in various tables, has been used to represent a number of different horizons, but its last use was to limit it to the upper part of the section exposed in the hill just west of the hotel at Bromide, and it was thought that the fauna represented in this section was younger than that found in the upper part of the Simpson elsewhere. Further studies of a section above the three artesian wells at the northeast edge of Bromide, and sections on the Robertson ranch about three miles south of Bromide, have contributed evidence to show that certain parts of the fauna and the physical characteristics of the upper part of the Simpson at the east end of the mountains are almost identical with those of the upper part of the Simpson in most of its outcrops. As Bromide has been used more extensively and longer in connection with the Simpson, it is thought better to retain it as the name for the upper formation of this group and drop the name Criner, which was at first the name for a member, but later was raised to a formation name, before it was realized that the fauna at Rock Crossing in the Criner Hills is largely a duplication of the upper Simpson fauna to the north with the addition of several apparently local forms. Accordingly, it seems wiser to limit the subdivision of the Simpson to five formations.

JOINS FORMATION

This formation has been named for the Joins ranch on which it is well developed north and northwest of Woodford. In the recent change of the Simpson from a formation to a group, Joins is the oldest and lowermost of the five formations in the new group.

CHARACTER AND DISTRIBUTION

The Joins consists chiefly of thin limestones and shales with a thin conglomerate at the base. The conglomerate varies from 3 to 15 inches in thickness and it is thoroughly indurated and very resistant. It is commonly an edgewise conglomerate, or breccia, in which the fragments consist of angular pieces of limestone, though locally it contains well-rounded chert pebbles. A good illustration of the conglomerate is shown in Plate II B. One and locally two conglomerates occur higher up within the Joins.

While some pure limestones occur, shales and shaly limestones are predominant. The shales commonly contain small nodules and lenses of limestone. A zone of very resistast thin argillaceous limestones varying from 2 to 12 feet in width occurs a short distance above the base and it is in one of these beds that the graptolites are found.

The limestones vary greatly. Some are dark gray coarsely crystalline. Others are finer grained and some of these near the base have many of the characteristics of the upper thin beds of the Arbuckle limestone. Some are dense and vary from yellow to light brown in color.

The distribution of the Joins is local. It is limited to the middle, southern, and western part of the Arbuckle Mountains and to the north end of the Criner Hills. The largest outcrop of the Joins is along the southern edge of the mountains in a narrow strip extending from near the town of Tatums southeastward for nearly 40 miles almost to Ravia. Narrower separate strips extend from a point a little west of Dougherty, across Falls, Honey, and Lick Creeks to Colbert Creek. Small outcrops occur in Sec. 3, T. 1 S, R 1 W., on the north side of the West Timbered Hills; in sec. 36, and northward T 2 S., R 3 E., southeast of Nebo; in sec. 32, T 1 S., R 4 E., about 8 miles southeast of Sulphur; and in sec. 16, T 5 S. R 1 E., and at the north end of the Criner Hills.

TOPOGRAPHIC EXPRESSION

As the shales and thin limestones of the Joins are relatively non-resistant to weathering, it commonly forms a narrow low-lying plane between the more resistant beds of the Arbuckle limestone below and the Oil Creek formation above.

THICKNESS

The thickness varies from 30 feet in sec. 33, T 2 S., R 2 E., on the south side of Falls Creek to 112 feet on the south side of Lick Creek in sec. 23, T 1 S., R 1 E.; 162 feet on Sycamore Creek in sec. 22, T. 3S., R. 4 E.; 342 in sec. 24, T. 2 S, R 1 E, to 296 feet on Spring Creek in sec 28, T. 2 S., R. 1 W.—(Table II).

AGE AND CORRELATION

The Joins is believed to represent the very basal part of the Chazy, going right down to the top of the Beekmantown. A marked graptolite horizon occurs a short distance above the base in one of a series of thin argillaceous limestones.

The graptolite was identified by Doctor Reudemann as *Didy mograptus artus* which he says is a close associate of *Didymograptus bifidus*.[4] This latter form is found at the top of the Beekmantown in the St. Anne zone of New Foundland, the *Didymograptus bifidus* zone of Scandinavia and Bohemia, and in the Auriferous shales of Victoria, Australia. *Didymograptus artus* was found widespread in the central, northern, western, and southern parts of the Arbuckle Mountains, and at the north end of the Criner Hills. It forms a small, delicate colony shaped like the top of a two-pronged tuning fork in which the entire colony is only a little over one-half inch in length (Pl. II D and E). show camera lucida drawings of a colony by Doctor Ruedemann. Though this graptolite has a wide geographic range, its vertical range is very limited. While there may be a zone of 10 or 12 feet of argillaceous limestones in which it occurs, it is generally limited to a single one of the thin limestone beds usually not over 2 inches thick. (Plate II A.) shows practically the width of the bed under the two fingers of Rex McGehee where he first found them on the west side of Highway 77. E. O. Ulrich says[5] "This graptolite horizon possibly is in the basal Simpson, which formation doubtless extends farther down in the time scale than the base of the Chazyan. Provisionally, however, it is included in the upper Arbuckle. Its age, accordingly would be late Canadian."

However, it is now known that this *Didymograptus artus*

4. Ruedemann, Rudolph, Graptolites of New York: New York State Mus. Memoir 7, Part 1, table op. p. 490.
5. Ulrich, E. O. Revision of Paleozoic Systems: Bull., Geo. Soc. America, vol. 22. p. 663, 1911.

zone is definitely in the lower part of the Joins formation where it has been found in a narrow zone widespread in the northern, middle, western, and southern parts of the Arbuckle Mountains and at the north end of the Criner Hills. The distance of this graptolite zone above the base of the Joins differs as follows: North side of West Timbered Hills, 43 feet; 45 feet south of Crusher quarry on east side of Washita River; 60 feet on Sycamore Creek; 93 feet on U. S. Highway 77; 102 feet on Hickory Creek; and 198 feet at the north end of the Criner Hills.

We are fortunate to have the following recent statement of Rudolph Ruedemann concerning the significance of this graptolite:[6]

> "The occurrence of *Didymograptus artus* in a narrow zone near the base of the Simpson seems to me quite significant. *Didymograptus artus* is closely related to *Didymograptus bifidus* and in Great Britain both occur only in one zone, that of *Didymograptus bifidus* which is now placed at the base of Llandeilo and close to Arenig and would correspond to the base of our Chazy. * * * The occurrence of *Orthis costalis* below the zone of *D. artus* is certainly evidence that the zone belongs in the Chazy. Besides, also here in the East, parts have become known indicating that at least the upper Normanskill is younger than the Chazy. So you see the occurence of *D. artus* may not contradict the other faunules as much as it would appear at first sight. It may actually be here a Chazy form and not a Beekmantown form."

A very common and characteristic lower Chazyan brachiopod, *Orthis costalis,* ranges through the formation, but it occurs in greatest numbers generally about 20 feet above the basal conglomerate. At this horizon it commonly fills a bed of limestone 4 to 8 inches thick. Two pedicle views of this form are shown in Plate II C. Gastropods occur plano-spirally coiled and a few of the *Eccyliomphalus* type are loosely coiled. Numerous ostracodes occur in the Joins particularly in the lower part where some of the thin limestone beds are filled with them. *Leperditia brookingi* and *Leperditella cooperi* are common and characteristic forms in zone 98 which are illustrated on Plate III, 1, 2.

STRATIGRAPHIC RELATIONS

No break of importance has been recognized between the top of the Arbuckle limestone and the thin conglomerate at the base of the Joins. A similar conglomerate occurs at a number of localities a short distance below the *Hormotoma* gastroped bed and the algal bed near the top of the Arbuckle. Especially is this true along U. S. Highway 77 and along the highway about 12 miles south of Sulphur. Locally, also, a similar conglomerate occurs within the Joins a considerable distance above the base. In its rather limited distribution the Joins is apparently conformable at the top with the basal sandstone of the Oil Creek formation.

6. Unpublished correspondence.

However in the eastern and northeastern parts of the mountains where the Joins is absent the basal Chazy part of the Simpson is represented by a hiatus of considerable extent. (Fig. 2).

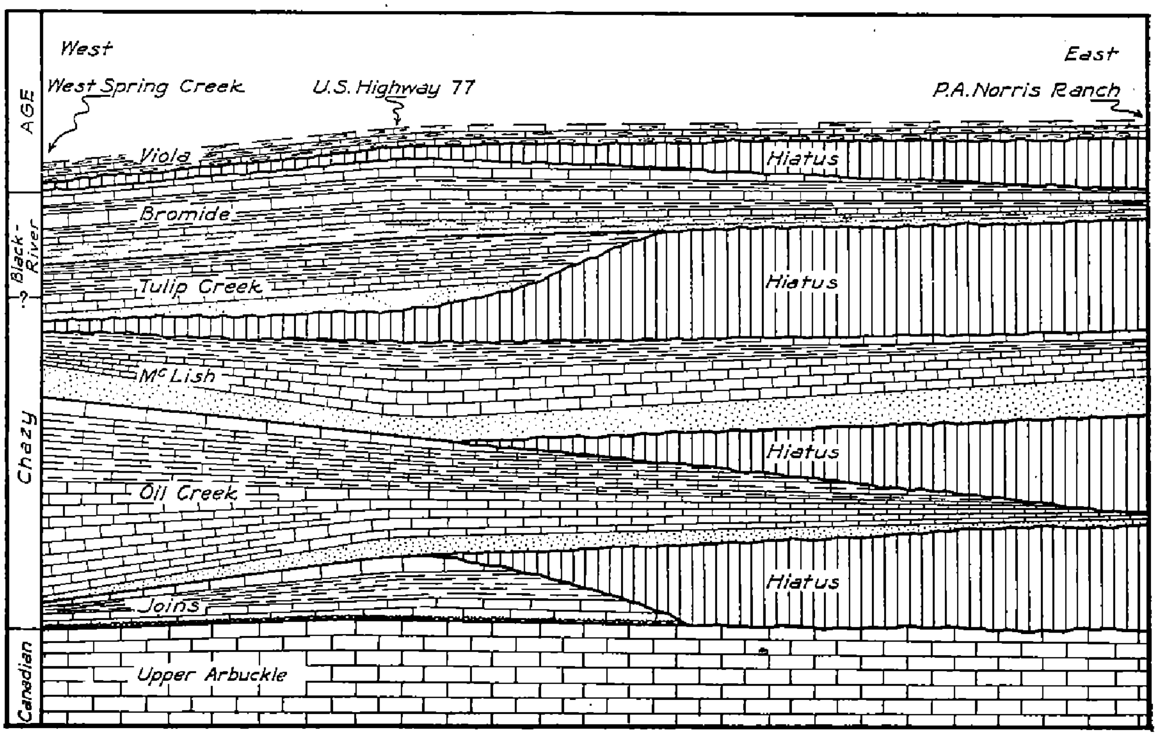


Figure 2. Diagram showing age, thickness, and relation of formations of the Simpson group together with the extent and position of the unconformities.

EXPLANATION OF PLATE II.

A. Photograph to show the thickness of the argillaceous limestone bed, practically covered by the two fingers of Rex McGehee, in which the graptolite *Didymograptus artus* is commonly found in sec. 25, T. 2 S., R. 1 E., on the west side of U. S. Highway 77. Photo by C. E. Decker.

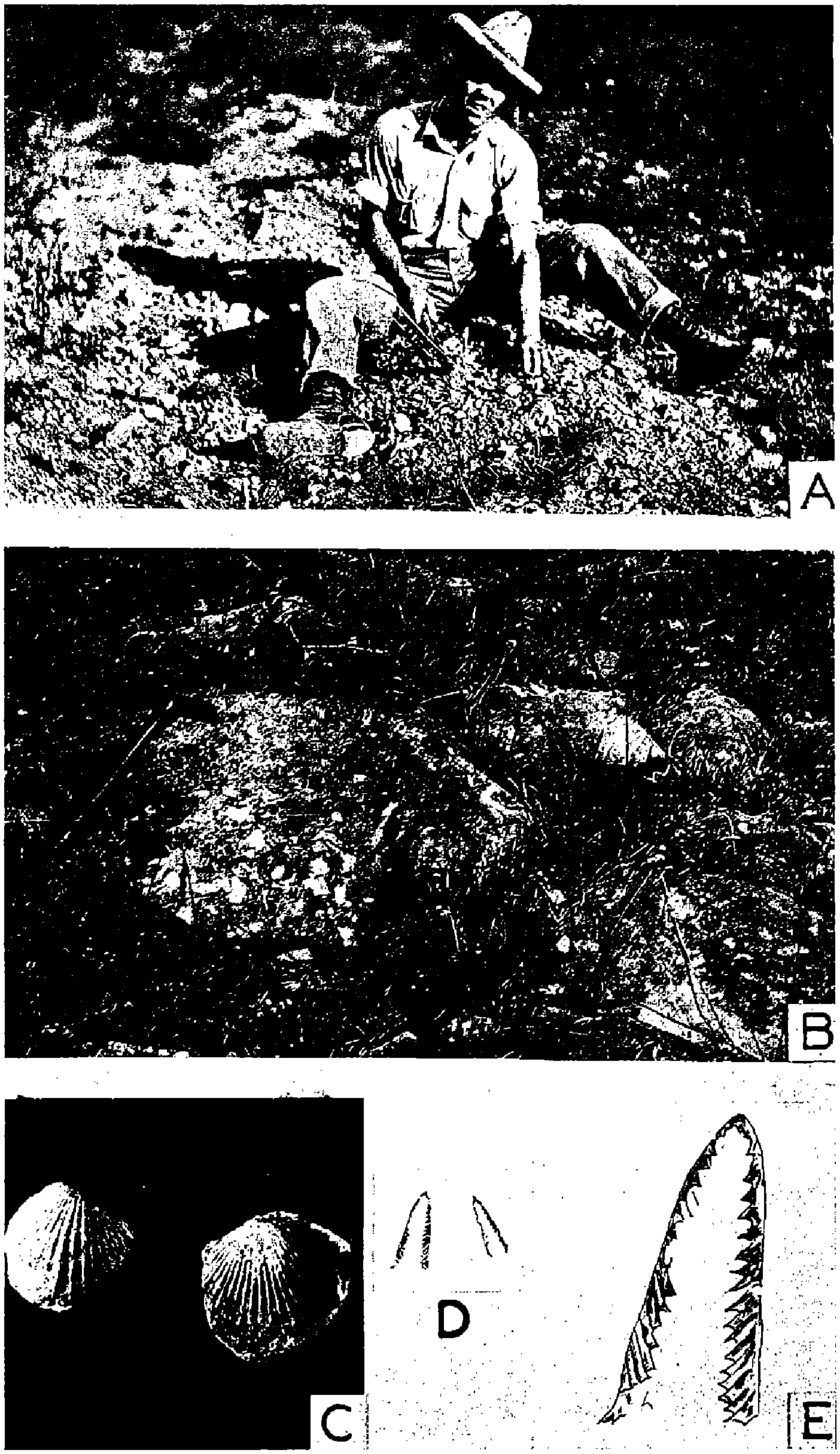
B. Limestone conglomerate at the base of the Joins formation marking the contact of the upper part of the Arbuckle limestone with the basal part of the lowest formation of the Simpson Group. Photo taken in sec. 21, T. 2S., R. 1 E., on east side of Henryhouse Creek by C. E. Decker.

C. Two pedicle views of *Orthis costalis*, a brachiopod which occurs in great numbers about 20 feet above the basal conglomerate of the Joins. Locally this form occurs more sparsely scattered at higher horizons in the Joins. It is recognized as a typical fossil of the lower part of the Chazy. Photo by Ray L. Six.

D. Two colonies of *Didymograptus artus*, natural size. Photo and camera lucida drawing by Dr. Rudolph Ruedemann. This graptolite is commonly found in a very narrow horizon in the basal part of the Joins in the Arbuckle Mountains and at the north end of the Criner Hills.

E. A colony of *Didymograptus artus*, X4, with drawing and photo by Dr. Ruedemann as above.

PLATE II



EXPLANATION OF PLATE III.

1. *Leperditella cooperi* n. sp.: a, side view, right valve; b, dorsal view; c, anterior view. Joins formation. X38.
2. *Leperditella brookingi* n. sp.: a, side view, right valve (note dotted, broken overlap); b, dorsal view; c, anterior view. Joins formation. X38. Drawings by L. I. Price.

OIL CREEK FORMATION.

This formation derives its name from Oil Creek which crosses it in sec. 17, T. 3 S., R. 4 E., about 14 miles southeast of Sulphur. In the western and southwestern parts of the mountains where there are five formations in the Simpson group, it is the second from the bottom, but in the eastern and northern parts it is the basal one of three formations.

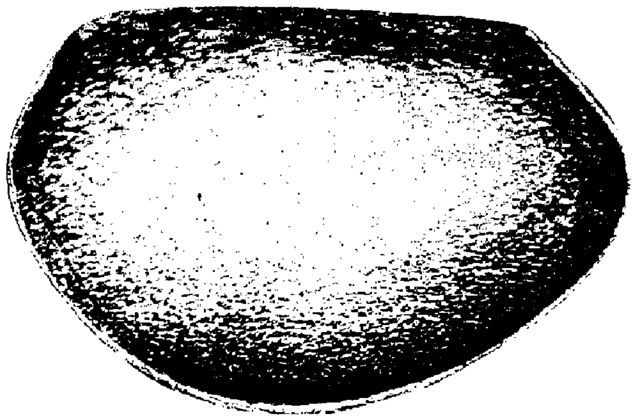
CHARACTER AND DISTRIBUTION

The Oil Creek formation consists chiefly of limestones and shales in the western part of the mountains and of sandstone and limestone in the northern and eastern parts. The limestones are generally very coarse grained, yellowish or brownish in color, and frequently they consist largely of fragments of cystids and crinoids. These limestones which are about 500 feet thick along Highway 77, increase to almost 700 feet near Pooleville at the west end of the mountains, and thin eastward to 50 or in some cases to 20 feet. This formation contains several thin intraformational limestone conglomerates (Pl. IV A). In contrast with the limestones, the sandstones decrease westward and locally finger out, separating into two parts, and increase eastward. A sandstone of 19 feet in thickness along Highway 77 thins westward to almost zero and thickens eastward to about 175 feet on Sycamore Creek. Commonly a shale zone or several shale ones occur near the top of the formation. Within the mountains the Oil Creek has a wide distribution (Pl. I, in pocket). It forms a narrow strip from near Tatums at the west extending about 40 miles almost to Ravia at the southeast. It extends with minor gaps also from a point west of Dougherty northwestward to Colbert Creek. It occurs on the north side of the West Timbered Hills and south and east of Sulphur. It is the only Simpson formation near Hickory and on the Horse Shoe ranch east of that town. It extends eastward where it thins markedly near Franks, Connerville. and Pontotoc. It occurs also at the north end of the Criner Hills.

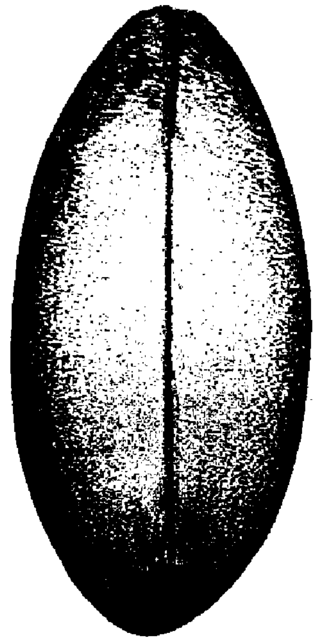
TOPOGRAPHIC EXPRESSION

In the western part of the mountains where the lower two-thirds of the Oil Creek consists of limestones, it forms an elongate rounded ridge which rises gradually above the Joins below it and above the upper shaly part of the formation at the top. In the northern and eastern parts of the mountains where it consists chiefly of poorly indurated sandstone with minor amounts

PLATE III



1a



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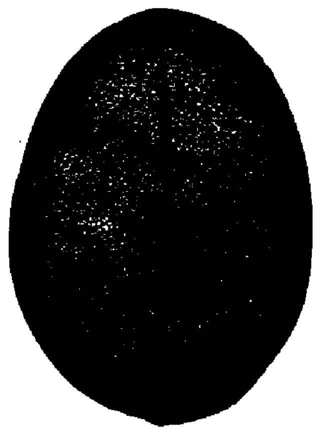
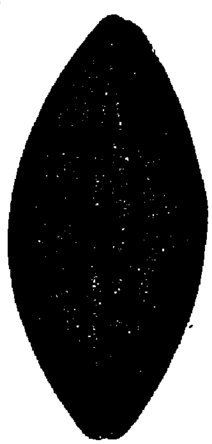


1c

2a

2b



2c

of limestone and shale, it forms a flat featureless plain, much of which is covered with loose sand.

THICKNESS

The thickness of the Oil Creek varies greatly. It is thickest at the west and southwest and thins rapidly toward the north and east. On West Spring Creek east of Pooleville it is 1075 feet thick; on Highway 77, 681; on Sycamore Creek 803 feet; Lick Creek, southwest of Davis, 443 feet; north edge of Bromide, 330? feet; and in the continuation of the P. A. Norris ranch section, 46 feet. Much evidence has been secured recently to show that in the eastern part of the mountains the sand in the lower part of the Oil Creek formation is thin and that much of the sand formerly assigned to this formation really belongs in the upper part of the Arbuckle limestone. A six inch red oxidized clay bed (Pl. IV E). occurs at the base of the Oil Creek at the northwest edge of the P. A. Norris ranch and a similar bed occurs about three-fourths of a mile east of Connerville on the east bank of Blue River. At the latter locality the clay bed lies at the base of the Oil Creek limestones suggesting that the Oil Creek sand may be entirely missing there. See Table II).

AGE AND CORRELATION

The Oil Creek formation is correlated with the lower Chazyan.[7] One of the most common fossils in the lower part of the Oil Creek limestone is a peculiarly shaped brachiopod with a high cardinal area, *Clitambonites multicosta*. Another very common fossil of the Oil Creek is a large trilobite *Pliomerops nevadensis* (Pl. IV C). The *Pliomerops* is much more conspicuous fossil than the *Clitambonites*. More commonly only the pygidium is found. These vary greatly in size, but some of them are nearly two inches long. This probably indicates that the larger individuals of this species were four or five inches long. Also in the lower part of the limestones a short distance above the basal sandstones are marked zones of ostracodes and pelecypods which are found in great numbers, and they have a wide geographic distribution. The ostracodes are of the *Leperditella* type and occur in such great numbers that they literally pepper the rocks with brown spots (Pl. IV D). Also, about 100 feet below the top of the formation, a rugose ostracode, *Eridoconcha magna*, (Pl. V, 3), coats the surface of the limestone beds and occurs in great numbers in the adjacent shales. This species is found concentrated in millions here, and it is thought to be limited to this zone. A smaller *Eridoconcha simpsoni* occurs in both the Tulip Creek and

7. It is realized that increased collections and more complete study of the faunas may give reasons for changing the present correlation, but the few bryozoa sectioned and studied add corroborative evidence to that of other parts of the faunas and help to substantiate the conclusions reached in these correlations.

Bromide formations. In the upper part of the formation a number of marked fossil horizons occur. One of the most conspicuous of these is the *Dinorthis pectinella* zone in which the brachiopods nearly fill the thin limestones in which they occur, (Pl. IV B). Bryozoa of both the ramose and massive types are very abundant in the upper shales and thin limestones. Many small gastropods and large *Maclurites* are very common (Pl. IV F). The latter form is thicker and higher than *M. magnus* which occurs in the McLish formation above. Several species of Orthoceras occur. Few coiled cephalopods were found. A few sponges were found in about the middle of the limestones, being very thin representatives of the *Receptaculites* genus. Crinoid and cystid plates are very abundant at some localities, particularly at the east end of the mountains.

OIL CREEK FOSSILS

Receptaculites sp., (thin form.)
Batostoma suberassum
Monticulipora near insularis
Clitambonites multicosta
Clitambonites porcia
Dinorthis cf. pectinella
Orthis acutiplicata
Orthis ignicula
Orthodesma sp., (nearest minnesotense)
Bellerophon sp.
Lecanospira cf. compacta
Liospira cf. progne
Maclurites cf. oceanus
Pleurotomaria cf. obesa
Scenella cf. montrealensis
Triblidium cf. ebule.
Cyrtoceras sp.
Endoceras magister
Loxoceras moniliforme
Murrayoceras sp.
Nautilus cf. perkinsi
Orthoceras rectilineatum
Orthoceras cf. subarcuatum
Pyroceras cf. clintoni
Drepanodus arcuatus
Aparchites perforata
Eridoconcha magna
Isochilina bulbosa
Leperditella sp.
Illaenus cf. arcturus
Pliomerops nevadensis

STRATIGRAPHIC RELATIONS

The Oil Creek is conformable on the Joins in the central and western parts of the mountains or wherever the Joins is present, but in the northern and eastern parts where the Joins is absent, it doubtless rests unconformably on the Arbuckle limestone. As noted above, at the west edge of the P. A. Norris ranch and in several other localities an old red oxidized clay bed (Pl. IV E) separates basal Oil Creek from Arbuckle, and about three-fourths of a mile east of Connerville a red oxidized 6-inch clay bed lies directly beneath Oil Creek limestones. Also, in the central and western part of the mountains where the formation is thickest, it is apparently conformable beneath the McLish formation, but in the eastern part there is evidence of unconformity between the Oil Creek and the McLish (Fig. 2). The evidence of the unconformity lies not alone in the greatly decreased thickness of the limestone, but also in the marked variation in thickness in short distances; then commonly a coarse limestone conglomerate lies at the top of the Oil Creek limestones (Pl. IV A).

EXPLANATION OF PLATE IV.

A. A coarse limestone breccia or conglomerate which occurs at several horizons within the Oil Creek formation and at the eastern end of the mountains at the top where it may represent the basal part of the McLish. Locally in that part of the mountains the conglomerate contains large limestone fragments in which are numerous Oil Creek gastropods. Photo by Ray L. Six.

B. Slab of limestone filled with shells of the brachiopod, *Orthis acutiplicata*. This form generally occurs in greatest numbers in the base of the shale zone near the top of the Oil Creek formation.

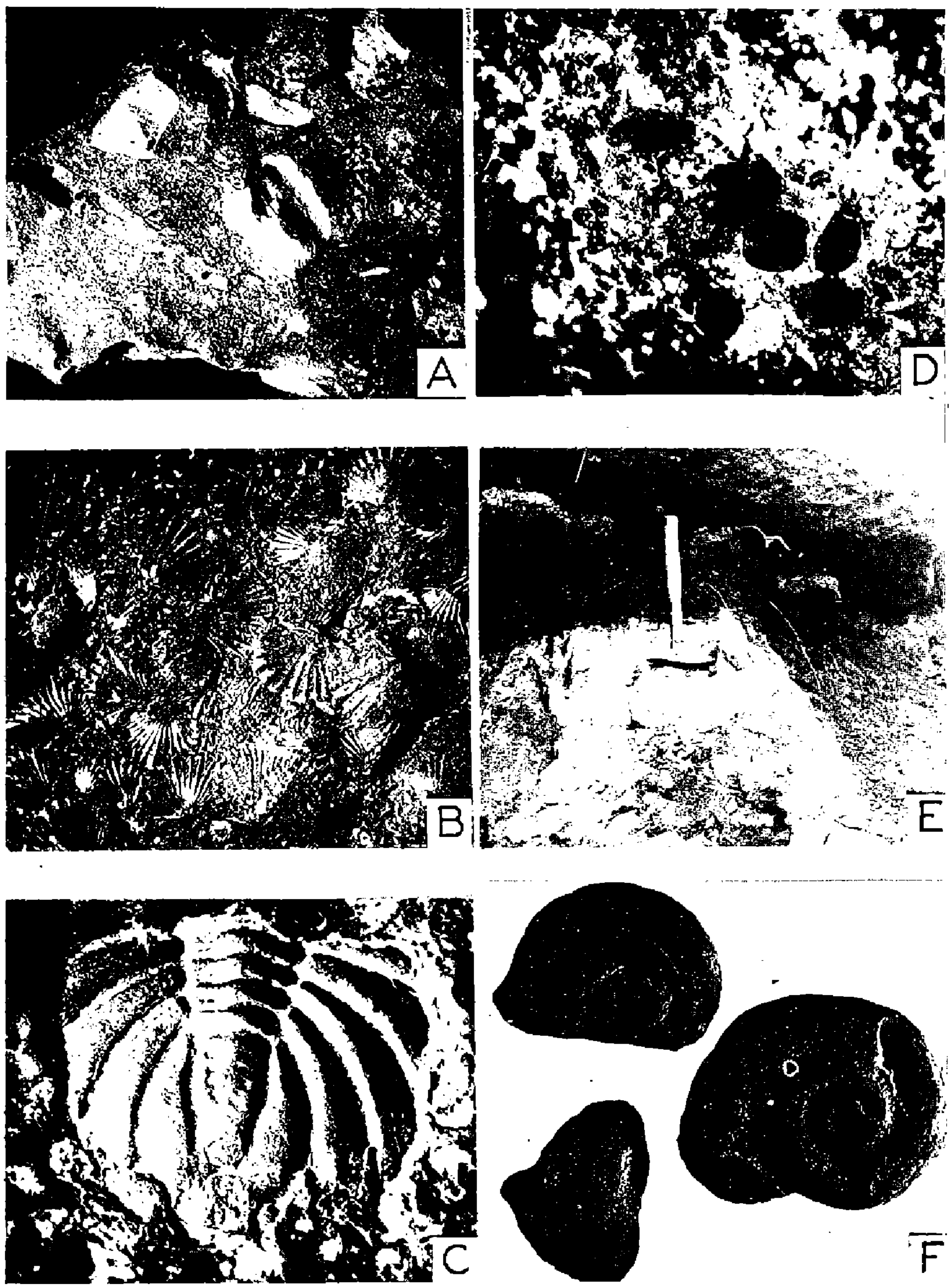
C. Pygidium of *Pliomerops nevadensis* which is very common in the limestones of the Oil Creek formation. Photo by Ray L. Six.

D. Several *Leperditella* sp. which occur in great numbers near the base of the Oil Creek. This fossil has served as a very important marker in the limestones at this horizon. Photo by Ray L. Six.

E. A red oxidized clay zone is shown measured by the upper three-fourths of the hammer handle. This is taken to represent the deposits of the erosional interval between the upper part of Arbuckle and the lower part of the Oil Creek.

F. Three specimens of a *Maclurea* or *Maclurites* which occur in great numbers in the upper part of the Oil Creek formation throughout the mountains. Photo by J. W. Stovall.

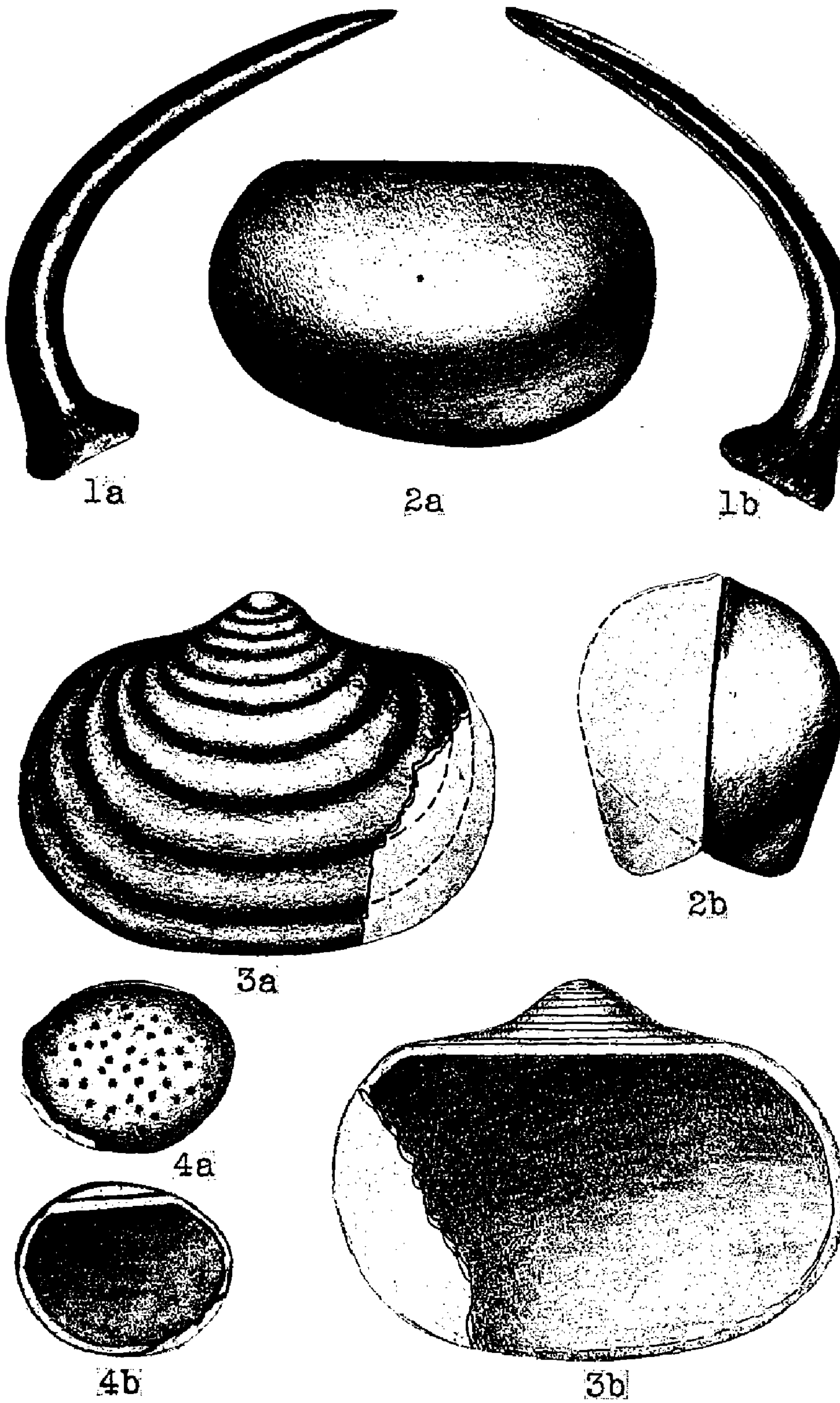
PLATE IV



EXPLANATION OF PLATE V.

1. *Drepanodus arcuatus*, Pander. a, smooth, rounded exterior; b, keeled interior. Oil Creek formation. X50.
2. *Isochilina bulbosa* n. sp.: a, side view, left valve; b, posterior. Oil Creek formation. X30.
3. *Eridoconcha magnus* n. sp: a, side view, right valve; b, interior, right valve. Oil Creek formation. X30.
4. *Aparchites perforata* n. sp.: a, side view, right valve; b, interior, right valve. Oil Creek formation. X33. Drawings by L. I. Price.

PLATE V



McLISH FORMATION

This formation is named for the McLish ranch on which it is well developed. The old McLish ranch house is about four miles northwest of Bromide. The original section from which Chester Reeds collected for Doctor Ulrich was taken from an eastward heading ravine about one mile south and a little west of this old ranch house.

CHARACTER AND DISTRIBUTION

The McLish formation consists of a basal sandstone with limestones, shales, and sandstones in varying proportions forming the rest of the formation above.

The basal standstone, which has been called "Burgen" along Highway 77, varies greatly in the characterictics of its western and eastern outcrops. At the west it is a thoroughly indurated, cross-bedded, resistant sandstone (Pl. VII B). Eastward this sandstone becomes progressively less indurated, until in the glass sand pit at Roff and on John Fitt's place, four miles west of Bromide, a large mass of the sand is loose and wholly uncemented. At the east end of the sand pit at Roff (Pl. VII A), about 40 feet of soft sand forms the east wall of the pit.

A short distance above the basal sandstone along Highway 77 an olive green shale has been called "Tyner". These shales, which are less than 20 feet thick along Highway 77, increase westward to six or seven times that amount on West Spring Creek. Above these shales occurs a mass of relatively resistant limestone, part of which is fine grained and earthy in appearance, and part coarsely crystalline. The color varies from yellowish brown to gray. In the central part of the mountains to some extent, but particularly in the eastern and northeastern parts, the middle and upper part of the McLish consists of ledges (Pl. VI B) of dense resistant limestone alternating with dolomites, shales, and sandstones. These dense limestones have numerous phenocryst-like calcite crystals scattered through them, giving the limestone a birdseye-like appearance. Some of this calcite occurs in worm borings, in gastropod shells, and in other types of organic openings (Pl. VIII F). A picture of some of the

EXPLANATION OF PLATE VI.

A. Beds of dolomite at the right and behind Ross Maxwell are characteristic of the McLish in the eastern part of the Arbuckle Mountains. At this locality on the P. A. Norris ranch, sec. 2, T. 1 N., R. 6 E., the dolomite occurs relatively high in the formation, but to the southeast in the region along Delaware Creek most of the dolomite occurs near the top of the basal sandstone where it locally caps monadnocks.

B. Heavy beds of dense birdseye-like limestone the thickness of which can be seen by comparing with Rex McGehee who is sitting on one of them. This type of limestone is characteristic of the McLish of the eastern part of the mcuntains and at the north end of the Criner Hills. Photo taken in the north edge of sec. 2, T. 1 N., R. 6 E.

C. Irregular sandstones in the McLish formation in a low monadnock in sec. 3, T. 2 S., R. 7 E., on the west side of Delaware Creek. Norval Ballard and Rex McGehee are standing on one of the resistant ledges. Photos A, B, and C by C. E. Decker.

PLATE VI

massive beds of birdseye-like limestone is shown in Plate VI B. At some horizons it contains sparsely scattered ostracodes. (Pl. X). Dolomites and dolomitic sandstone form a part of this formation. One of the dolomites about six feet in thickness is shown in plate VI A where the weathered beds of dolomite are well exposed on Ross Maxwell's right. Also, alternating with the dense limestones and dolomites, shales and sandstones occur in varying amounts. Some of the sandstones are coarse; cross-bedded sandstones are shown in Plate VII C.

Because of the interlocking of faunas, that which was temporarily called Falls formation has now been included in the McLish; thus giving the latter a widespread distribution throughout the region considered. It occurs in practically every outcrop of the Simpson except at the south end of the Criner Hills, on the north side of the Wichita Mountains, the north side of the West Timbered Hills, at Hickory, and the Horse Shoe ranch east of Hickory. While it occurs in all other outcrops, it is particularly well developed in the eastern and northeastern part of the mountains. East and northeast of Pontotoc it outcrops over many thousand acres. This extensive outcrop is in part due to faulting and in part to a flattening of the eastward dip which is more marked in the upper part of the Simpson. Doubtless because of the similarity of the dense limestones of the McLish to some of the beds of the Viola, not only thousands of acres of the McLish or middle Simpson, but also considerable upper Simpson has always been included with the Viola. Accordingly, for the first time now these large areas will be credited properly to the Simpson (Pl. I, in pocket).

TOPOGRAPHIC EXPRESSION

At the western end of the mountains where the basal sandstone of the McLish is thoroughly indurated it is the most resistant part of the Simpson and forms a distinct ridge which rises abruptly above the shales of the uppper part of the formation and the shales and thin limestones of the upper part of the Oil Creek formation. Eastward, where it is poorly cemented, this basal sandstone helps to form some of the sandy plains so characteristic of large areas of the Simpson to the east. Locally, some of the intraformational sandstones have contributed sandy soil over areas of considerable extent. In the eastern part of the

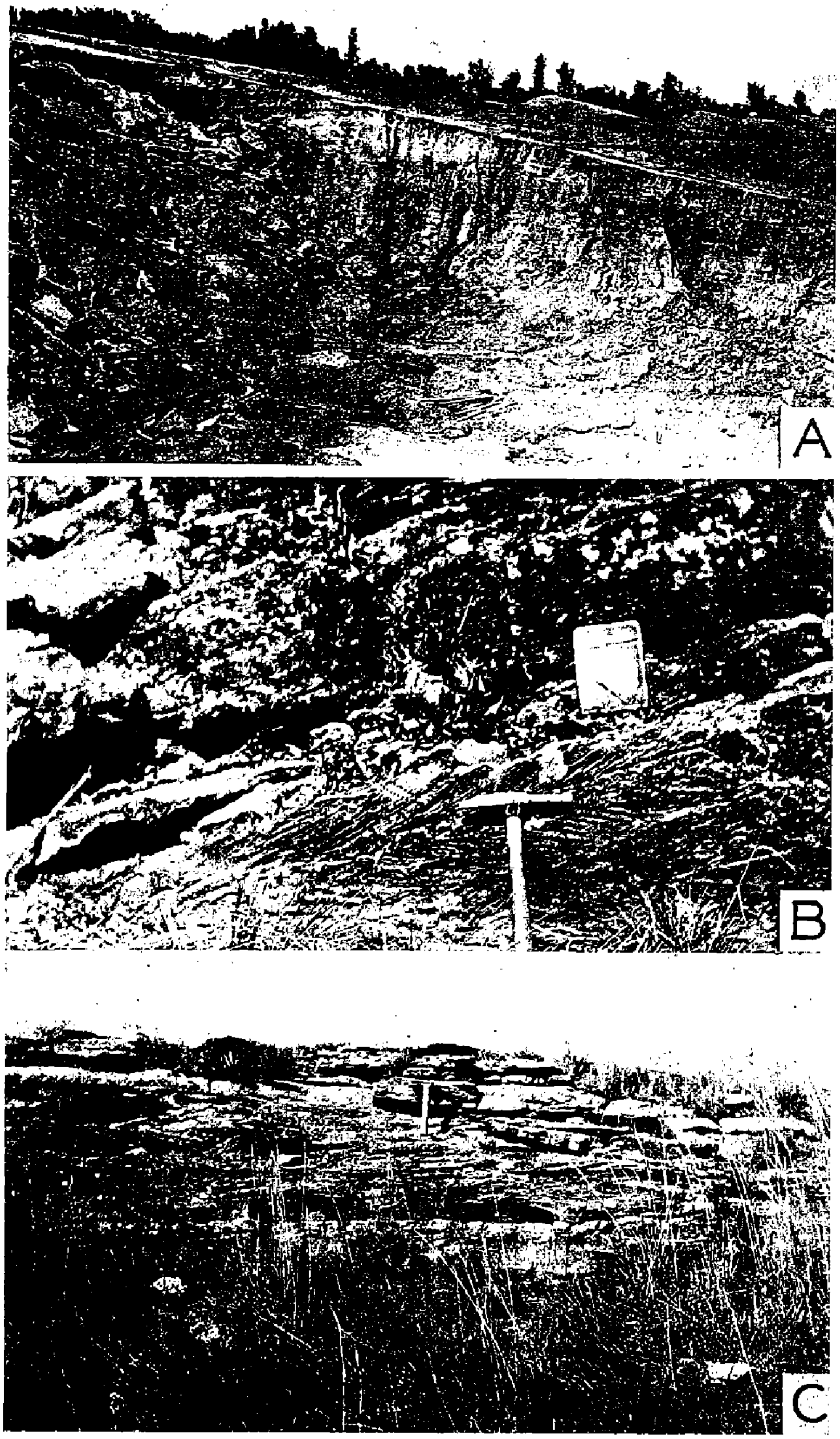
EXPLANATION OF PLATE VII.

A. Sand pit at northeast edge of Roff. The fine, white, loose sand is used for glass. The slabs which have fallen down at the left are indurated with dolomite. This is the sand at the base of the McLish and it corresponds to the sandstone which has been called "Burgen" in the western part of the mountains. Photo by John Fitts.

B. Thoroughly indurated sandstones at the base of the McLish in sec. 17, T. 2 S., R. 1 W., on West Spring Creek, showing cross-bedding in two different directions in the same bed.

C. Sandstones and conglomerates showing complex cross-bedding and lensing indicating the shallow water conditions under which they were deposited and also of the birdseye-like limestones which occur below and above them. About 4 miles southeast of the Bar X ranch house. Photos in B and C by C. E. Decker.

PLATE VII



mountains the resistant dense limestones and dolomites form a number of relatively steep west-facing slopes, some taking the form of small hog-backs. They also form rock terraces and numerous short, steep escarpments. On the west side of Delaware Creek, in the vicinity of the Coatsworth school, several monadnocks are capped with the dense limestone or with dolomite. As noted above, these outlying monadnocks, together with the hills to the east and northeast of them, doubtless represent a remnant of the old peneplain which is so markedly developed at about 1,000 feet above sea level in the western part of the mountains.

THICKNESS

The McLlish reaches its greatest thickness of 533 feet on Sycamore Creek. It has a thickness of 475 feet on Highway 77, 334 feet on West Spring Creek, 339 feet on Lick Creek, 369 feet on the Robertson ranch, 395 feet in artesian well No. 3 at Bromide, and 437 feet on the P. A. Norris ranch south of Franks.

AGE AND CORRELATION

The McLish is taken to be middle Chazyan in age. While it has rather a limited fauna, the members of a single species are often very numerous. Several different types of sponges occur most commonly a short distance above the basal sandstone. Some of these are of the *Zittelella* type, but there are several other types which have not been identified and several of them probably have not been described. One of the most common fossils is *Lichenaria carterensis*, a large colonial coral which may attain a diameter of 15 inches in some of the largest forms. These are abundant in the eastern part of the region and they have been traced north and westward to Roff and Sulphur. Top, bottom, and side views of this coral are shown (Pl. IX A, B, C).

Several brachiopods occur including *Rafinesquina, Strophomena* cf. *incurvata, Camarotoechia* cf. *pristina,* and *Zygospira recurvirostris*. One of the most common fossils of the central and eastern areas is a large almost plano-spiral gastroped *Mac-*

EXPLANATION OF PLATE VIII.

A. The flat side of a left-handed gastropod *Maclurites magna* which is abundant at a number of localities in the McLish formation, especially in the eastern end of the mountains. They are commonly 3 or 4 inches in diameter but in the Lenoir limestone of Alabama some have been found twice the size of these.

B. Cast of the interior of a specimen of *Maclurites magna* showing the suture line more clearly and the very flat surface characteristic of one side of this species.

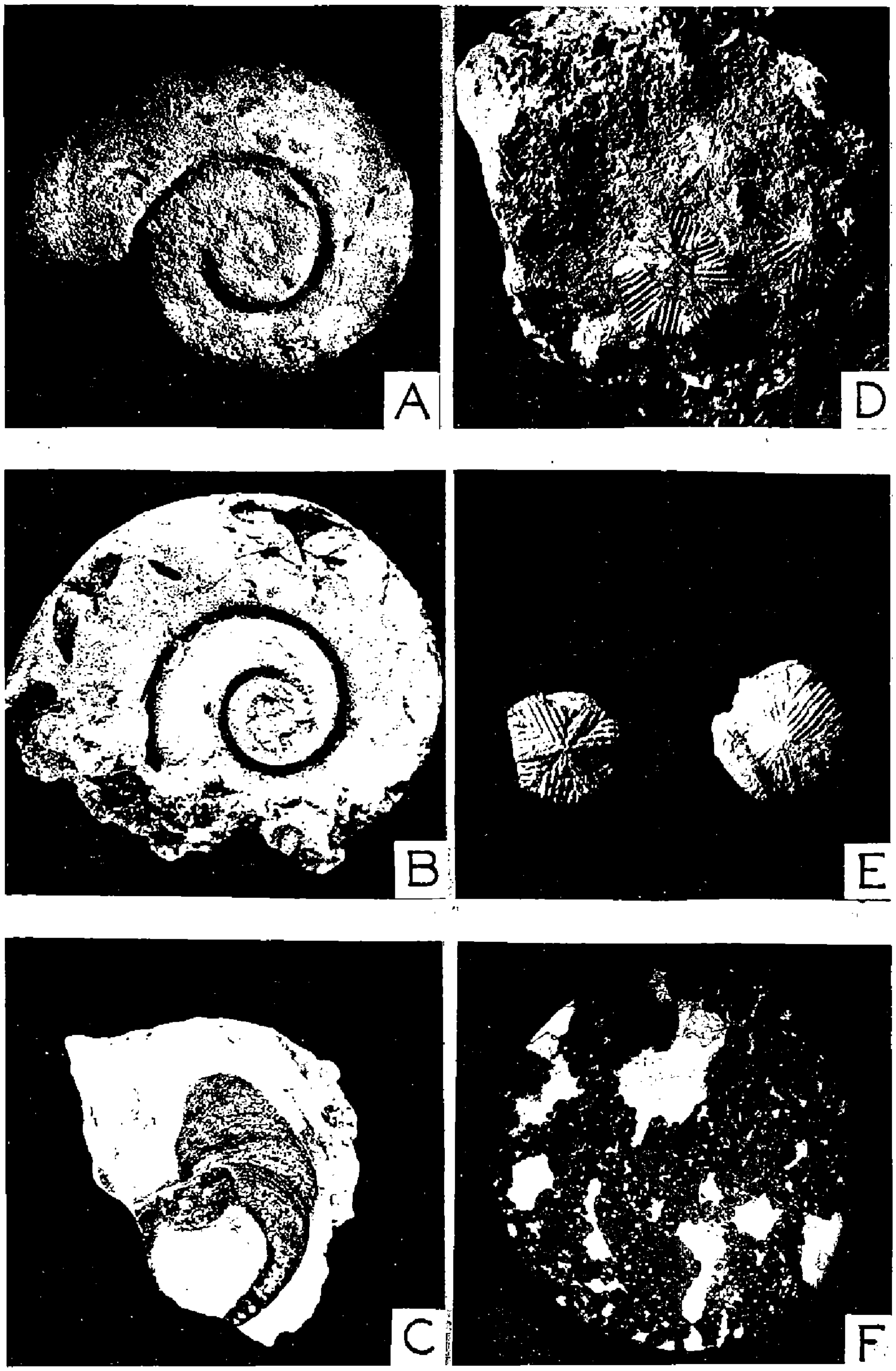
C. Peculiar elongate operculum of *Maclurites magna* frequently found in great numbers in association with the shells of these forms. This gastropod has been used as a very important middle Chazy marker throughout the Appalachian mountains.

D. A piece of limestone containing two plates of the cystid *Paleocystites tenuiradiatus*, which occurs in great numbers in a zone a short distance above the basal sand in the McLish formation. This cystid zone has been an extremely important one in correlation throughout the entire length of the mountains.

E. Two separate plates of *Paleocystites tenuiradiatus*.

F. Thin section of the birdseye-like limestone, showing in white the numerous calcite flecks which occur scattered through the dense limestone. Many of these seem to have resulted from the filling of previous organic openings. Photos by Ray L. Six.

PLATE VIII



lurites magnus. Top and edge views and an operculum are shown (Pl. VIII A, B, C). Another much smaller gastropod, *Raphistoma stamineum,* is found in great numbers 2 miles south of Sulphur. It occurs also 2 miles southwest of Franks and on the McLish ranch northwest of Bromide. Bottom, top, and edge views are shown (Pl. IX E). A massive bryozoan is common and generally is silicified. Two species of *Orthoceras* occur and ostrocodes (Pl. X, 1, 2) are abundant in some localities, sparsely scattered through the dense limestones. A marked cystid zone, *Paleocystites tenuiradiatus,* which occurs a short distance above the basal sandstone in the extreme western part of the region, extends throughout the mountains eastward beyond Connerville where it is associated with the typical McLish fauna. While these cystid plates extend through quite a wide zone, they are particularly abundant at this horizon, some loose in the shales and others more largely making up thin and locally thick limestones. Illustrations of these cystid plates are shown (Pl. VIII D, E). Closely related to the cystids mentioned above, a marked zone of small pelecypods, *Ctenodonta* sp., occurs at nearly the same interval in the Springer section and the section 8 miles southeast of Sulphur where the McLish fauna is well developed a short distance above them (Pl. IX F). Numerous fucoids are found at various localities in the basal sandstone, but they are found near the top of this sand in greatest abundance in the Roff sand pit. Some of these fucoids are shown (Pl. IX D).

Several species of pelecypods, including *Modiolopsis* cf. *greggalis* occur in great numbers in the basal sandstone called "Burgen" on the east side of Highway 77. Numerous pelecypods occur also in the original Burgen sandstone northeast of Tahlequah, although it has not been possible thus far to correlate the two by means of these. With reference to the relations of a part of the Simpson to the Tyner and Burgen of eastern Oklahoma, the following suggestions are made: In view of the indecision as to the age of the Tyner and Burgen, and as Cram[8] on subsurface evi-

EXPLANATION OF PLATE IX.

A. Side view of a colonial coral *Lichenaria* cf. *carterensis* which commonly occurs in the McLish formation between the birdseye-like limestone and the basal sandstone, but locally, especially east of Pontotoc, it ranges up into the limestones. Most abundant in the eastern part of the mountains, it ranges west to Roff and Sulphur.

B. Top view of *Lichenaria* cf. *carterensis.*

C. Bottom view of *Lichenaria* cf. *carterensis.*

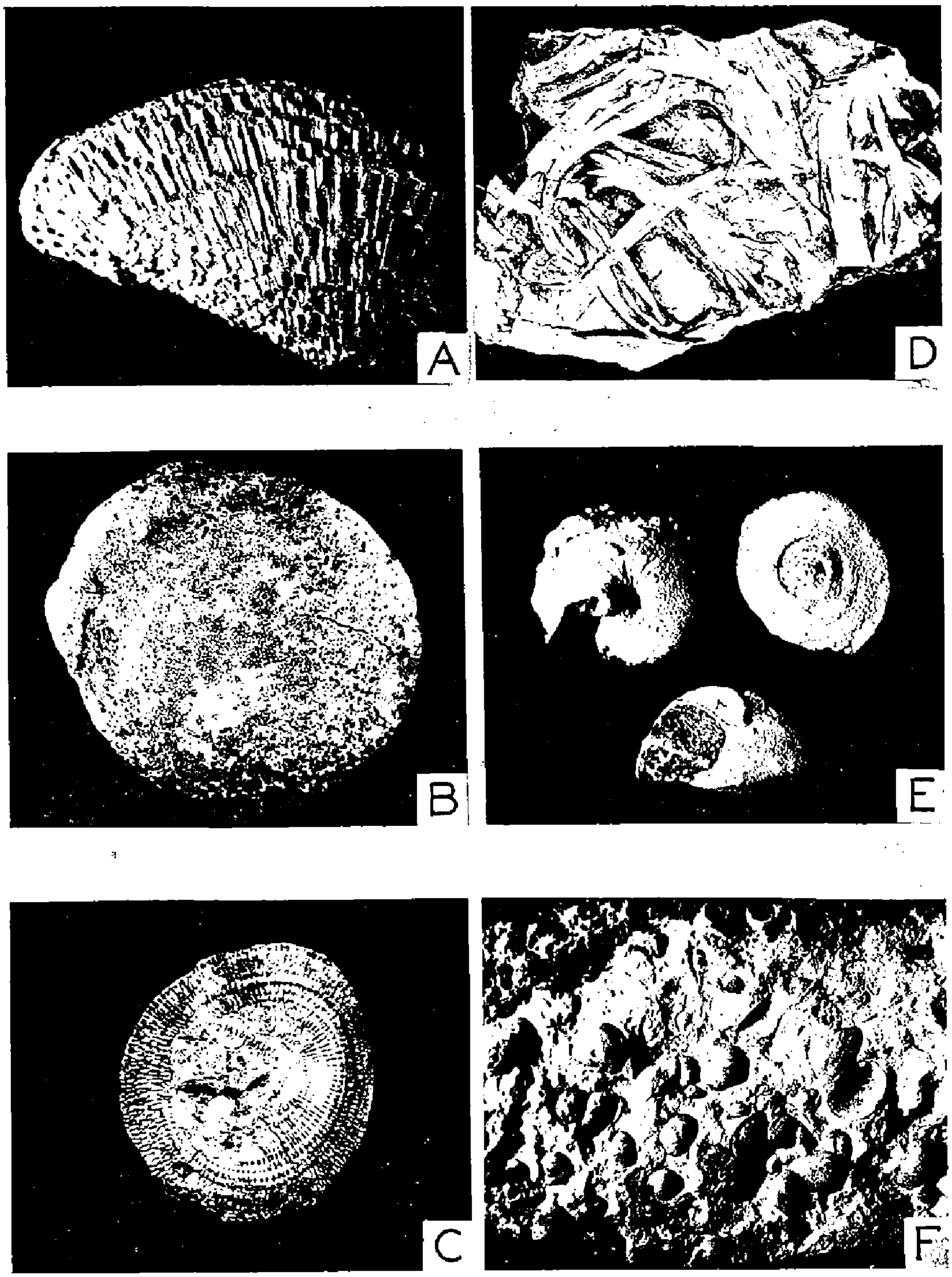
D. Fucoids from the indurated beds at the top of the pit of loose sand at Roff in sec. 24, T. 2 N., R. 4 E. Several different species of fucoids occur at this locality covering great slabs of rock.

E. Three views of *Raphistoma stamineum* which occurs in great numbers in the McLish formation 2 miles south of Sulphur in secs. 13 and 14, T. 1 S., R 3 E. This form also ranges eastward well towards the east end of the mountains at the same horizon and it is also an important middle Chazy marker in the Appalachian region.

F. A small *Ctenodonta* which occurs in great numbers in a thin limestone in the McLish a short distance above the *Paleocystites tenuiradiatus* zone. The interval between these two zones holds almost constant for many miles. Photos by Ray L. Six.

8. Cram, I. H., Oklahoma Geol. Survey Bull. 40, vol. 3, pp. 534-546, 1930.

PLATE IX



dence favors placing the lower part of the Tyner in the Chazy, it is here suggested that all evidence be checked again to see if all of the Tyner and Burgen may not be placed in the Chazy. If it were not for the apparent certainty as to the age of the Fite limestone, it would be suggested also that the evidence be checked again to learn whether or not it may not be upper Chazy in age. After a brief visit to the outcrops of the Tyner and Burgen formations, it is believed that more extended collections of fossils may be secured which may help to place these formations more definitely in the time scale and thus help to correlate them more clearly with other formations in this and other states. While we have not had an opportunity to study the Tetradium group in detail, the one found in the Fite limestone compares closely with the illustrations and description of *Tetradium syringoporoides*, a Chazyan form. While the Tyner and Burgen may not be the exact equivalents of any one or two formations of the Simpson group, it is here suggested that they probably are most closely represented by the McLish and Oil Creek formations. As noted below, the McLish contains a number of forms in common with the Lenoir[9] limestone as developed in Alabama..

Of the forms represented in the McLish of Oklahoma and the Lenoir of Alabama, two well known and widely distributed gastropods are most noteworthy. The smaller of these two gastropods, *Raphistoma stamineum* (Pl. IX E) has been found from Alabama northward into eastern Tennessee, in New York, Vermont, and at several places in Canada.[10] It is interesting to note that while this form is found in the basal conglomeratic limestone of the Lenoir of Alabama, it is found in a coarse calcareous sandstone in the McLish 2 miles south of Sulphur whence it ranges eastward to the east end of the mountains. However, still more significant is the larger gastropod, *Maclurites magnus* (Pl. VIII A, B, C). This form is found in greatest abundance in the McLish of the eastern part of the Arbuckle Mountains, but it ranges westward to the region around Sulphur. Eighty-seven years ago Hall said of this gastropod: "From the wide geographic distribution and limited geologic range of this shell, I regard it as of great importance in the identification of strata [11]." As recently as four years ago Butts has said of this form:

"In Alabama shells of this type are so common in the Lenoir and so rare or of such plainly different species in other limestones that the presence of

EXPLANATION OF PLATE X.

1. *Leperditia fabulites*, (Conrad) Jones. Left valve. McLish and Oil Creek formations. X10.
2. *Leperditia fabulites* (Conrad) Jones. Another left valve. X10. Drawings by L. I. Price.

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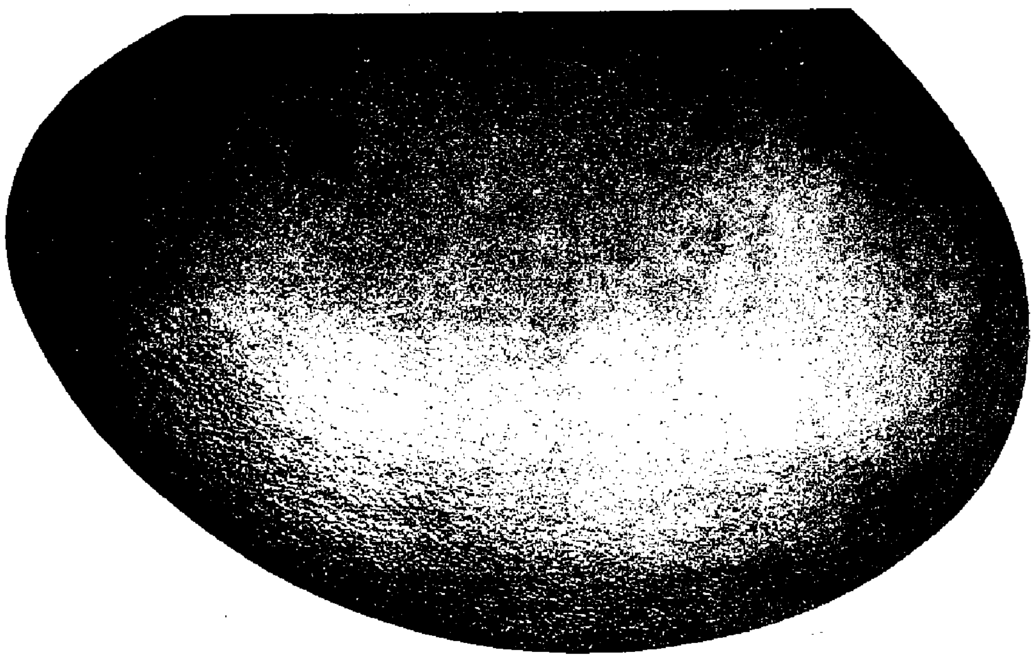
9. Butts, Chas., Geology of Alabama: Geol. Survey Alabama, Special Dept. No. 14, pp. 103-107, plates 21 and 22, 1926.
10. Bassler, R. S., U. S. National Museum, Bull. 92, pp. 1092-1093, 1915.
11. Hall, Jas. H., New York Geol. Survey, Paleontology, vol. 1, footnote p. 27, 1843.

PLATE X



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2

the shells or their opercula (Pl. 21, figs. 4-6) in any numbers is sufficient to identify the containing limestone as Lenoir. They also serve to correlate the Lenoir unmistakably with the middle part of the Chazy limestone of the type locality in northeastern New York. *Maclurea magna* occurs rarely in the Ridley limestone of the Stones River group of Middle Tennessee, and by this means the Lenoir is correlated with the Ridley"[12]

In his publication of the following year he says:

"Maclurea magna is a common fossil throughout the Lenoir limestone in these quadrangles. This fossil occurs along the Appalachian Valley northward to northeastern New York and northwestern Vermont where it seems to be confined to the part of the Chazy group now known as the Crown Point limestone. This evidence seems sufficient ground for correlation of the Lenoir with the middle Chazy."[13]

It is indeed a satisfaction to thus anchor the McLish, the middle formation of the Simpson group of the Arbuckle Mountains, and correlate it definitely with the Lenoir of Alabama and the middle Chazy formations northward in Tennessee, Virginia, Maryland, Pennsylvania, Vermont and into the Crown Point formation of New York at the type location of the Chazy. A marble-like algal form, *Girvanella ocellata*, occurs widespread in the middle part of the McLish and it is most commonly associated with *Maclurites magna*. According to Perkins this same association holds for the middle Chazy of New York and Vermont[14].

McLISH FOSSILS

Girvanella ocellata
Zittelella sp.
Lichenaria carterensis
Pleurocystites tenuiradiatus
Nematopora cf. ovalis
Pachydictya cf. elegans
Pachydictya robusta
Rhinidictya basalis
Camarotoechia sp.
Orthis acutiplicata
Orthis iguicula
Plectambonites pisum
Rafinesquina champlainensis
Strophomena incurvata
Valcourea strophomenoides
Zygospira recurvirostris
Ctenodonta cf. socialis
Ctenodonta cf. gibberula
Ctenodonta parvidens
Modiolopsis cf. gregalis
Lophospira cf. bicincta
Maclurites magna
Pleurotomaria cf. euconica
Raphistoma stamineum
Orthoceras sp.

12. Butts, Chas., Geology of Alabama: Alabama Geol. Survey Special Report 14, p. 105, 1926.
13. Butts, Chas., U. S. Geol. Survey, Geol. Atlas, Bessemer-Vandiver Folio (No. 221), pp. 5, 6, 1927.
1901-1902) page 156, Pl. LVIa 1901 1902.
14. Perkins, G. H., Report of State Geologist of Vermont (Third of this series

Leperditia fabulites
Bumastus globosus
Isotelus canalis
Isotelus harrisi

STRATIGRAPHIC RELATIONS

In the western part of the mountains the McLish is thought to be conformable on the Oil Creek below, but in the eastern part where the Oil Creek is thin and is represented at the top by a coarse limestone conglomerate it is thought that a marked hiatus occurs representing much of lower Chazy time. Also, in the eastern part of the mountains there is thought to be a marked hiatus at the top of the McLish representing all of upper Chazy time. And now evidence is accumulating to show that the Tulip Creek is more closely related to the Bromide than to the McLish. Accordingly, the hiatus of the eastern part of the mountains extends west and southwest at the top of the McLish though the extent of the hiatus doubtless decreases somewhat to the west. (See Fig. 2).

TULIP CREEK FORMATION

This formation gets its name from Tulip Creek, the main branches of which cross the Simpson a short distance west of Highway 77, 2¼ miles north of Springer, Oklahoma.

CHARACTER AND DISTRIBUTION

The Tulip Creek consists of a basal sandstone which has been called "Wilcox" in the section north of Springer. Above the sandstone alternating shales and limestones occur generally, but to the west on West Spring Creek a number of thin sandstones alternate with the shales. Extensive shale deposits occur east of Highway 77.

The Tulip Creek is very local in its distribution, occurring only in the western, northwestern, and southwestern parts of the mountains (See Fig. 2). Thus it forms a narrow belt from east of Pooleville almost to Ravia, and another one broken in the middle by a fault from west of Dougherty northwestward to Colbert Creek. There is a grave question whether it should be recognized at all in the section west of Nebo, and in the one at the north end of the Criner Hills. In these two sections it seems to merge with the basal part of the Bromide with no sandstone present to separate the two. The formation is entirely wanting in the central, eastern, and northeastern parts of the mountains. However, it may extend beneath the surface to the west and north of the mountains, and it is now thought that it may be represented in the Oklahoma City area by the thickest sandstone in the Simpson of that region.

TOPOGRAPHIC EXPRESSION

As no part of the Tulip Creek is very resistant, except that locally, the basal sandstone is indurated sufficiently to make it stand up a few feet above the adjacent shales and limestones, it helps to form a somewhat irregular part of the Simpson plain.

THICKNESS

Along Highway 77 north of Springer it has a thickness of 394 feet, on West Spring Creek east of Pooleville 271 feet, on Sycamore Creek 380 feet, and on Lick Creek 192 feet.

AGE AND CORRELATION

The Tulip Creek has few fossils in comparison with the Oil Creek and Bromide formations, and thus far these seem to supply somewhat conflicting evidence. While a few of the fossils near the base seem to be of upper Chazy age, those in the middle and near the top are typical Black River forms. Particularly as to the latter is this true of the conodonts (Pl. XI, 3) which occur at a number of horizons in the Tulip Creek and the most common form correlates with the Black River of Minnesota. Several bryozoa and brachiopods of typical Black River are present. Then, too, the crinoids and cystids which are so abundant near the base of the Bromide started in the Tulip Creek, as they are found both below and above the basal sandstone member of the Bromide. Also, part of the rich ostracode fauna (Pl. XI, 1, 2, 4) of the Bromide occurs in the Tulip Creek, indicating that several of the Bromide species started in the Tulip Creek and lived on into the Bromide. Thus the evidence indicates that the Tulip Creek is transitional formation with the basal part representing upper Chazyan age, and the upper part representing Black River age.

TULIP CREEK FOSSILS

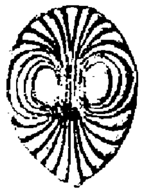
Cystid plates
Crinoid stems and plates
Anolotichia impolita
Batostoma fertile
Eridotrypa cf. aedilis
Pachydictya acuta
Rhinidictya grandis
Dalmanella sp.
Dinorthis deflecta
Pianodema sp.
Modiolopsis cf. occidens
Raphistoma cf. peracutum

EXPLANATION OF PLATE XI.

1. *Eridoconcha simpsoni* n. sp.: a, side view, right valve; b, dorsal view; c, anterior view, right valve; d, interior, right valve. Tulip Creek and Bromide formations. X33.
2. *Primitiopsis bassleri* n. sp.: a, side view, left valve, short female; b, dorsal view; c, interior view, left valve, female; d, side view, left valve, long male. Tulip Creek and Bromide formations. X33.
3. *Prionodus aculeatus*, Stauffer. Tulip Creek formation. X55.
4. *Schmidtella* cf. *affinis*, Ulrich. a, interior, left valve; b, side view, left valve. Tulip Creek formation. X33. Drawings by L. I. Price.

PLATE XI

1a



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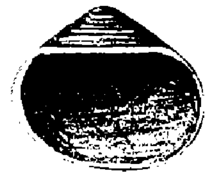

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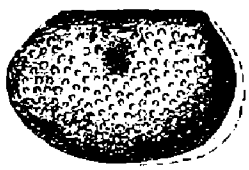
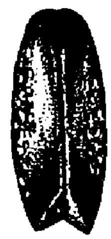


2a



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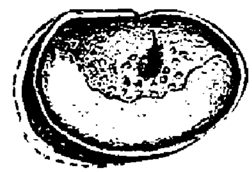

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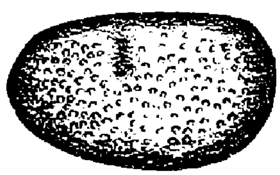

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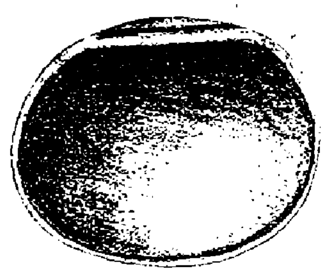
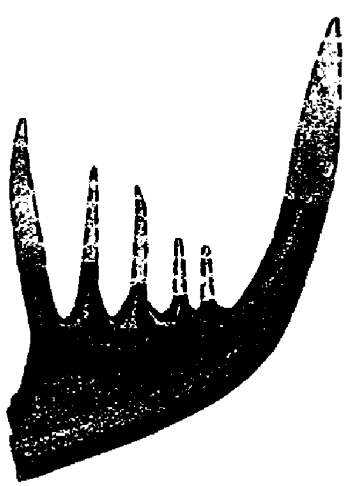


4a



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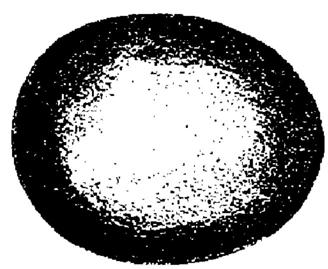


4b

Endoceras cf. annulatum
Ormoceras deckeri (New sp. to be described by Dr. Foerste)
Eridoconcha simpsoni
Primitiopsis bassleri
Prionodus aculeatus
Schmidtella cf. affinis
Bumastus erastusi (pygidium)
Ceraurus sp. (spine)

STRATIGRAPHIC RELATIONS

As noted above, the Tulip Creek has a very limited distribution in its outcrops, occurring only in the western part and on the south side of the mountains. The fossils in the upper and middle parts are Black River types and several of them continued on into the Bromide. Accordingly, the Tulip Creek and Bromide are thought to be closely related. Then there is thought to be a large hiatus at the base of the Tulip Creek representing nearly all of upper Chazy time.(See fig 2). The limited number of bryozoa sectioned and studied add corroborative evidence to the other faunules in the assignments made as to the age of the formation.

THE BROMIDE FORMATION

This formation is named for the town of Bromide where the type section was made on a hill northwest of the Galbraith Hotel. The upper part of the Simpson is exposed at this locality in the eroded crest of a westward plunging anticline. Bromide is here used for the upper part of the Simpson in most of its outcrops, and it includes also those rocks which were temporarily placed in the Criner member and Criner formation. This is in line with Ulrich's expressed purpose in regard to Black River and Trenton as follows: "As used by me in the past two years the Bromide includes all beds of Black River and Trenton ages that were deposited in the Arbuckle region[15]."

CHARACTER AND DISTRIBUTION

The Bromide consists of a basal sandstone with numerous alternating limestones and shales above, and locally, a thin in-

EXPLANATION OF PLATE XII.

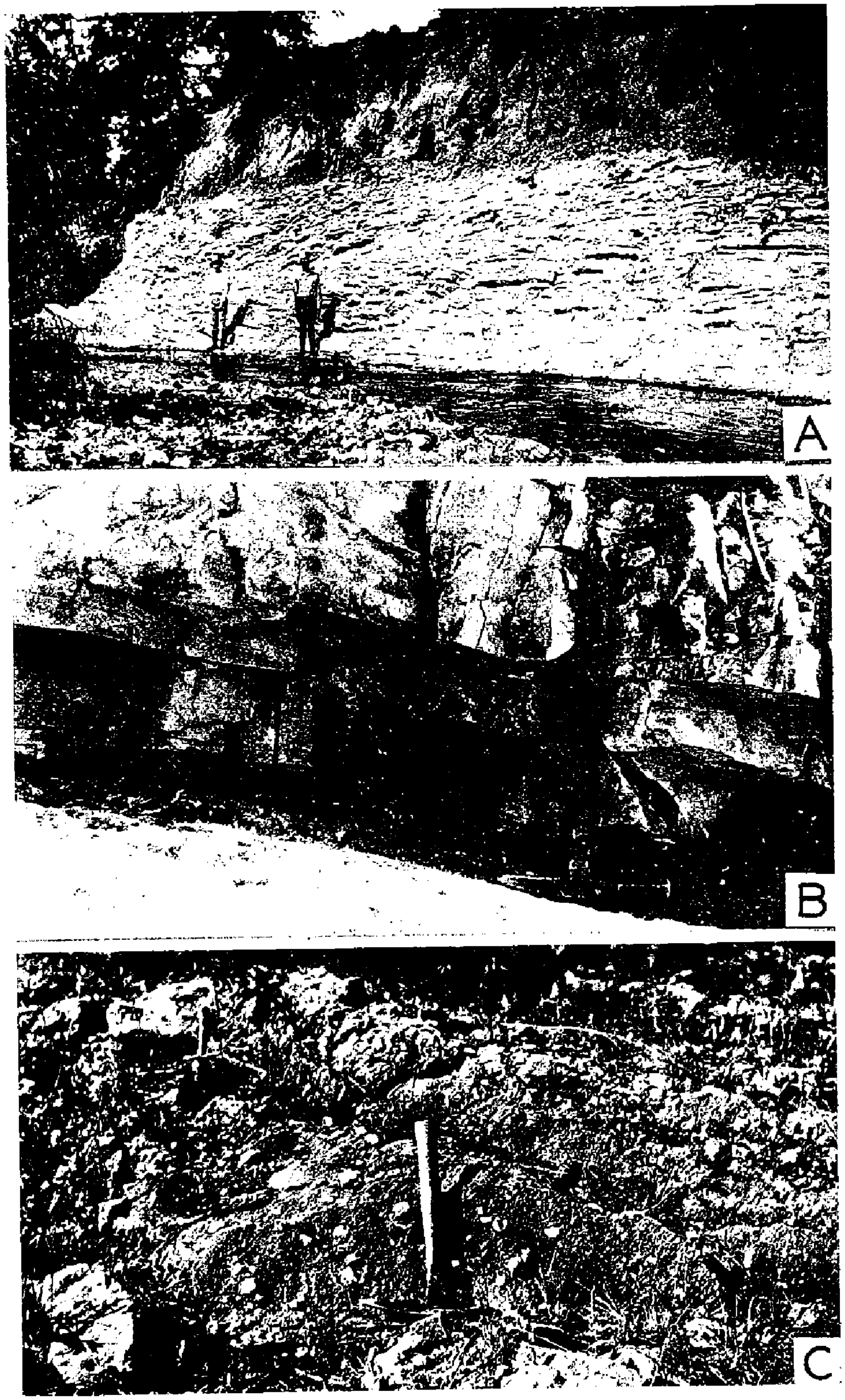
A. Thin argillaceous limestones of the upper part of the Bromide formation from which the uppermost beds have been eroded, the evidence of which is shown in B of this plate. The beds are dipping about 45 degrees southwest away from Norval Ballard on the left and Ross Maxwell on the right. The limestones are covered above by some limestone shingle and about 12 feet of flood plain alluvium.

B. Three inch clay bed marking the contact of the Bromide below with the Viola above. This seems to be a residual clay representing an erosional interval. Contributory evidence of erosion is shown by a thin layer of bog iron ore on top of the clay bed. This illustration was taken only a few hundred feet to the northwest of the one in A of this plate. Both were taken at Rock Crossing of Hickory Creek in sec. 35, T. 5 S., R. 1 E., in the Criner Hills.

C. Breccia with chert fragments standing out on the surface. This seems to mark a fault by which the middle part of the Viola has been brought in contact with the basal part of the Bromide, at north edge of sec. 2, T. 1 N., R. 6 E. However, in the eastern part of the mountains, a cherty conglomerate generally separates the Viola from the Simpson in such a way as to indicate that it represents an erosional interval. All photos of plate XII by C. E. Decker.

15. Ulrich, E. O. Unpublished Correspondence, Letter of Nov. 11, 1929.

PLATE XII



traformational sandstone occurs. The basal sandstone, particularly in the southern and western parts of the mountains, consists of sandstones, green shales, and a few sandy limestones. These shales may be seen to some extent in the sections near Highway 77 and on West Spring Creek, but they are exposed best on the West Branch of Sycamore Creek in sec. 27, T. 3 S., R. 4 E. This basal sandstone is thin in the eastern part of the mountains varying from 8 to 38 feet, 52 feet on Highway 77, and 283 feet, with the included shales, on Sycamore Creek. The basal sandstone is commonly followed by sandy limestones and these in turn by several shale zones separated by thin limestones. The upper part of the formation generally consists of limestones thin bedded below and massive at the top in contact with the Viola. The thin beds are exposed well on the southwest side of Hickory Creek at Rock Crossing in the Criner Hills where they are very argillaceous. A view of these thin beds is shown (Pl. XII A). Norval Ballard is standing near the left of the picture and Ross Maxwell nearer the center. The dip is 45 degrees to the southwest away from them. The massive beds at the top are very characteristic of the Bromide in most of its outcrops. This zone of heavy beds is generally 10 to 15 feet thick. This massive zone thins northeastward and has slight development in some sections in the eastern and northeastern parts of the mountains, though it holds its thickness along the entire south side to the Robertson ranch south of Bromide. These massive beds are in marked contrast with the relatively thin beds of the Viola above. This contrast usually forms a ready means of finding the Simpson-Viola contact and so marked is the contrast that the contact can be seen generally at considerable distance. At one locality on the south side of Colbert Creek, four miles southwest of Davis, about 30 feet of thin limestones occur between the heavy beds and the typical Viola.

The Bromide is very widespread in its distribution, and it occurs in practically every outcrop of the Simpson except on

EXPLANATION OF PLATE XIII.

A. Two cystid plates from the upper cystid zone about the middle of the Bromide formation. They occur from Bromide and the McLish ranch on the east to U. S. Highway 77 and southward to the Criner Hills. They seem to be plates of *Glyptocystites logani*.

B. *Glyptocystites logani*, two plates of which are shown in A of this plate.

C. A small sponge, *Ischadites iowensis*, which occurs about 30 feet above the top of the sandstone at the base of the Bromide formation.

D. *Illaenus americanus*, from near the top of the Bromide at Rock Crossing in the Criner Hills. Fragments of this were found at a number of localities in the Arbuckle Mountains.

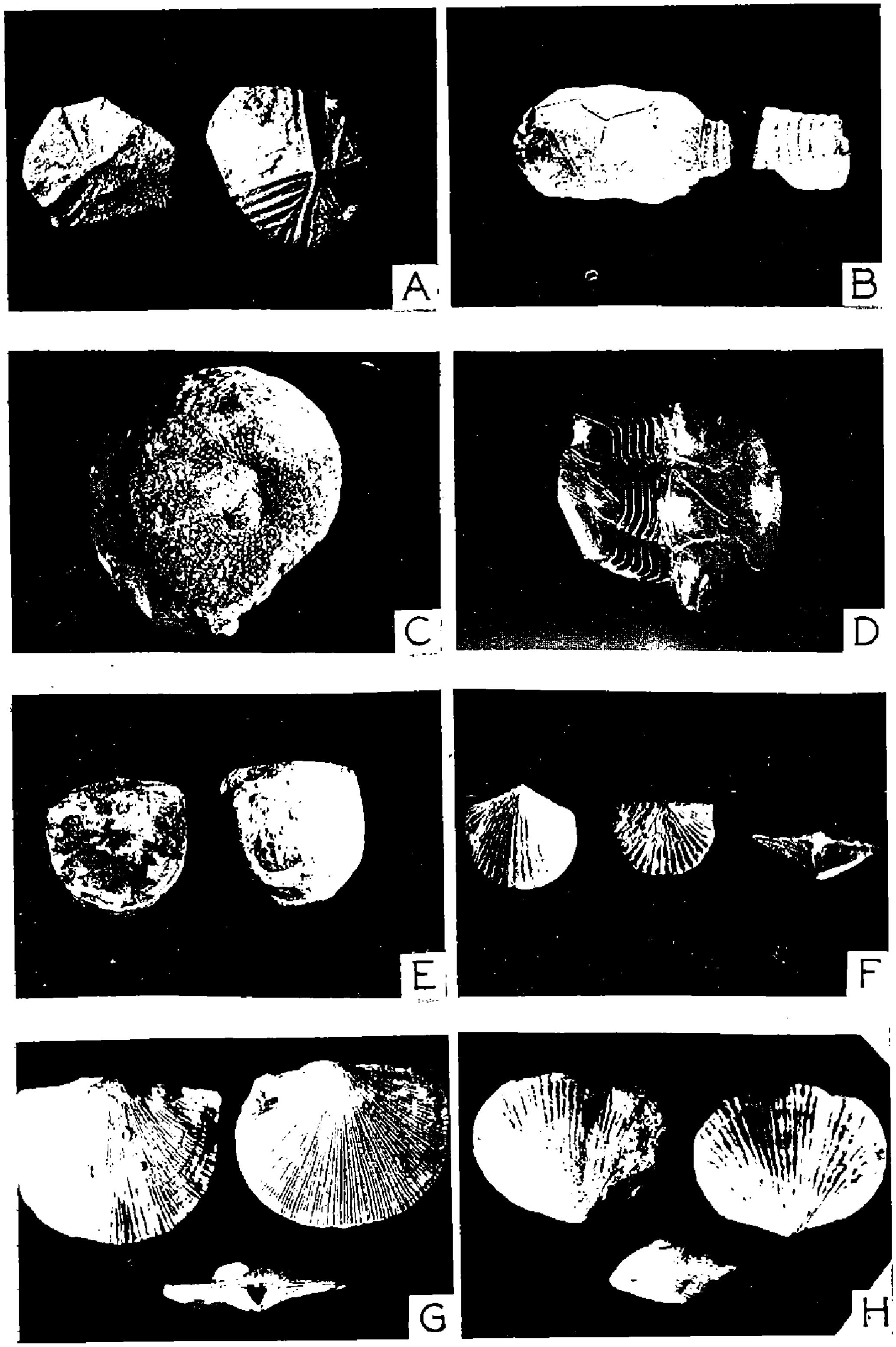
E. *Rafinesquina minnesotensis*, a brachiopod which is found in great numbers in a horizon a short distance below the top of the Bromide in practically every outcrop of the formation. The species frequently ranges down 50 to 100 feet lower, generally being more sparsely scattered in the older beds.

F. *Orthis tricenaria*, a very common brachiopod in the Bromide ranging somewhat differently in different sections from near the top almost down to the top of the basal sandstone. The three views beginning at the left are pedicle, brachial and cardinal.

G. *Dinorthis subquadrata*, a brachiopod which is very common near the top of the Bromide and may range through 50 to 100 feet of strata.

H. *Cliftonia gouldi*, a most characteristic brachiopod which commonly occurs in a zone about 100 to 150 feet below the top of the Bromide. Photos by Ray L. Six.

PLATE XIII



the north side of the West Timbered Hills, at Hickory, and on the Horse Shoe ranch. Besides its numerous outcrops in the Arbuckle Mountains, it occurs at both ends of the Criner Hills and on the north side of the Wichita Mountains (Pl. I, in pocket).

TOPOGRAPHIC EXPRESSION

The upper part of the Bromide commonly occurs part way up the slope of the Viola hills and the less resistant shales and thin limestone generally form a low irregular plain at the base of these hills.

THICKNESS

The thinnest exposed section is on the north side of the Wichita Mountains south of Gotebo where it is about 86 feet thick[16], while it has a thickness of 440 feet on Sycamore Creek. The thick ness on Highway 77 is 427 feet; on West Spring Creek 403 feet; at Rock Crossing, south end of the Criner Hills, 351 feet; P. A. Norris Ranch, 145 feet; and on Lick Creek, 450 feet.

AGE AND CORRELATION

The Bromide is considered Black River in age and is thought to be closely related to the Plattin of Missouri and the Platteville of Wisconsin and Illinois, and contains many of the Black River forms of Minnesota. Also, some forms which are more characteristically Trenton occur in the upper part with those of Black River age. (See table I, page 48).

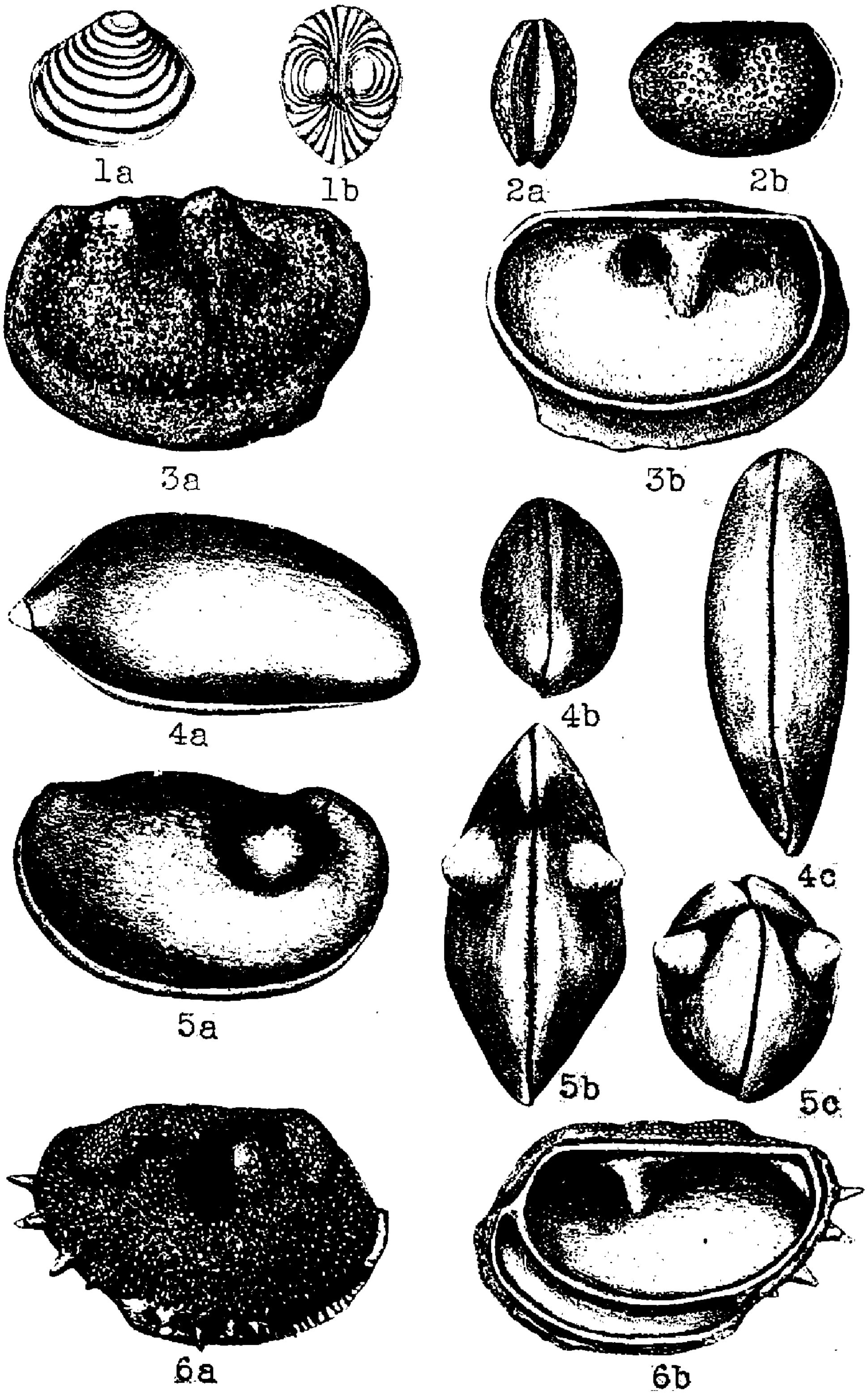
The Bromide is an extremely fossiliferous formation. While some sections are much better for collection than others, good zones may be found on nearly every section. The Bromide illustrates well how some fossils are wide in their distribution and others local. The most outstanding and significant characteristic of the fauna of the upper part of the Simpson is the *Rafinesquina minnesotensis* zone which is found in practically every outcrop of the upper part of the Simpson. This zone, with other associated fossils, serves to tie the scattered outcropping parts of

EXPLANATION OF PLATE XIV.

1. *Eridoconcha simpsoni* n. sp.: a, side view, right valve; b, dorsal view, complete carapace. Bromide and Tulip Creek formations. X33.
2. *Primitiopsis bassleri* n. sp.: a, anterior, female form; b, side view, left valve, female form. Bromide and Tulip Creek formations. X33.
3. *Dicranella macrocarinata* n. sp.: a, side view, right valve; b, interior view, right valve. Bromide formation. X33.
4. *Krausella arcuata*, Ulrich: a, side view, right valve; b, anterior; c, dorsal. Bromide formation. X33.
5. *Leperditella? deckeri* n. sp.: a, side view, right valve; b, dorsal; c, anterior. Bromide formation. X33.
6. *Bromidella reticulata* n. gen. and sp.: a, side view, left valve; b, interior, left valve. Bromide and Oil Creek formations. X33. Drawings by L. I. Price.

16. In a well, the Tah-hah-Ta-Tite No. 1, sec. 13, T. 7 N., R. 16 W., about 6 miles north of the Simpson outcrops, 1466 feet has been taken as the total thickness of the Simpson, though the actual thickness is doubtless less, as the rocks probably dip some to the north. The log does not give sufficiently specific information to recognize and distinguish the separate formations of the Simpson.

PLATE XIV



the uppermost Simpson in a very clear cut way into one formation, the Bromide. *Rafinesquina minnesotensis* is commonly found in great numbers near the top, and in some sections this species ranges through an upper zone of several feet in thickness. In many localities the limestones are so filled with the shells of this species that they may well be called shell limestones. A picture of one of the smaller types of this form is shown in Plate XIII E. Two zones of the sponges occur, *Receptaculites occidentalis* near the top and *Ischadites iowensis* a short distance above the basal sandstone. An illustration of *Ischadites iowensis* from the lower of the two zones from the east side of Highway 77 is shown in Plate XIII C. This *Ischadites* in the lower part of the Bromide is found widespread in the central and western part of the Mountains and the Criner Hills. The *Ischadites* of the upper zone are commonly large and generally are closely associated with the *Rafinesquina minnesotensis,* usually occurring near them in the heavy beds at the top, but in some localities they range down for 20 to 30 feet below the heavy beds. It may also be noted that a small species of *Ischadites* is found up in the middle of the Viola. Another larger sponge, *Receptaculites occidentalis,* very commonly occur with the *Ischadites* in the upper heavy beds. Some species of the genus *Receptaculites* range down to the middle of the Oil Creek formation and others up into the middle of the Viola.

One of the most common and widespread of the brachiopods is *Dinorthis subquadrata.* In the eastern part of the mountains this form commonly occurs in the topmost beds of the Bromide, and some of the individuals occur silicified on the surface of the limestones. In the western part of the mountains they are generally found near the top of the Bromide but locally they may range down about 75 feet below the top. Illustrations of this species are shown in Plate XIII G. in which the brachial view is at the left, a pedicle view at the right, and a cardinal view at the bottom.

One of the most common and characteristic brachiopods of the western and southern part of the region is *Cliftonia gouldi.* West of Nebo the gouldi zone is only about 25 feet below the top of the Bromide. At the south end of the Criner Hills *gouldi* is found within 10 or 15 feet of the of the top but it is thought that some of the top of the Bromide has been eroded at that locality. Along Highway 77 the gouldi zone is found at the base of zone 10 and top of zone 11 of the detailed section, about 150 feet below the top of the Bromide. On west Spring Creek the gouldi zone is about 180 to 190 feet below the top of the Bromide. Illustrations are shown of the pedicle valve at the left, the brachial valve at the right, and a cardinal view at the top (Pl. XIII H).

Another very common brachiopod in the Bromide is *Orthis tricenaria.* This form generally occurs near the gouldi zone, but on the west side of Highway 77 it ranges down almost to the top of the basal sandstone. Pedicle, brachial, and cardinal views of *Orthis tricenaria* are shown. (Pl. XIII F).

A marked upper cystid zone of the Simpson occurs about 30 to 40 feet above the basal sandstone in the Criner Hills and northward in the Arbuckle Mountains and eastward to the vicinity of Bromide and Franks. Loose plates are most common as shown in Plate XIII A., but complete specimens of several species were found on the east side of Highway 77, on Sycamore Creek, and on the east side of the McLish ranch northwest of Bromide. An illustration of one of these forms from Sycamore Creek, *Glyptocystites logani,* is shown in Plate XIII B.

Monotrypa magna is one of the common bryozoans which is widespread in its distribution, occurring generally near the middle of the formation. Associated with this form another species, *Stictoporella cribrosa,* is also very widespread. Some of the forms which are very abundant but have local distribution *are Camarella* cf. *volborthi,* and *Rhychotrema minnesotense.*

As a gastropod bed occurs a short distance below the top of the Arbuckle limestone, one is found in a similar manner very widespread a short distance below the top of the Bromide. Lower down in the Bromide a cephalopod zone extends from the Wichita Mountains outcrop to the Criner Hills and throughout the Arbuckle Mountain region. A rich ostracode fauna occurs in the Bromide, many species of which are new (Pl. XIV).

STRATIGRAPHIC RELATIONS

The Bromide is apparently conformable with the Tulip Creek in the western and southwestern part of the mountains or wherever the latter formation is present, and while it is apparently conformable on the McLish in the central, eastern, and northeastern areas a hiatus doubtless exists (See fig. 2) where the Tulip Creek is wanting. There is apparent conformity also in most sections with the Viola above, but at Rock Crossing at the south end of the Criner Hills an erosion interval between the Bromide and the Viola is shown by a clay bed and bog iron ore deposit between them. Plate XII B shows the basal beds of the Viola and the 2 to 3 inch clay bed beneath them. At a number of places in the eastern part of the mountains there is a conglomerate between the Simpson and Viola. Plate XII, C. shows a thoroughly indurated one north of P. A. Norris, ranch where the McLish is in contact with Middle Viola, the Bromide and Lower Viola having been eroded away or faulted out, or possibly both the agents of erosion and faulting may be responsible for the hiatus and unconformity.

TABLE I.

BROMIDE FOSSILS	LOCALITY																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Solenopora compacta						■		■										■					
Ischadites iowensis	■	■		■			■	■		■	■		■	■									
Receptaculites occidentalis	■	■	■	■	■	■	■		■	■				■									
Diplograptus maxwelli							■			■													
Stromatocerium ruginosum					■								■					■		■	■		
Tetradium cellulosum						■	■									■	■						
Amygdalocystites florealis								■															
Cheirocrinus logani													■						■				
Lepadocystites moorei?																			■				
Archaeocrinus subglobosus							■	■															
Carabocrinus tumidus				■				■			■		■							■			
Carabocrinus cf. vancortlandi							■						■										
Cleiocrinus regius																				■			
Dendrocrinus rusticus								■															
Periglyptocrinus priscus								■					■										
Chasmatopora reticulata							■																
Corynotrypa delicatula	■						■																
Diastoporina flabellata							■																
Homotrypella cf. ovata							■												■				
Monotrypa magna	■			■	■		■										■	■	■			■	
Pachydictya occidentalis											■			■								■	
Prasopora simulatrix	■	■		■	■	■					■		■						■			■	
Rhinidictya exigua							■																■
Rhinidictya mutabilis							■																■
Rhinidictya mutabilis major																						■	
Rhinidictya cf. neglecta																						■	
Stictopora elegantula												■											
Stictoporella cribrosa					■		■				■								■				
Camarella cf. volborthi																		■		■			
Cliftonia gouldi	■	■		■			■	■			■												
Crania granulosa				■																			
Crania trentonensis							■																■
Dalmanella fertilis	■																						
Dinorthis deflecta		■																					
Dinorthis subquadrata	■	■		■	■		■	■			■							■		■	■		
Hebertella bellarugosa	■			■			■																
Hebertella frankfortensis				■			■						■						■				
Lingula coburgensis							■																
Lingula cf. elegantula?							■																
Lingula eva							■																
Orbiculoidea cf. lamellosa							■																
Orthis tricenaria	■	■		■	■	■	■				■		■		■				■	■			■
Pianodema cf. subaequata				■			■																■
Plectambonites sericeus	■	■	■	■	■	■	■	■	■	■	■		■	■				■		■		■	■
Plectambonites sp? (small)	■	■	■	■	■		■	■		■	■		■										
Plaesiomys sp.							■																
Rafinesquina alternata	■		■				■													■			
Rafinesquina minnesotensis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Rafinesquina winchesterensis	■			■													■						
Rhynchotrema minnesotense			■	■		■				■							■						
Scenidium anthonense				■			■																■
Schizambon? dodgei							■																
Strophomena incurvata		■					■										■					■	■
Strophomena cf. planumbona							■																
Strophomena trentonensis	■	■		■			■				■												■
Zygospira nicolleti				■																		■	■

TABLE I (Continued)

BROMIDE FOSSILS	LOCALITY																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Archinacella valida																				■			
Clionychia rhomboidea						■																	
Cyrtodonta persimilis																	■						
Bellerophon platystoma																				■			
Bucania minnesotense						■																	
Eotomaria vicina																				■			
Liospira micula			■																				
Liospira progne	■																						■
Liospira sp.					■																		
Lophospira helicteres																	■						
Platyceras wisconsinense																	■						
Tetranota obsoleta	■		■		■								■							■			
Trochonema cf. bellum																				■			
Cornulites flexuosus							■																
Conularia sp.							■																
Cyrtoceras camurum																	■			■			
Cameroceras approximatum				■													■						
Endoceras proteiforme				■			■													■		■	■
Endoceras subanulatum	■																						
Gonioceras occidentale																	■						■
Orthoceras arcuoliratum				■															■				
Orthoceras beltrami																			■				
Spyroceras bilineatum																			■				■
Bromidella reticulata				■																			
Dicranella macrocarinata				■																			
Eridoconcha simpsoni				■																			
Krausella arcuata				■																			
Leperditella? deckeri				■																			
Primitiopsis bassleri				■																			
Amphilichas cucullus							■																
Amphilichas trentonensis							■																
Ampyx (Lonchodomas) mcgeheei							■																
Bumastus milleri																				■			
Ceraurus cf. bispinosus						■																	
Ceraurus pleurexanthemus							■																
Encrinurus vigilans							■																
Eoharpes bispinosus							■																
Illaenus americanus							■																
Isotelus gigas							■																
Pterygometopus callcephalus						■	■																
Thaleops ovatus							■															■	■

1. West Spring Creek
2. Spring Creek
3. Henryhouse Creek
4. U. S. Highway 77, North of Springer
5. Falls Creek
6. Lick Creek, or Colbert Creek
7. Rock Crossing, Criner Hills
8. Section 26, Criner Hills
9. North end of Criner Hills
10. Cool Creek
11. 2 miles west of Nebo store
12. 12 miles south of Sulphur
13. Sycamore Creek
14. S. E. of Sulphur, Sec. 7-1S-4E
15. S. E. of Sulphur, Secs. 26 & 35, 1S-4E
16. Fitzhugh
17. P. A. Norris ranch
18. 8 Miles northwest of Bromide
19. McLish ranch
20. Bromide
21. Robertson ranch
22. North side of Wichita Mountains
23. Platteville, Dixon, Illinois*

*Knappen, R. S., Illinois State Geological Survey, Bull, No. 49; pp. 59, 60, 1926.

DETAILED SECTIONS

In order to identify and correlate the various parts of the Simpson in its numerous outcrops nearly thirty different sections were studied in considerable detail. Where available, fossils were collected from specific horizons. These collectons were made not only along the line of the measured section, but generally also along the strike of the beds at considerable distance either side of the section. Nine of these sections are included in this publication.

For the information in these tables the field and laboratory studies on the fossils were conducted by C. E. Decker and assistants, while the chemical tests on the rocks were made by C. A. Merritt and assistants.

The section (Table III) on West Spring Creek is from the extreme west end of the Arbuckle Mountains. At that locality the Joins formation is well developed and consists chiefly of thin limestones. At some places it is difficult to determine its upper limit except by means of fossils, as the basal sandstone of the Oil Creek formation, thins, lenses out and apparently disappears locally. Even though the basal sandstone almost disapears, the Oil Creek formation has its greatest development at this locality. This extensive development was accomplished by a marked thickening of both the limestones in the lower part and the shales in the upper part. From this locality the Oil Creek thins markedly toward the east and northeast (Fig. 2). The sandstone at the base of the McLish formation is more indurated here than in any other part of the mountains. A few feet of limestones occur above this basal sand and the rest of the formation consists of several hundred feet of shale with a few thin intercalated limestones. Besides the poorly indurated sandstone at the base, the Tulip Creek formation consists chiefly of shale with some sandy limestones. As at many localities, the basal sandstones of the Bromide formation are separated by shales. A considerable amount of shale occurs above the basal sandstones. These shales are best exposed near the dam on Spring Creek about 3 miles to the southeast. The upper part of the Bromide consists chiefly of thin fossiliferous limestones with a few typical heavy beds at the top.

The Springer section (Table IV) on U. S. Highway 77 has all five formations of the Simpson well developed. Not only was this one of the first sections studied, but, because of accessibility, it is studied more now than any other section. Good outcrops of the formations occur at considerable distance, both east and west of the highway.

The section on Sycamore Creek 7 miles northwest of Ravia

Correlation Table of Formations of Simpson Group

With thickness of formation, basal sandstones, and Birdseye limestone in feet and inches in as far as possible to measure.

TABLE II

GENERAL EASTERN SECTION		1*** West Spring Creek	2 Spring Creek	4 Ardmore-Davis U. S. Hy. No. 77	6 Lick Creek S. W. of Davis	7 Criner Hills Rock Crossing	9 Criner Hills North End	11 Nebo, South of of Sulphur	13 Sycamore Creek	14 East of Sulphur	17 P. A. Norris Ranch	19 McLish Etc. 2-2S-7E 36-1S-7E 12-1S-7E	20 N. E. of Bromide and Artesian Well No. 3	21 Robertson Ranch South of Bromide	22 N. Side of Wichita Mts. Rainy Mts., Middle Hill	24 North Edge West Timbered Hills	25 Hickory	26 Roff
BLACK RIVER	Name	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE	BROMIDE			BROMIDE
	Thickness	403	421	427-6	450	351	316±	329	440-2	†	145	183	291	325	86-6			†
	Basal Sandstone	38	75	52	74	75		38	283		35	35	10	8	18			
	Shale in Sandstone	Some		Some		Much		Some	85									
	Name	TULIP CREEK	TULIP CREEK	TULIP CREEK	TULIP CREEK		TULIP CREEK	TULIP CREEK	TULIP CREEK									
?	Thickness	271-6	216	394-7	192		530±	468± x	380									
	Basal Sandstone	40	68	166 "Wilcox"	124			300±	175									
	Shale in Sandstone			A Little	24 Ls.			Some	Some									
CHAZY	Name	McLISH	McLISH	McLISH	McLISH		McLISH	McLISH	McLISH	McLISH	McLISH	McLISH	McLISH	McLISH				McLISH
	Thickness	334-6	271	475-4	339		428±	378±	533-6	†	437	314	395±	369				120±
	Basal Sandstone	126	178	55 "Burgen"	57			246±	160		170	176 & Dol.	125	201				75 "Burgen"
	Shale in Sandstone								Some									
	"Birdseye" Limestone						85			20	113**	42	85	51				25■
	Name	OIL CREEK	OIL CREEK	OIL CREEK	OIL CREEK		OIL CREEK	OIL CREEK	OIL CREEK	OIL CREEK	OIL CREEK	OIL CREEK †x	OIL CREEK	OIL CREEK		OIL CREEK	OIL CREEK	OIL CREEK
	Thickness	1075	844±	681-6	443		648±	409	803-1	†	46†		204±	260±		96	350±	100±
	Basal Sandstone			19	76			220	178		27		193	165±		24	254±	65±
	Shale in Sandstone																	
	Name	JOINS	JOINS	JOINS	JOINS		JOINS	JOINS*	JOINS							JOINS		
	Thickness	149-2	296±	294-2	112		198±	21±	162							100		
	Basal Conglomerate	0-4	0-4	1	0-6		0-9		0-9							0-4		
	Total Thickness	2233-2	2048±	2273	1536±	351	2120±	1605±	2318-9	?	628	497	890±	954±	86-6	196	350±	220±

*This small amount of Joins is exposed in Sec. 36-2S-3E about two miles south of where section 11 was measured.
***Sections in this table have been numbered to correspond as far as possible with those in Table I.

†Present but difficult to secure accurate measurement.

■Southeast of Park; also, outcrops of birdseye limestone occur, one mile north and 2 1-2 miles northeast of Roff.

**Birdseye with included sandstones and shales.

xAt Coatsworth School and westward.

(Table V) has all five formations present, but the Joins has thinned materially. The Oil Creek sand has increased to nearly 200 feet in thickness. The Bromide is particularly well exposed and very fossiliferous. Much shale alternates with the sandstone at the base of the Bromide. At this locality the Simpson group has the greatest total thickness of any measured section.

The section (Table VI) on the P. A. Norris ranch is of great importance because in it may be seen many of the characteristics of the Simpson of the eastern part of the mountains. Only three instead of five formations occur, the Joins and Tulip Creek being absent. In the McLish formation dolomites and dense birdseye-like limestones occur which are so characteristic of this formation in the central and eastern part of the mountains. Numerous thin sand and shale zones occur and to the southeast conglomerates are found in such a way as to indicate the shallow nature of the deposits that formed these rocks. In the Bromide part of this section a number of fossils occur which are found at similar horizons in most of the outcrops of the Bromide formation. Thin *Tetradium* zones occur practically at the top of the Bromide as at Fitzhugh, Colbert Creek, and Rock Crossing, Criner Hills. The *Rafinesquina minnesotensis* zone is well developed here as elsewhere near the top of the Bromide. Lower down *Orthoceras* and *Monontrypa magna* zones are well developed, and *Stictoporella cribrosa* occurs. The Oil Creek formation is very thin at this locality with evidences of erosion both at the base and at the top. A red oxidized clay bed (Pl. IV E) marks the contact with the Arbuckle limestone, and a limestone conglomerate occurs at the top at many places in the eastern end of the mountains (Pl. IV A). This is the thinnest section of the Simpson in which all three of the formations which are found in this general region are present (Table II, 17).

The section at Bromide is a composite one (Table VII). The Simpson is exposed at this locality in the eroded crest of a small anticline. Only the upper part of the Bromide outcrops and it is difficult to tell where the base should be placed because some of the log of the well showing the lower part is not complete. In the upper part of this section a number of forms occur which are found widespread in the upper part of the Bromide, and only a very few with local distribution. The upper cystid zone is well developed, as well as *Monotrypa magna,* and *Stitctoporella cribrosa* zones. A very fossiliferous horizon in the Bromide occurs on the east side of the McLish ranch about 2 miles west of Bromide.

The section at Rock Crossing is at the south end of the

Criner Hills (Table VIII). At this locality only the Bromide is exposed and not all of this formation is represented, as a considerable amount of the upper part is thought to have been eroded away. Yet the section is considered important because it is the most southwesterly outcrop of the Simpson, and the argillaceous limestones are very fossiliferous. The heavy beds, typical of the top of the Bromide generally, are absent from this locality. While some forms occur here which have not been found elsewhere, several of the main fossil horizons typical of the Bromide in other areas are well developed here, such as the *Cliftonia gouldi* zone, the *Dinorthis subquadrata* zone, the *Plectambonites sericeus* zone, the *Orthoceras* zone, *Stictoporella cribrosa* zone, and *Ischadites iowensis* zones. While these zones correlate well with those in many other sections, the intervals between them are decreased materially at this locality.

The section on the south side of Lick Creek (Table IX) is of interest because it is on the north side of the Arbuckle anticline. While all five formations are present, there is a marked decrease in thickness. The total thickness here is 1,536 feet as compared to 2,273 in the Springer section. This is a decrease of over 700 feet, or a decrease of about one-third of the total in the Springer section. This marked decrease in thickness is significant also, as it occurs in a distance of only about 8 miles. An excellent complete section of the Simpson occurs on the south side of Colbert Creek about 2 miles north of the one shown in this section. Under 6 (Table 1) the relatively large number of forms are shown which are found in this short section. Furthermore, that table shows that most of the forms found at this locality occur also in other localities.

Two short sections occur at the northwest edge of the Wichita Mountains (Table X) and so far as known, they represent the only outcrops of the Simpson of that region. They are related to two of the four outcrops of Viola. The first section is from the southwest edge of the hill which occurs furthest to the northwest. Only a small part of the typical Bromide is exposed here, but it contains sufficient fossils which are characteristic of the formation of the Arbuckle Mountains and the Criner Hills to correlate it definitely with horizons of the formation there. In the hill next to the one at the southeast a more extensive outcrop of the Bromide occurs along the south slope of the hill in which the dip is to the northeast. At this last locality, chiefly shales and sandstones with only a minor amount of thin limestones characterize the Simpson. The shales and limestones contain *Monotrypa magna, Plectambonites sericeus* and a number of other Black River forms characteristic of the Bromide.

From the study of these published sections and others which are not included two outstanding types of evidence have been secured. One is with reference to the faunas. While some of the forms are local in distribution, others are widespread as are several zones in the Oil Creek, the lower cystid zone in the McLish, and several zones in the Bromide. The forms have served not only to correlate the outcrops of the Simpson in a satisfactory manner, but also to correlate them with formations hundreds, and in the case of a graptolite, thousands of miles away.

The other is with reference to the variable character of the Simpson. Thin at the north and east, thick at the south and west, it often changes rapidly in a short distance. It is thought that most of the changes can be explained by a variable land mass to the northeast and a shore line which shifted toward the southwest and back several times, during the period of deposition of the sediments in the Simpson group.

TABLE III.

Detailed Section of the Simpson Group

Section, West Spring Creek, East of Pooleville, Oklahoma. Dip 23° to 25° S.W. (No. 1.)

BED NO.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					BROMIDE FORMATION 403 FEET				
1	16	6	16	6	Thick gray limestones with *Receptaculites occidentalis, Stromatocerium ruginosum.*	6	93	1	Angular quartz and a few rounded, glassy grains 1.0 mm. diam.
2	30		46	6	Thin yellow and gray limestones. Gastropod bed, *Tetranota obsoleta.*	4	95	1	Shale and fine angular quartz.
3	19	6	66		Thin limestones, *Rafinesquina minnesotensis. Liospira progne, Tetranota obsoleta.*	5	94	1	Rounded, glassy quartz 0.15 to 0.25 mm. diam. Minor iron stain.
4	45		111		Thin shaly limestones.	14	62	24	Angular quartz and silt.
5	19	6	130	6	Shaly, grass covered. Large Bryozoa.				
6	17	6	148		Yellow and gray limestone with about one-sixth of zone more resistant at base. *Strophomenas* near top, large *Orthoceras* near base, *Endoceras subannulatum.*	6	93	1	Semi-rounded, glassy quartz 0.1 mm. and one rounded 0.75 mm. diam.
7	45		193		Thin limestones, more resistant at base. Contain *Cliftonia gouldi.* Equals zones Rock Crossing, Criner Hills, and zone 11 of Springer section.	8	91	1	Angular, milky quartz and silt. Minor iron staining.
8	51	6	244	6	Mostly shaly slope, grass covered. Large bryozoa. *Ischadites* cf. *iowensis.*	10	86	4	Iron stained silt.
9	10		254	6	Rough yellow coarse limestone, resistant.	12	83	5	Semi-rounded glassy quartz 0.1 diam. Angular, milky quartz and minor iron staining.
10	15		269	6	Shale interval.				
11	4	6	274		Coarse brown limestone.				
12	7	6	281	6	Mostly shale with some thin limestones at base. *Dalmanella fertilis, Dinorthis subquadrata, Hebertella bellarugosa, Orthis tricenaria.*				

TABLE III.—(Continued)

BED No.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
13	18		299	6	Shale and a few thin limestones. Brachiopods and bryozoa weathered on surface. *Prasopora simulatrix, Rafinesquina winchesterensis, Strophomena trentonensis.*				
14	10	6	310		Shales and thin limestones. Large bryozoa. *Monotyrpa magna.*	8	89	3	Rounded, glassy quartz 0.05 to 0.1 mm. diam. Minor iron staining.
15	18		328		Shales and thin limestones. Bryozoa and *Plectambonites sericeus.*	12	87	1	Rounded, glassy quartz 0.1 mm diam. Minor iron staining.
16	27		355		Shale, grass covered.				
17	12	6	367	6	Brown fine grained sandstone.				
18	10		377	6	Covered, shale or soft sand.				
19	25	6	403		Sandstone.				
					TULIP CREEK FORMATION 271½ FEET				
20	42	6	445	6	Fissile green shales and a few thin sandstones	8 1	90 13	2 86	(Sand.) Fine angular quartz. (Shale.) Silt
21	4		449	6	Resistant ledge of heavy sandstones.	2	20	78	Iron coated quartz rounded, 0.1 to 0.35 mm. diam. Excessive iron staining.
22	17	6	467		Fissle green and brown shales.	1	0	99	Green silt.
23	1		468		Sandstone containing gastropods and cephalopods.	6	84	10	Semi-rounded, glassy quartz 0.1 mm. Many rounded also 0.1 mm. diam. A few rounded, glassy 0.3 mm.
24	15		483		Green and brown fissile shale.	7	4	89	Green silt.
25	1		484		Sandstone and dark sandy limestone. Brachiopods.	20	72	8	Rounded, glassy quartz 0.1 to 0.3 mm. diam. A few 0.5 mm.

TABLE III.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
26	16	6	500	6	Green and brown fissile shales.	0	1	99	Silt.
27		6	501		Gray calcareous sandstones with gastropods, cephalopods, and bryozoa.	4	91	5	Rounded, glassy quartz 0.1 to 0.3 mm. diam. Some rounded 0.05. Shale and minor iron staining.
28	18	6	519	6	Shales and thin sandstones resistant sandstone at the base.	1	8	91	Silt.
29	105		624	6	Grass covered, shale or soft sand.				
30	50		674	6	White to brown fine sandstone. (Wilcox.)........................				Sand.
					McLISH FORMATION 334 FEET 6 INCHES.				
31	137	6	812		Mostly green fissile shales with a few thin limestones and sandstones.	5	5	90	Green silt.
32	12		824		Shales and thin limestones. *Valcourea strophomenoides.*	13	72	15	Semi-angular quartz 0.15 mm. and iron stained silt.
33	35		859		Thin brown coarsely crystalline limestones. Brachiopods, bryozoa, cystid plates, *Paleocystites tenuiradiatus.*	17	81	2	Glassy, semi-rounded quartz 0.1 and 0.5 to 0.10 mm. diam. Rounded. Minor iron staining.
34	150		1009		Mostly even bedded white and yellow sandstone, som cross-bedded. Surface case hardened, soft inside.(Burgen)	7	21	72	Glassy, semi-rounded quartz 0.25 to 1.0 mm. diam.
					OIL CREEK FORMATION 1,075 FEET.				
35	50		1059		Thin brown limestones and shales. Small ramose bryozoa.	11	80	6	Glassy, semi-rounded quartz 0.1 mm. to 0.2 mm. diam. Some silt, and a little glauconite. Minor iron staining.
36	25		1084		Covered in flood plain of creek.				
37	3		1087		Thin limestones and grayish green shale. *Dinorthis pectinnella.*	7	68	25	Mostly iron stained silt.
38	13	6	1100	6	Covered on flood plain.	8	91	1	Semi-rounded, glassy quartz 0.05 and a few round glassy grains 0.2 mm. diam. Minor iron staining.

TABLE III.—(Continued)

BED NO.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
39	12	6	1113		Coarse gray limestones, sandy at top.				
40	13	6	1126	6	Green shales.	3	90	7	Silt and semi-rounded, glassy quartz 0.05 diam. Minor iron staining.
						4	94	2	Shale. Green shale.
41	82	6	1209		Mostly thin limestones, some shaly.	16	77	7	Silt and minor iron stain.
42	7	6	1216	6	Mostly shale, some fine sandy limestones (Lime) at base.	3	35	62	Semi-rounded, glassy quartz 0.1 mm. diam.
					(Shale)	0	2	98	Green shale.
43	42	6	1259		Shale—grass covered.				
44	15		1274		Thin gray and brown limestones.	8	67	25	Semi-rounded, glassy quartz 0.15 mm. diam. and a little silt.
45	7	6	1281	6	Green fissile shale.	8	89	3	Iron stained silt.
46	2	6	1284		Yellow limestones cystid plates and stems.	17	72	11	Green shale and a few semi-rounded, glassy quartz 0.05 to 0.15 mm. diam.
47	17	6	1301	6	Alternating shales and limestones, mostly shale, *Stropohmenas.*	8	88	4	Iron stained silt.
						7	26	67	Shale.
48	125		1426	6	Largely grass covered.				
49	0	2	1426	8	Dinorthis pectinella zone.	3	8	89	Iron stained quartz rounded 0.3 and 0.75 to 1.0 mm. diam.
50	30		1456	8	Sandstone and sandy limestone.	12	86	2	Iron stained silt. Pyritohedrons, now limonite. Some semi-rounded, glassy grains of quartz 0.2 to 0.3 mm. diam.
51	15		1471	8	Thin gray limestones, gastropods and ostracodes at base.				

TABLE III.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
52	30		1501	8	Sandstone and sandy limestone.	10	86	4	Rounded, glassy quartz 0.1 to 0.35 diam. A little silt.
53	16		1517	8	Thin fine gray limestones, gastropods, ostracodes.	3 2	75 96	12 2	Semi-rounded, glassy quartz 0.1 mm. diam. Semi-rounded, glassy quartz 1.0 mm. Minor iron staining.
54	36		1553	8	Brown and gray limestones. Gastropods and trilobites.	13	60	27	Fine, angular quartz.
55	27		1580	8	Thin limestones on weathered slope. Numerous bryozoa.	7	66	27	Semi-rounded, glassy quartz 0.05 to 0.1 mm. diam. Minor iron staining.
56	2		1582	8	Thin brown limestones. Bryozoa, gastropods and cystids.	15	81	4	Semi-rounded, glassy quartz two sizes 0.1 mm. and 1.0 mm. diam. Some angular grains. Minor iron staining.
57	17	6	1600	2	Thin brown limestones and some sandstones.	7	89	4	Semi-rounded, glassy quartz 0.05 mm. Rounded 0.2 mm. diam. A few semi-rounded 0.4 mm. diam. Glauconite and minor iron staining.
58	37	6	1637	8	Thin limestones and shales.				
59	1	4	1639		Thin sandy limestone, numerous ostracodes.	12	87	1	Semi-rounded, glassy quartz 0.05 and a few 0.35 mm. diam. Minor iron staining.
60	27	6	1566	6	Soil covered.				
61	12	6	1679		Coarse yellowish brown sandstone. Trilobite fragments.	8	88	4	Iron stained silt and rounded, glassy quartz 0.1 to 0.25 mm. diam.
62	75		1754		Yellow and brown limestone, ostracodes. *Pliomerops nevadensis.* Bottom	13 8	86 88	1 4	Rounded, glassy quartz 0.5 mm. diam. Silt and a little glauconite. Angular, glassy quartz. Silt and some glauconite.

TABLE III.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
63	65		1819		Yellow and brown coarse crystalline limestone on slope. *Maclurites* sp.	8	90	2	Rounded, glassy quartz 0.1 to 0.5 mm. diam. Many semi-rounded 0.3 mm. diam. Glauconite and minor iron staining.
					Bottom	12	85	3	Silt and rounded, glassy quartz 0.1 to 0.5 mm. diam. Minor iron staining.
64	100		1919		Yellow and brown limestones. Brachiopods ostracodes and gastropods. *Receptaculites.*	9	90	1	Iron stained silt.
65	60		1979		Thin and thick yellow limestones, ostracodes, brachiopods and trilobites. *Clitambonites multicosta.*	6	92	2	Green shale.
66	45		2024		Thin limestones. Ostracodes and brachiopods.	17	81	2	Semi-rounded, glassy quartz 0.15 mm. diam. and a few angular grains. Mostly silt.
67a.	60		2084		Thin limestones Pelecypod bed, base of zone, *Ctenodonta*?				
					JOINS FORMATION 149 FEET, 2 INCHES				
67b.	90		2174		Gray and yellow limestone in thin beds.				
68	36		2210		Thin limestones.	9	89	2	A few rounded, glassy quartz grains 0.15 to 0.25 mm. diam. Silt and minor iron staining.
69	23		2233		Thin gray limestones. Ostracodes.	8	90	2	Rounded, glassy quartz 0.3 to 0.75, a few 1.5 mm. diam., and angular larger. Semi-rounded, glassy quartz 0.05 mm. diam. Minor iron staining.
70		—2	2233	2	Breccia with gastropods in it. (Twenty-four feet above gastropod bed in upper part of Arbuckle.	7	92	1	Rounded, glassy quartz 0.1 to 0.3 mm. diam.
					TOTAL THICKNESS 2,233 FEET, 2 INCHES.				

Detailed Section of the Simpson Group

SPRINGER SECTION (No. 4.)

Measured for most part along the edge of Ardmore-Davis Highway (U. S. 77), but upper 579 feet measured about one-fourth mile west of the highway, starting at the top, at base of Viola. Dip 55° S.W., strike N. 60° W.

BED NO.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					BROMIDE FORMATION 427 FEET, 6 INCHES				
1a.	10	4	10	4	Heavy gray limestones. *Receptaculites occidentalis* zone.	11	88	1	Fine quartz.
1b.	20	6	30	10	Thin limestones. *Rafinesquina minnesotensis* zone, Gastropod bed of zone 1 at Bromide, *Tetranota obsoleta*.				
1c.	4	9	35	7	Mostly covered, probably shales and thin limestones.				
2	14		49	7	Thin limestones and shale, 18 inch bed of limestone at base contains *Rafinesquina minnesotensis*, *Rhynchotrema minnesotense*.	7	61	32	Silt.
3	14	5	64		Upper part thin limestones at top of which compact 6 inch limestone contains many Plectambonites sericeus. Two 12 inch beds at base of zone form resistant ledge.				Quartz 0.15-0.2 mm. diam., semi-rounded to rounded.
4	7	10	71	10	Mostly covered, probably shale and thin limestones.	0	95	5	Silt.
5	4	4	76	2	Mostly thin limestones. One bed 2 feet 6 inches thick is mottled with red and yellow. 5a 5b	0 13	99 86	1 1	Quartz 0.2 mm. diam. Quartz 0.3 mm. diam., semi-rounded.
6	6	4	82	6	Mostly covered. Probably shale with a few thin limestones.	0	97	3	Fine quartz and silt.
7	16	1	98	7	Thin bedded limestones 2 inches to 5 inches thick. This zone makes a low ridge between shales on either side.	0	98	2	Fairly well rounded quartz. 3mm. diam. some iron staining.
8	11	1	109	8	Thin limestones 1 to 3 inches thick. More shaly and less resistant in upper part. 8a 8b	13 5	54 91	33 1	Rounded quartz 4 mm. diam. Some black, opaque minerals. Silt.
9	4		113	8	Shale and thin limestones. Numerous bryozoa of which *Prasopora simulatrix* is most common. Also a few brachiopods, *Strophomena* sp.	7	67	26	Rounded quartz .2 mm., 5 mm. diam.

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION		DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
10	35	6	149	2	Brownish buff shales. Very fossiliferous. Collections made from top, middle and bottom of zone. Ostracodes abundant.	10a	7	41	52	Shale.
						10b	0	99	1	
						10c	0	80	20	Fine quartz and silt.
						10d	9	87	4	Silt.
						10e	0	27	73	Shale, very little quartz.
11	7	2	156	4	Heavy resistant beds of yellow iron-stained limestones with many brachiopods in top beds, *Cliftonia gouldi*. Equals zone 2 at Rock Crossing Criner Hills, and zone 7 West Spring Creek.		4	93	3	Mostly shale.
12	20	10	177	2	Yellow and grayish green shales containing a few limestones 3 to 5 inches thick interspersed (5 samples). *Orthoceras* cf. *gorbyi*.	12a	3	7	90	Shale.
						12b	2	61	37	Fine quartz and silt.
						12c	2	2	96	Silt.
						12d	0	5	95	Silt.
						12e	6	12	82	Shale.
13	1	6	178	8	7 inches of yellow limestone at top followed by 18 inches of shaly limestone below. This is the main *Plectambonites sericeus* zone in which they make up a good part of the limestone. The same species is abundant in zone 2 at Rock Crossing, Criner Hills.					
14	48		226	8	Mostly shales, some fissile, but mostly clayey. A few thin limestone beds included.	14a	0	17	83	Shale and a few rounded quartz grains .2 mm. diam.
						14b	2	8	90	White, rounded quartz .15 mm. diam.
						14c	0	1	99	Fine quartz and silt.
						14d	0	4	96	
						14e	0	1	99	Silt and a few pieces of quartz.
15	4	7	231	3	Thin bedded yellowish brown limestones.		1	96	3	Silt.
16	5		236	3	Thin limestones alternating with yellow and green clay shales. *Endoceras proteiforme* zone. Equals base of zone 4 in Criner Hills, Rock Crossing Section. *Monotrypa magna*.	16a	2	97	1	Yellowish, iron stained silt.
						16b	2	8	90	White, rounded quartz .15 mm. diam
						16c	0	37	63	Shale and a few quartz grains .2 mm. diam.
						16d	3	94	3	Iron stained silt.

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION		DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
17	16		252	3	Mostly shale with a few thin limestones. Those near top of zone have numerous fucoids on the under side.	17a 17b	0 0	15 15	85 85	Shale. Shale.
18	6	2	258	5	Top of zone formed by 2 foot bed of yellow limestone.		0	90	10	Iron stained silt.
19	13		271	5	Thin beds of yellowish gray limestone. More resistant beds at base for 3 inches. Thin limestones and shales in center.	19a 19b	13 7	85 92	2 1	Quartz grains 0.3 mm. diam., and less. Some silt. Silt.
20	8	1	279	6	Thin beds of coarse yellowish gray limestone at top and bottom. Shale or shaly limestone for 3 feet at base.		8	85	10	Quartz slightly iron stained. 0.5 mm. diam. and smaller.
21	10	5	289	11	Thin beds of yellowish brown limestone. 2 inches trilobite beds 5 feet below top. *Plectambonites sericeus* bed 1 1-2 inches thick 3 feet below top.		0	94	6	White, semi-angular quartz 1 mm. and less in diameter.
22	57	7	347	6	A few thin yellowish limestones in shale.		0	93	2	Iron stained silt and quartz 0.05 mm. diam.
22	Cont.				A 5 inch sandy fossiliferous limestone at base. Some *Orthis tricenaria* and cystid plates. *Cheirocrinus logani, Hebertella* cf. *insculpta.*		12	74	14	
23	28		375	6	Thin yellow limestones with shales. Top 9 feet above base		0 0	13 7	87 93	Quartz .1-.2 mm. diam. Minor silt. Silt and a few rounded quartz 0.3 mm. diam.
24	28		403	6	Ledge of saccharoidal sandstone, cross-bedded with beds of 8 inches to 18 inches thick.		0	9	91	Rounded quartz 0.2-0.3 mm. diam.
25	24		427	6	Mostly thick and thin shaly sandstone with 2 feet of clear sandstone at base.		0	16	84	White, rounded quartz 0.2 mm. diam.
					TULIP CREEK FORMATION 394 FEET, 7 INCHES					
26	48	8	476	2	Mostly covered in flood plain of creek except near base where there is an olive green shale.		0	18	82	Shale and a few quartz grains .5 mm. diam. and larger, semi-rounded.

TABLE IV.—(Continued)

BED NO.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
27	12		488	2	Hard yellowish gray siliceous limestone containing cystid plates at base. Rest covered.	6 0	15 7	79 93	Rounded quartz, minor iron staining, a few black, opaque minerals. Silt and quartz 0.3 mm 0.4 mm. diam.
28	6	4	494	6	Heavy beds of sandy limestone. *Anolotichia impolita, Batostoma fertile, Eridotrypa* cf. *aedilis.*				Semi-rounded quartz 0.1-0.2 mm. diam. iron stained.
29	13	7	508	1	Yellowish brown sandy shale contains a few discontinuous beds of sandstone.	0 0	12 6	88 94	
30	2		510	1	Single bed of sandy limestone. Dip 53 degrees south, strike east-west. (Local change in strike.) *Pachydictya acuta, Rhinidictya grandis.*	0	44	56	Quartz partly iron stained, a few black opaque grains.
31	48		558	1	30 feet of shales at base of zone. Upper part covered in east-west road. *Eridoconcha simpsoni.*	2 0	26 65	72 35	Silt. Greenish, gray shale-like mass.
32	44	5	602	6	40 feet exposed along second creek west of road mostly thin sandstones and limestones in shales. 28 feet of this zone exposed along west edge of road consists of sandy shale containing numerous rough little nodules. *Primitiopsis bassleri.*	0 0 5	21 23 68	79 77 27	Silt. Mostly clay, a few quartz grains 0.3 mm. diam. Mostly silt, a few quartz grains.
33	3	3	605	9	Zone consists 3 inch bed of coarse dark gray limestone, three 5 inch beds of sandy shale. A coarse gray fossiliferous limestone 4 inches thick contains many brachiopods and trilobite fragments.	23	76	1	Fine silt.
34	4	9	610	6	Yellowish brown and gray clay shales. *Prionidus aculeatus, Schmidtella* cf. *affinis.*				
35	7	4	617	10	Grayish sandy shales at top containing numerous white nodules at top. Grayish brown shales below.				
36	3	8	621	6	Brown sandy clay.				
37	1	2	622	8	Yellowish brown sandstone.				

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
38	11	2	633	10	Grayish green sandy clay containing numerous white nodules. 4 inch bed of fossiliferous limestone at the base.	0 0	82 17	18 83	Fine quartz and silt 0.2 mm. diam. Silt and a few rounded quartz grains 0.2 mm. diam.
39	6	4	640	2	Thin bedded gray sandy shale containing white, flat lens-like nodules. A 3 inch bed of coarse limestone at the base with a few pelecypods on the surface. *Modiolopsis* cf. *occidens*, *Raphistoma* cf. *peracutum*.	0	34	66	Gray silt with a few quartz grains up to 0.3 mm. diam.
40	5	9	645	11	Green clay shale containing some white powdery shale material.	0	8	92	Well rounded quartz but mostly green (glauconite?).
41	2	3	648	2	Dark grayish green plastic clay with some brown sand in it. *Dinorthis deflecta*.	0	4	96	Quartz .4 mm. diam., very little silt.
42	6	9	654	11	Yellowish brown clayey sand. *Endoceras* cf. *annulatum*, *Bumastus erastusi*.	0	2	98	Rounded quartz .5 mm. diam.
43	4	2	659	1	Thin bedded, poorly indurated, white and yellow sandstone containing fossils, chiefly pelecypods poorly preserved.	0	1	99	Rounded quartz .2-.7 mm., mostly .5 mm. diam.
44	7	9	666	10	Light green and yellow sandy clay.	0	1	99	Rounded quartz .2-.4 mm. diam.
45	53		719	10	Top of what is called "Wilcox." Iron stained yellow and white sandstone in beds mostly thin, but some 8 inches to 14 inches thick. Cross-bedded to east of road.	0	1	99	Rounded quartz .3-.5 mm. diam.
46	1	7	721	5	Light green clayey shale containing thin sandstone lenses.	0	10	90	About 40% quartz and silt. Quartz 0.5 mm. diam. and rounded.
47	60		781	5	Mostly soft, poorly indurated, brown sandstone with about 20 feet of more resistant sandstone in the center of zone.	0	1	99	Rounded quartz .5 mm. diam. Minor iron stain.
48	0	5	781	10	Light green clay shale.	0	4	96	Mostly clay or glauconite, a few rounded quartz grains up to 0.4 mm. diam.

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
49	30		811	10	Thin bedded yellowish brown sandstone.	0	1	99	
50	3	9	815	7	Yellow and gray shales with some sandy thin beds interspersed.	0 0 7	5 1 89	95 99 4	Mostly silt and a few quartz grains. Rounded quartz .4 mm. diam. Minor iron staining. Quartz 0.5 to .10 mm. diam. Semi-rounded. Several grains of pyrite.
51	6	6	822	1	Thin bedded brown sandstone. Base of what is called "Wilcox."	0	1	99	Rounded quartz 0.4 mm. diam. Minor iron staining.
					McLISH FORMATION 475 FEET, 4 INCHES				
52	2	5	824	6	Yellowish brown sandy limestone.				
53	8	2	832	8	Gray and olive green shales containing some thin limestones at the base of the zone.	0	23	47	Semi-rounded white quartz 0.1-0.3 mm. diam.
54	4	2	836	10	Green and olive clay shales with 8 inch yellow and gray, coarse, fossiliferous limestone at base. *Orthis acutiplicata, Dinorthis pectinella.*				Semi-rounded white quartz 0.2-0.4 mm. diam.
55	23	6	860	4	Olive green clay shales with 4 inch bed of coarse gray and yellow limestone at base.	0 2	26 83	74 15	Silt. Silt.
56	10		870	4	Olive green clays and shales with 3 inch beds of yellow limestone at base.	0 7	32 92	68 1	Silt. Silt.
57	4	7	874	11	Brown, gray, and olive clay shales containing a few thin limestones, and with 2 inch brown limestone at the base.	0 11	11 84	89 5	Semi-rounded white quartz .1-.2 mm. diam. Silt, iron stained and fine quartz.
58	10		884	11	Mostly yellow and gray shales containing a few thin limestones. One 3 inch limestone.	0	64	36	Angular to rounded .1-.3 mm. diam. quartz..
59	24	5	909	4	Dark weathered clay shale.	0	18	82	

TABLE IV.—(Continued)

BED NO.	THICKNESS				DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE	
	OF BED		TOTAL						
	Ft.	In.	Ft.	In.				Per Cent	DESCRIPTION
60	6	6	915	10	Thin yellowish brown limestone at top grades into sandy limestone in center, and into cross-bedded sandstone at base of zone.	0 0	0 83	100 17	Quartz semi-angular .2 mm. diam. Rounded white quartz .75 mm. diam.
61	16	5	932	3	Weathered, dark clay with 12 inch fossiliferous coarse limestone at base.	11 0	88 19	1 81	Irregular quartz. Silt.
62	8		940	3	Olive green clays and shales.	0	56	44	Silt (and glauconite?).
63	4	9	945		Thin yellowish gray limestone containing some thin shaly limestone.	2	97	1	Irregular quartz (and glauconite?).
64	7		952		Olive green shales at top, rest covered by weathered soil.	7	8	85	Iron stained quartz.
65	6	8	958	8	Thin yellow and gray limestone.	23	73	4	Semi-angular quartz .1-.4 mm. diam.
66	12		970	8	Olive green shales with a 3 inch yellow limestone at the base.	8 0	68 99	24 1	Quartz 0.08 mm. diam. Quartz .2 mm. diam.
67	12		982	8	Greenish clay and shale for 2 feet at top, rest covered.	0	14	86	Silt.
68	17		999	8	Resistant yellow and gray limestone, mostly coarsely crystalline.	3	96	1	Rounded quartz .1-.2 mm. diam.
69	13		1012	8	Gray and green sandy shale and brownish gray shale.	0 7	25 83	75 10	Shale and a few quartz grains 0.2 mm. diam. Shale and a few quartz grains 0.5 mm. diam.
70	3	3	1015	11	Yellowish gray limestone beds 3 inches to 8 inches thick.	15	84	1	Quartz 0.5 mm. diam. rounded.
71	30	4	1046	3	Gray to light green sandy shale.	4	41	55	Iron stained quartz 0.1 mm. diam.
72	15	0	1061	3	Thin yellow limestone beds with bryozoa at top; yellow, gray, and purple with some light green sandy shale below.	3	52	45	Shale and considerable quartz 0.1 mm. diam., semi-angular.
73	4	5	1065	8	Thin fossiliferous yellowish gray limestone for 18 inches at top. Sandy fossiliferous shales with many bryozoa below.	7	93	0	Shale, minor quartz.

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
74	34		1099	8	Resistant coarse yellow and gray limestone with a few fossils. *Zygospira* cf. *acutirostris*, *Camarotoechia* sp.	5	94	1	Angular quartz 0.4 mm. diam. and smaller.
75	35		1134	8	Several thin limestones with bryozoa in weathered zone, probably shale.	12	85	3	Semi-rounded quartz 0.1 mm. to .2 mm. diam.
76	50		1184	8	Brownish yellow and gray limestones coarse for most part, but fine near the base. *Ctenodonta* bed at base. A thin limestone conglomerate occurs at this horizon at a number of localities.	5	95	0	Shale.
77	15		1199	8	Upper 8 feet covered with soil, 9 feet of yellow and white shale. 12 inches yellow limestone with numerous cystid plates on surface at base.	0	45	55	Shale.
78	8	3	1207	11	Green and gray shale with 5 inch bed of bryozoan limestone at base. Called "Tyner shale." *Pleurocystites tenuiradiatus.*	0	31	69	Shale with a few small quartz grains.
79	19	6	1227	5	Covered with soil.				
80	15		1242	5	Resistant yellowish gray limestone for 9 feet at top, rest soil covered. *Pachydictya* cf. *elegans*, *Pachydictya robusta*, *Rhinidictya basalis.*	24	79	1	Quartz semi-rounded and 0.75 mm. diam.
81	55		1297	5	White, yellow and brown saccharoidal sandstone; some poorly preserved pelecypods near top. *Modiolopis* cf. *gregalis* which occurs in the St. Peter sandstone of Minnesota. Called "Burgen sand."				
					OIL CREEK FORMATION 681 FEET, 6 INCHES				
82	23		1320	5	Soil covered.				
83	5		1325	5	Yellow shales with a few limestone beds in upper half contain *Dinorthis pectinella* at top. Lower one-half soil covered.	1	31	68	Shale.

TABLE IV.—(Continued)

BED No.	THICKNESS				DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE	
	OF BED		TOTAL						
	Ft.	In.	Ft.	In.				Per Cent	DESCRIPTION
84	36		1361	5	Thin bedded limestone contains ostracodes and gastropods. *Bellerophon* sp., *Lecanospira* cf. *compacta*, *Maclurites* cf. *oceanus*.	7	90	3	Iron stained silt.
85	43		1401	5	Alternating thin limestones in green and yellow shales. Very fossiliferous. *Drepanodus arcuatus*, *Isochilina bulbosa*. *Loxoceras momiliforme*, *Endoceras magister*.	6 3 1	93 26 43	1 71 57	Shale, minor quartz. Shale.
86	22	6	1426	11	Heavy bedded yellowish gray limestone. Top bed contains many Maclurea. *Eridoconcha magnum*, *Aparchites perforata*. *Pliomerops nevadensis*.	0	76	21	Quartz semi-rounded 0.2 mm. diam.
87	51		1477	11	Alternating thin limestones and shales. About 20 feet above base of zone many bryozoa occur. *Batostoma subcrassum*, *Monticulipora* near *insularis*.	2	87	11	Semi-rounded quartz .1-.3 mm. diam.
88	63		1545	11	Alternating thin, dark, crystalline 3-4 inch to 2 inch beds of limestone and light gray and green shales. Shale predominates in ration of 6 to 1.	0	60	40	Iron stained silt.
89	52		1597	11	Brown, gray and green shales and thin linestones; shale predominates in ratio of 10 to 1.	8	46	46	Iron stained shale.
90	35		1632	11	Shales and thin, dark limestones; shale predominates in ratio of 2 to 1. *Receptaculites* sp.	0	46	54	Shale and considerable rounded quartz 0.5 mm. diam.
91	278		1910	11	Thin dark and light gray limestones, contain a few fossils which it is difficult to get out. *Leperditella* n. sp. and many pelecypods.	0	38	62	Silt.
92	19		1929	11	Yellowish brown sandstone containing a few fossils near base, mostly brachiopods. *Clitambonites multicosta*.	0	18	82	Angular quartz 0.3 mm. diam.
93	41		1970	11	Only a few weathered limestones exposed.	3	96	1	Rounded quartz .1.
94	8		1978	11	Yellow, gray sandstone.	0	1	99	Clear, glassy angular quartz 0.2 mm. diam.

TABLE IV.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					JOINS FORMATION 294 FEET, 2 INCHES				
95	28		2006	11	Thin limestones containing ostracodes. 6 inch limestone breccia at base of zone.	3	95	2	Angular and semi-rounded quartz 0.2 mm. diam.
96	142		2148	11	Thin bedded dark gray limestone.	7	92	1	Rounded quart .3 mm. diam.
97	13	9	2162	8	Thin bedded yellow and gray shaly limestone.	0	99	1	Minor iron stained. Semi-angular 0.1-0.3 mm. diam.
98	18	3	2180	11	Light green shale at top, rest yellow and gray limestone.	3	79	18	Silt and fine quartz 0.1 mm. diam.
99	9	8	2190	7	Thin yellow and gray limestones alternating with dark gray shaly limestone. Graptolite-*Didymograptus artus*, bed is 7 feet above the base of this zone.	11 3	79 92	10 5	Silt.
100	12	6	2203	1	Thin bedded yellowish gray limestone and shaly limestone.	6	79	15	Rounded quartz .3 mm. diam.
101	50		2253	1	Thin bedded yellowish gray limestone and shaly limestone. Many ostracodes.	16	83	1	Fine quartz and silt, a few rounded quartz 0.2 mm. diam.
102	20		2273	1	Nine feet of buff and dark gray limestone at top. *Orthis costalis*. Mostly soil covered below. Twelve inch conglomerate and breccia at base. Dip 55 degrees S. W.; Strike N. 60 degrees W.				
					Thickness of Simpson group, 2,273 feet. Dip 48 degrees to 55 degrees.				

TABLE V.

Detailed Section of the Simpson Group

Section Xa on west branch of Sycamore Creek, Sections 22 and 27, T. 3 S., R. 4 E., 7 miles northwest of Ravia, Oklahoma. Rocks practically vertical. (No. 13.)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					BROMIDE FORMATION 440 FEET, 2 INCHES.				
1	7		7		Heavy gray limestone with 4 feet of dense limestone at top. A few gastropods.	1	98	1	Clear, glassy, rounded quartz 0.1 mm. diam.
2	8	9	15	9	Thin bedded, fine grained to coarsely crystalline limestone. Some *Solenopora* at top.	6	93	1	Clear, glassy, angular quartz and iron stained chert.
3	15	4	31	1	5 feet of heavy beds of limestone at top with many gastropods, *Tetranota obsoleta*, *Liospira progne*.	1	89	10	Shale.
4	19		50	1	Massive beds of gray limestone containing *Stromatocerium ruginosum*.	5	94	1	Iron stained chert.
5	11	8	61	9	Covered, probably shaly limestone.				
6	10	6	72	3	Thin yellow and gray limestone containing several brachipods and gastropods. *Rafinesquina minnesotensis* zone.	4	95	1	Clear, glassy, angular quartz.
7	10	9	83		Covered, probably shaly limestone.				
8	21	6	104	6	Brownish coarsely crystalline limestone. Two 5 inch beds contain brachiopods and bryozoa.	8	91	1	Iron stained silt and angular, glassy quartz.
9	43	10	148	4	Mostly covered with a few beds of platy shale at the base.	4	60	36	Shale.
10	26	2	174	6	Thin gray cherty limestone and interbedded shale. Bryozoa, a few graptolites and *Plectambonites sericeus*. Top 10A	6	93	1	Rounded, glassy quartz 0.1 mm. diam.
					Top 10B		1	99	Milky, angular quartz. Clearly fractured particles with no signs of grains.
					Base 10	8	91	1	Angular, milky quartz and a few semi-round, glassy grains 0.1 mm. diam. Minor iron staining.

TABLE V.—(Continued)

BED NO.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
11	10		184	6	Buff and gray limestone beds 5 to 15 inches thick, somewhat sandy in places. Bryozoa and crinoid stems.				
12	13	3	197	9	Upper 10 feet soil covered, 3 feet of resistant limestone at base of zone.				
13	33		230	9	Thin shaly gray to buff limestones, about 5 feet of shale in middle of zone. Sandy in places, large bryozoa.	7	92	1	Clear, glassy, rounded quartz.
14	7	3	238		Heavy beds of gray sandy limestone at the top and shale in the middle separating heavy beds below. Few bryozoa.				
15	22		260		Bryozoan limestone and some coarsely crystalline 15A yellow limestone. Elongate branching bryozoa weather loose on surface with some large cystid plates 15B and brachiopods, chiefly *Hebertella* cf. *insculpta*	9 4	89 91	2 5	Rounded, glassy quartz .1 to .25 mm. diam. A little iron stained chert. Silt and rounded, glassy quartz 0.1 mm. diam.
16	7	9	267	9	Heavy beds of brown limestone at the top and bottom, with thin yellow limestones in the middle. Large bryozoa and cystid plates in upper part. *Dendrocrinus* cf. *latibranchiatus*, *Cheirocrinus logani*, *Carabocrinus* plates.				
17	12		279	9	Thin buff and gray limestone beds 2 inches to 4 inches thick at top. lenses near base. Large bryozoa.				
18	33	6	313	3	Thin limestones containing many bryozoa.				
19	21	6	337	9	Iron stained on outside, mostly white saccharoidal sand-sandstone.				
20	47	8	385	5	Four feet sandy ledge 2 feet, four inches high. Sandy shales in midst of zone.				
21	17	6	402	11	Thin beds of sandstone at top. 3 1-2 feet of indurated brown fucoidal limestone at the base.				
22	37	3	440	2	Soil covered zone with shale or soft sandstone.				

TABLE V.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					TULIP CREEK FORMATION, 330 FEET.				
23	7	6	447	8	Brown crystalline limestone at top. Sandy limestone at base. Gastropods at base.	2	92	6	Semi-rounded, glassy quartz 0.01 mm. diam. Rounded, glassy quartz 0.2 to 0.3 mm. diam. Minor iron staining.
24	17	6	465	2	Shale at top, soft sandstone at the base. Soft sandy beds in middle.				
25	13	4	478	6	Heavy gray limestones at top, green clay shales and sandy calcareous shales below.				
26	18		496	6	Yellow calcareous shales in part, with sandy beds predominating, *Prionidus aculeatus* zone.				
27	19	3	515	9	Green fissile shale and some sandstone.	2	96	2	Green shale.
28	32	5	548	2	Most of zone soil covered. About 6 feet of yellowish brown and gray crystalline limestone near base. A few *Strophomenas* present.				
29	15	6	563	8	Heavy beds of case hardened sandstone at top. Sand soft and white on inside, fine grained and rounded. Some banding and a little cross-bedding and black specks of magnetite.				
30	17		580	8	Thin sandy shales in creek bed.	8	78	14	Clear, glassy, rounded quartz 0.1 mm. diam.; and small amount of greenish shale.
31	40		620	8	Heavy sandstones 1 to 3 feet thick at top, followed by less resistant white fine gravel and sand.				
32	26	6	647	2	About 4 feet soil covered at top, followed by thin bedded fine grained light chocolate limestone beds 1 to 1 1-2 inches thick, with 3 feet of calcareous shales at the base.	12	87	1	Iron stained, angular quartz. Some magnetite.

TABLE V.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
33	97		714	2	A ledge at top 4 feet thick of indurated sandstone. Remainder mostly soft yellow sandstone in beds 6 inches thick.				
34	26		770	2	Soft sandstone, coarse crystalline limestone and heavy beds of fine grained indurated sandstone.				
35	50		820	2	Some massive sandy limestones with alternating thinner beds in between.	3	89	8	Angular, glassy quartz 0.1 mm. diam.
					McLISH FORMATION 533 FEET, 6 INCHES.				
36	27	10	848		Heavy calcareous sandstones at top followed by sandy shales and green clay shales below.				
37	11	3	862	3	Four feet of grayish brown hard sandstone followed by laminated and slightly cross-bedded calcareous sandstone.				
38	10	9	873		Shale at top, followed below by sandy clay with sandstone at base.				
39	12		885		Thin limestones at top, sandstone and green shale in the middle, sandstone at the bottom of zone.				
40	21		906		Green fissle shale at top, brownish gray sandy limestone in the middle with greenish shale and crystalline limestones at base of zone.				
41	9	6	915	6	Heavy beds of brownish gray crystalline limestone at top. Interbedded thin marly white limestone and sandstone in middle, with limestone at base containing *Strophomenas* and *Orthids*.				
42	17	2	932	8	Sandy shales at top with green clay shales below.				
43	27		959	8	Heavy ledge of thin bedded white sandstone at top with 8 feet of shales at base.				
44	21	9	981	5	Thin sandy limestones.				
45	7	6	988	11	Sandy gray crystalline limestones in beds 3 to 8 inches thick.				

TABLE V.—(Continued)

BED NO.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
46	8		996	11	Soil covered, probably shale.				
47	12		1008	11	Thin sandy limestones.				
48	4		1012	11	Thin coarsely crystalline limestones.				
49	12	3	1025	2	Thin sandy limestones.				
50	4		1029	2	Coarse gray crystalline limestones.				
51	30		1059	2	Yellow nodular sandy shales and thin brownish gray limestone.				
52	17		1076	2	Thin gray sandy limestones.				
53	33	8	1109	10	Thin gray sandy and marly limestones at top, olive green shale below. Bryozoa, brachiopods and cystids, *Paleocystites tenuiradiatus.*				
54	18	9	1128	7	Heavy beds of limestone at top with thin sandy limestone below.				
55	25	8	1154	3	Alternating thin limestones and shales green and fissle, and sandy limestones. A few cystids, *Paleocystites tenuiradiatus.*	4	93	3	Glassy, semi-rounded quartz 0.1 mm. diam. A few rounded 0.3 mm. diam. Minor iron staining.
56	33		1187	3	Buff limestones at top, thin sandy limestones below.				
57	6		1193	3	Thin coarse limestones.				
58	77	5	1270	8	Mostly sandy soil with a few sandy ledges exposed.				
59	8		1278	8	Fine grained case hardened white sandstone.				
60	75		1353	8	Mostly soft sandstone with a few resistant beds near to				
					OIL CREEK FORMATION 803 FEET 1 INCH.				
61	150		1503	8	Thin coarse yellowish brown limestones, crinoid stems and some gastropods, *Maclurea* sp. *Orthoceras* cf. *moniliforme.*				

TABLE V.—(Continued)

BED No.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
62	41		1544	8	Thin bedded coarse crystalline brown limestone.				
63	102	1	1646	9	Mostly covered, a few thin crystalline limestones.	8	91	1	Silt and glauconite.
64	173		1819	9	Mostly covered, some thin crystalline limestones exposed.	0	97	3	Round, glassy grains 0.1 mm. to 1.0 mm. dia., and iron stained chert.
65	159		1978	9	Thin yellowish gray limestones at top, middle covered, sandier toward base. Gray siliceous limestone, and breccia 10 feet above base of zone. *Leperditella* sp. abundant near base.				
66	90		2068	9	Soft fine grained white sandstone.				
67	50		2118	9	Resistant grayish white sandstone.				
68	38		2156	9	Soft sandstone, with a few resistant beds of white sandstone. Crystalline sandy limestones. Fucoids and some cross bedding.				
					JOINS FORMATION. 162 FEET.				
69	162		2318	9	Thin fine grained gray limestones, to conglomerate. *Orthis costalis*, *Didymograplus artus* near base. 18 feet to gastropod bed in Arbuckle.	3	93	4	Fairly well rounded, glassy quartz 0.3 mm. diam. Some galuconite. Minor iron staining.
					TOTAL THICKNESS 2,318 FEET, 9 INCHES.				

TABLE VI.

Detailed Section of the Simpson Group

Section North edge of P. A. Norris Ranch, Section 2, T. 1 N., R. 6 E. Dip 8° East. (No. 17.)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
					BROMIDE FORMATION 145 FEET				
1		10		10	Gray fine grained to dense limestone bed containing *Tetradium* cf. *cellulosum*, small ostracodes, and a small Orthid brachiopod. *Solenopora compacta* abundant in this zone 8 miles northwest of Bromide.				
2	5		5	10	White to gray limestones in beds 1 to 4 inches thick. Upper half of zone carries *Tetradium* cf. *cellulosum*. Lower thin beds contain some small pelecypods.	3	81	16	Silt.
3	2	6	8	4	Gray fine crystalline limestone in thin beds. *Rafinesquina minnesotensis* abundant near base and a few ostracodes in zone.	0	80	20	Quartz 0.2 mm. diam.
4	6		14	4	Pinkish gray fine limestone slightly sandy in places. Beds 4 to 12 inches thick and resistant to weathering so they form a small escarpment. Surfaces are rough with some solution cavities. *Rafinesquina minnesotensis* and a small rhynchonelloid brachiopod occur in this zone and some small pelecypods and a few gastropods.	0	92	8	Quartz.
5	10		24	4	Gray sandy limestones containing small, irregular yellow argillaceous spots. The upper three and one-half feet fine grained, the lower four and one-half feet medium grained. *Rafinesquina minnesotensis* ranges through this zone as do also *Vanuxemia gibbosa* and *Clionychia* cf. *lamellosa*.	0	45	55	Rounded quartz 1.0-2.0 mm. diam.
6	4		28	4	Medium to coarse gray limestone in beds 2 to 10 inches thick. Contains *Dinorthis subquadrata*, *Plectambonites sericeus*, a large *Rafinesquina winchesterensis* as in zone 13 West Spring Creek and at the same horizon in the sharp anticline 5 miles southeast of Davis, contains fragments of a large trilobite.	0	76	24	Quartz 0.1 mm. diam.

TABLE VI.—(Continued)

BED NO.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
7	7	6	35	10	Medium crystalline gray limestones with beds 2 to 3 inches thick. Contain several cephalopods, *Endoceras proteiforme*, *Cyrtoceras camurum*, *Gonioceras anceps*, a few *Rafinesquina minnesotensis*, some small bryozoa and a few of the large *Monotrypa magna*, which is widespread this zone in Arbuckle and Wichita Mountains and the Criner Hills of Oklahoma, and in the Plattin of Missouri and the Platteville of northern Illinois.	0	70	30	Quartz 0.1 mm. diam.
8	7	6	43	4	Mostly covered slopes with a few thin beds of sandy limestone outcropping, this is the main *Monotrypa magna*, *Stictoporella cribrosa* upper cystid zone. Also contains fragments of a small *Hebertella* cf. *insculpta* which occurs widespread at this horizon, in the *Carabocrinus* zone.	0	60	40	Iron stained quartz 0.2 mm. diam.
9	13		56	4	Fine to coarse crystalline limestones. Gray with yellow argillaceous spots in them. Contain bryozoa and trilobite fragments.	0	85	15	Glauconite and silt.
10	3	8	60		Fine white sandstone containing some yellow spots. Beds are 8 to 10 inches thick. No fossils seen.	0	40	60	Angular quartz 0.3 mm. diam.
11	8	6	63	6	Coarsely crystalline gray limestone in beds 3 to 6 inches thick. Contain some of the upper cystid plates, *Stictoporella*, some large bryozoa, and *Orthis tricenaria*.	0	90	10	Rounded quartz, 0.5-1.5 mm. diam.
12	13	6	82		Buff to gray sandy limestones, more coarsely crystalline at top of zone, medium in middle and lower part soil covered, probably sandy shale.	2	10	88	Rounded quartz 0.5-1.5 mm. diam.
13	3		85		Almost white medium grained pulverulent sandy limestone in beds 8 to 10 inches thick.	0	79	21	Quartz 0.1-0.3 mm. diam., angular.
14	19		101		Fine to medium grained thin limestones with interbedded sandy shales. Limestones become coarser and more yellowish toward base. Contains some shale, bryozoa, and and brachiopods.	0	69	31	Silt and fine quartz.

TABLE VI.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
15	41		145		a. 6 feet of medium grained sandstone nearly white, with some yellow spots included. b. 3 feet of thin bedded sandy limestone. c. 16 feet of shale covered zone with a little sandstone included. d. 4 feet of yellowish brown sandstone. e. 3 feet of impervious clay. f. 3 feet grass covered soil. g. 1 foot bed of limestone. h. 5 feet sandy soil.	0	75	25	Rounded quartz, 1.0 mm. diam
					McLISH FORMATION 437 FEET				
16	4		149		Buff to cream colored fine limestone.	0	92	8	Quartz.
17	11		160		Dense birdseye-like limestone contains some *Maclurites*-like gastropods. This is the *Maclurites magna* zone in which they are so abundant at Bell School two and one-half miles northwest of Connerville and on the McLish and Harris ranches and some south and east of Sulphur, some *Tetradium*-like filaments occur, but no true *Tetradium* structure was discovered.	4	67	29	Semi-rounded quartz 0.1 mm. diam.
18	13		173		Six feet of dense birdseye-like limestone followed below by by light gray sandy shale.	0	55	45	Rounded quartz, 0.5-1.0 mm. diam.
19	12		185		A zone with 3 feet of dense birdseye-like limestone followed below by 4 feet of shale, then 2 feet of limestone and 3 feet of shale at base of zone.				
20	19		204		Dolomite at top followed by birdseye-like limestone and these followed below by 5 feet of shale at base.	83	13	4	Quartz.
21	17		221		Chiefly birdseye-like limestone.				
22	13		234		Covered slope, probably shale.				
23	7		241		Resistant, yellowish, gray dolomite.	78	15	7	Quartz.

TABLE VI.—(Continued)

BED No.	THICKNESS OF BED Ft.	THICKNESS OF BED In.	THICKNESS TOTAL Ft.	THICKNESS TOTAL In.	DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE Per Cent	RESIDUE DESCRIPTION
24	24		265		Birdseye-like limestone. The top of this limestone is about the zone in which the *Girvanella ocellata* are so abundant 8 miles northwest of Bromide and on the west side of the road 2 miles south of Sulphur.				
25	11		276		Dense, light gray limestone, yellowish toward the bottom.				
26	9		285		Alternating thin dolomites and birdseye-like limestones.				
27	15		300		Relatively thick beds of birdseye-like limestone.				
28	9		309		Mostly birdseye-like limestone in thin beds with a thin covered zone, probably of shale.				
29	16		325		About 2 feet of slightly dolomitic limestone at top of zone with thin beds of birdseye-like limestone below and probably some shale.	3	88	9	Quartz.
30	9		334		Yellowish argillaceous limestones in beds 2 to 6 inches thick.				
31	9		343		Mostly soil covered, a little argillaceous limestone exposed.	0	96	4	Quartz.
32	5		348		Yellowish argillaceous limestone.				
33	31		379		The zone is largely covered with some thin alternating limestones and shales exposed, with a 6 inch bed of white limestone at base of zone.				
34	9		388		Two feet of yellowish gray limestone at the top and 7 feet of thin bedded dense birdseye-like limestone below.				
35	4		392		Yellowish argillaceous limestone.				

TABLE VI.—(Continued)

BED NO.	THICKNESS				DESCRIPTION	DOLOMITE Percent	CALCITE Percent	RESIDUE	
	OF BED		TOTAL						
	Ft.	In.	Ft.	In.				Per Cent	DESCRIPTION
36	17		409		Buff to yellow argillaceous limestones which are in some places shaly and in others sandy. This is the main *Lichenaria* cf. *carterensis* zone which extends throughout the eastern part of the mountains, westward to Roff and and Sulphur, and occurs in the midst of the limestones formerly assigned to the Falls Creek formation. Elsewhere this zone carries *Strophomena* cf. *incurvata* and *Orthoceras* and cystid plates.				
37	17		426		Gray thin limestones somewhat marly above and more resistant at the base. They frequently contain numerous blood red spots. This is the main sponge zone of this formation in which at least four undescribed species have been found.	2	90	8	Quartz.
38	8	6	434	6	Dense fine grained sandy limestone, yellowish brown and resistant.	0	76	21	Quartz.
39	17	6	452		Brown sandstone slightly cemented with dolomite.				
40	130		582		Loose unindurated yellowish fine sand.				
41	20		602		OIL CREEK FORMATION, 46 FEET. Thin yellowish brown coarse limestones. Frequently has a limestone conglomerate at the top and at times others within it. This is the *Clitambonites multicosta* and *Pliomerops nevadensis* zone, with large *Maclureas* near the top.				
42	22		624		Poorly indurated yellowish brown sandstone.				
43	3	6	627	6	Resistant pink dolomitic sandstone.	6	66	28	Quartz.
44		6	628		Red residual clay.				
					Total thickness 628 feet. (Measured with hand level and modified to conform to alidade measurements.)				

TABLE VII.

NORTHEAST SIDE OF BROMIDE ANTICLINE & LOG OF ARTESIAN WELL No. 3, Section 32—T 1S—R 8 E. Dip 10° to 12° N.E. (No. 20.)

Zone	Thickness of Zone	Total Thickness	BROMIDE FORMATION, 291 FEET
1.	9ft.	9ft.	Mostly thin bedded light gray limestones *Camarella* cf. *volborthi*, *Rafinesquina minnesotensis*, *Dinorthis subquadrata*, *Tetranota obsoleta*, *Lophospira* cf., *trochonemoides*, *Eotomaria* cf. vicina. This equals zones on West Branch of Sycamore Creek and zone 1 on U. S. Highway 77, two miles north of Springer.
2.	6ft.	15ft.	Dark gray resistant limestones. Siliceous algae near base.
3.	15ft.	30ft.	Thin gray limestones.
4.	5ft.	35ft.	Thick gray limestones.
5.	20ft.	55ft.	Thin gray and yellow limestones in beds 2 to 8 inches thick.
6.	15ft.	70ft.	Zone mostly covered, a few thin limestones exposed.
7.	14ft.	84ft.	Thin gray limestones in part of zone, rest covered.
8.	11ft.	95ft.	Yellow and gray limestones 3 to 5 inches thick. Algae and bryozoa in basal beds.
9.	14ft.	109ft.	Mostly thin dense limestones with about 3 feet of more coarsely crystalline ones in the middle of the zone.
10.	3ft.	112ft.	Sandy limestone, somewhat cross-bedded.
11.	15ft.	127ft.	Marly limestones and shales. Large massive bryozoa. This equals the main *Monotrypa magna* zone 16 of the Simpson section north of Springer along Highway 77. The same zone extends westward to Henryhouse Creek and occurs also on the south of Falls Creek.
12.	6ft.	133ft.	Yellowish brown limestone with many crinoid and cystid plates. *Cheirocrinus logani*.
13.	20ft.	153ft.	Shale and marl. *Monotrypa magna*, *Stictoporella cribrosa*. Upper cystid zone. This zone is well developed on the opposite side of the anticline above the Galbraith hotel, a mile and a half to the west, on the east side of the McLish ranch. Zones 15 and 16 on Sycamore Creek, zone 22 on Springer section No. 77, and zone 8 Rock Crossing, Criner Hills. *Hebertella* cf. *insculpta*, *Carabocrinus* plates.
14.	18ft.	171ft.	Yellow limestones with some included shale to top of artesian well No. 3. A little sandstone just above top of well.
15.	60ft.	231ft.	Upper part of well log not described.
16.	60ft.	291ft.	Mostly shale to top of birdseye.
			McLISH FORMATION 395 FEET
17.	65ft.	356ft.	No record of log.
18.	5ft.	361ft.	Sandstone.
19.	5ft.	366ft.	Sandy dolomite.
20.	15ft.	381ft.	Sandy, shaly dolomite.
21.	25ft.	406ft.	Shaly dolomite.
22.	15ft.	421ft.	Shaly dolomite and limestone.
23.	40ft.	461ft.	Fine crystalline dolomite.
24.	85ft.	546ft.	Dense limestone.
25.	15ft.	561ft.	Dense limestone and shale, a little green.
26.	125ft.	686ft.	Soft pulverulent sand, equals glass sand at Roff and "Burgen" on Highway 77.

TABLE VII.—(Continued)

Zone	Thickness of Zone	Total Thickness	OIL CREEK FORMATION 340 FEET.
27.	15ft.	701ft.	Shale.
28.	50ft.	751ft.	Sandy shale and dolomite.
29.	10ft.	761ft.	Green shale.
30.	15ft.	776ft.	Shaly limestone.
31.	10ft.	786ft.	Dense limestone.
31.	47ft.	833ft.	No log reported.
32.	193ft.	1026ft.	*Fine sand. Bit wedged and remains in hole at 1,026 feet, from top of Simpson.

*All recent evidence indicates that the sand at the base of the Oil Creek formation in the eastern part of the mountains is very thin. Accordingly, it is probable that most of the sand logged in the lower part of this well belongs in the upper part of the Arbuckle. This doubtless means that the total thickness of the Simpson at this place is not over 900 feet. (See 20, Table II.)

TABLE VIII.

SIMPSON GROUP

Criner Hills section at "Rock Crossing" of Hickory Creek. Dip 50° S. W. Top of Bromide formation is marked by a four inch clay bed with an inch of bog ore on top of it. Partial list of fossils—see number 7 in table of Bromide fossils. (No. 7.)

Zone	Thickness of Zone	Total Thickness	BROMIDE FORMATION 351 FEET.
1.	24ft. 8in.	24ft. 8in.	Gray limestone beds 2" to 4" thick. *Receptaculites occidentalis, Archaeocrinus subglobosus, Corynotrypa delicatula, Dinorthis subquadrata, Hebertella bellarugosa, Lingula coburgensis, Lingula eva, Plectambonites sericeus, Rafinesquina minnesotensis, Strophomena trentonensis, Orthoceras duseri.*
2.	39ft.	63ft. 8 in.	Thin argillaceous limestones with distinct clay partings. *Dipolograptus maxwelli, Cliftonia gouldi, Orbiculoidea cf. lamellosa Plectambonites sericeus, Scenidium anthonese, Schizambon? dodgei, Cornulites flexuosus, Endoceras proteiforme, Ampyx mcgeheei, Illaenus americanus.*
3.	96ft. 9in.	160ft. 5in.	Thin bedded limestones partly argillaceous. Beds 1" to 3" thick. *Amphilichas trentonensis, Ceraurus pleurexanthemus, Encrinurus vigilans, Eoharpes bispinosus, Isotelus gigas, Pterygometopus callicephalus, Thaleops ovatus.*
4.	36ft.	196ft. 5in.	Mostly rough thin beds resistant gray and yellow limestone. Large *Orthoceras, Isotelus gigas.*
5.	4ft.	200ft. 5in.	Coarse yellow limestone at top followed below by thin shaly limestones. Numerous *Plaesiomys sp.* and some bryozoa.
6.	4ft. 2in.	204ft. 7in.	12" bed of coarse limestone at top of zone, rest green shales and thin limestones, numerous bryozoa.
7.	13ft. 6in.	218ft. 1in.	Thin yellow and brown limestone at top and bottom with about 4' of yellowish green shales in the middle. Many bryozoa and cystid plates. *Carabocrinus* cf. *vancortlandi, Monotrypa magma.*
8.	12ft.	230ft. 1in.	Gray and green shales with thin limestone lenses. Cystids and numerous bryozoa, *Amygdalocystites florealis, Stictoporella cribrosa* zone.
9.	13ft.	243ft. 1in.	Heavy brown sandy limestone at the top with numerous sponges, *Ischadites iowensis.* Rest green and yellow shales, with included thin limestone lenses. Some bryozoa.
10.	33ft.	276ft. 1in.	Mostly green shales with thin limestones at base with numerous branching bryozoa in them.
11.	14ft. 6in.	290ft. 7in.	Sandstone at top, thin limestones at the base.
12.	4ft.	294ft. 7in.	Light green shale.
13.	17ft. 7in.	312ft. 2in.	Shales and thin sandy limestones.
14.	14ft. 10in.	327ft.	Alternating green and yellow shales and thin sandstones.
15.	24ft.	351ft.	Brown limestone at top followed by green and yellow sandstones and shales to the edge of the Pennsylvanian conglomerate which covers the rest of the Simpson at this locality.

TABLE IX

Detailed Section of the Simpson Group

SIMPSON, SOUTH SIDE OF LICK CREEK
Section 23, T. 1S., R. 1 E., Southwest of Davis. Dip, 76° N. E., strike N. 40° W. (No. 6.)

BED NO.	THICKNESS OF BED Ft.	OF BED In.	TOTAL Ft.	TOTAL In.	DESCRIPTION
					BROMIDE FORMATION 450 FEET
1	37		37		16 feet of heavy dense limestones. 4 feet of heavy beds of gray limestone containing *Rafinesquina minnesotensis* zone, 12 feet of thin dense limestones, 6 foot bed of limestone.
2	40		77		14 feet soil covered, 10 feet yellowish brown somewhat argillaceous limestone, 12 feet soil covered, *Plectambonites sericeus* and numerous colonial bryozoa of *Prasopora simulatrix*.
3	27		101		9 feet of dense yellowish brown limestone, 12 feet of coarse crystalline limestone in beds 18 inches to two feet in thickness, with chert conglomerate at the base with 6 feet at base of zone soil covered.
4	59		163		8 feet of finely crystalline limestone in 2-foot beds at base of zone, 15 feet of covered slope, 20 feet thin yellowish dense limestone, 16 feet soil covered.
5	10		173		8 inches of deep yellowish brown limestone at the top followed by 9 feet 4 inches of thin shaly limestone below.
6	15		188		5 feet of cross-bedded sandstone at top followed below by 10 feet of thin brownish gray limestones.
7	39		227		Yellowish brown shales and brownish argillaceous limestones, some with deeper colors. Many bryozoans of different types, cystid plates, brachiopods, and the small sponge, *Ischadites*.
8	30		257		Partly covered with some shale and a little limestone exposed.
9	74		331		Soft brown sandstone.
10	30		361		Yellowish brown limestone beds 2 to 4 inches thick, cystid plates, bryozoa-*Orthis tricenaria* zone.
11	59		420		Thin brownish calcareous shale at top followed by thin coarsely crystalline limestones containing *Dinorthis subquadrata*.
12	30		450		Case hardened brown sandstone.
					TULIP CREEK FORMATION 192 FEET
13	24		474		Limestones more dense at top and coarsely crystalline toward base of zone.
14	94		568		Light brown pulverulent sandstone.
15	44		612		Thin limestones at top followed by sandy limestone with heavy 4 foot bed of limestone at base of zone.
16	30		612		Yellowish sandstone.
					McLISH FORMATION 339 FEET
17	77		719		59 feet of weathered slope with loose limestones. 18 feet covered, probably shale.
18	57		776		Brown limestones 10 inches thick at top followed by thin limestones, with calcareous sandstones at base of zone.

TABLE IX—(Continued)

BED No.	THICKNESS				DESCRIPTION
	OF BED		TOTAL		
	Ft.	In.	Ft.	In.	
19	34		810		Gray to brown coarse shaly sandstone.
20	18		828		Brownish shales at top becoming light green thin-bedded at base.
21	47		875		Brownish gray limestones. bryozoa, brachiopods, *Camarotoechia* sp. *Zygospira recurvirostris* and marked zone of many cystid plates near base.
22	49		924		23 feet of green shale (Tyner), 26 feet of yellowish brown limestone.
23	57		981		Soft sandstone case hardened on surface. (Burgen).
					OIL CREEK FORMATION 443 FEET
24	367		1348		Shaly zones at top, followed below by brown crystalline limestones with some argillaceous limestones. *Pliomerops nevadensis* zone and bryozoa, Orthoceras, Dinorthis small ostracodes and some brachiopods near base in yelish sandy limestones.
25	76		1424		Heavy bedded light gray to yellow pulverulent sandstone.
					JOINS FORMATION 112 FEET
26	112		1536		Yellowish brown to gray thin limestones, some siliceous and some argillaceous. *Didymograptus artus*.
					TOTAL THICKNESS 1,536 FEET.

TABLE X.-A

SIMPSON NORTH SIDE OF WICHITA MOUNTAINS

Southeast of Gotebo, Section 2—6N—15W.
Southwest edge of westermost of three Viola hills. Dip 16° NE, strike N 80 W.
A rapidly paced measurement gave 57 feet of Fernvale and 514 feet of Viola or a total of 571 feet exposed above the Simpson. (No. 22.)

Zone	Thickness of Zone	Total Thickness	BROMIDE FORMATION, 47 FEET*
1.	5ft.	5ft.	Covered below base of Viola.
2.	5ft.	10ft.	Thin gray limestone and marl with latter predominating.
3.	5ft.	15ft.	Thin brown to gray fine crystalline limestone in beds 1 to 3 inches thick. *Dalmanella hamburgensis, Strophomena* sp., *Rafinesquina minnesotensis, R. alternata, Pachydictya occidentalis, Rhinidictya* cf. *neglecta, R. Mutabilis var. major, Thaleops ovatus.*
4.	2ft.	17ft.	Brown sandy dolomite.
5.	30ft.	47ft.	Slumped shaly beds. *Prasopora simulatrix, Zygospira nicolleti* (young form) equals 17 on No. 77. *Orthoceras* sp., *Leperditella aequilatera* equals 17 on 77. *Monotrypa magna* as in zone 11 at Bromide and east side of McLish ranch, zone 16 on U. S. Highway 77, and zone 7 on P. A. Norris ranch.

TABLE X.-B

SIMPSON SOUTH SIDE OF MIDDLE HILL, Section 20—6N—15W, southeast of Gotebo, dip 18° NE., Strike N. 85° West. About 350 feet of thin bedded very cherty Viola exposed above the Simpson.

Zone	Thickness of zone	Total Thickness	BROMIDE FORMATION, 86 FEET, 6 INCHES*
1.	25ft.	25ft.	Covered zone below cherty conglomerate in base of Viola.
2.	2ft. 6in.	27ft. 6in.	Grayish brown medium grained argillaceous limestone. Massive and branching bryozoa. *Dinorthis* and large trilobite fragments.
3.	13ft.	40ft. 6in.	Shale at top 2 feet thick followed by yellowish pimk limestone with fragments of small trilobite. Olive green platy shales at base.
4.	5ft.	45ft. 6in.	Fairly well indurated white and yellow porous sandstone showing banding.
5.	20ft.	65ft. 6in.	Bright olive green shale exposed. *Monotrypa magna.*
6.	3ft.	68ft. 6in.	About 2 feet of very much iron-stained buff limestone. *Plectambonites sericeus* and *Strophomena* sp.
7.	18ft.	86ft. 6in.	Well indurated coarse grained sandstone, gray buff and pink in color. (Rest covered by Permian Red Beds.)

*The sections of the Bromide formation on the north side of the Wichita Mountains are much abbreviated, possibly partly from non-deposition, but largely by erosion, as a basal conglomerate marks the contact of Viola with the Bromide, and the basal part is covered by Permian deposits.

DESCRIPTION OF OSTRACODES AND CONODONTS

By
Reginald W. Harris

LEPERDITIA FABULITES (Conrad) Jones

Plate X, figs. 1, 2.

Cytherina fabulites Conrad, 1843, Proc. Acad. Nat. Sci. Phila., vol. 1, p. 332.
Leperditia fabulites Jones, 1856, Ann. Mag. Nat. Hist., 2d ser., vol. xvii, p. 89; also 1881. idem, 5th ser., vol. viii, p. 342; also 1891, Contri. Can. Micro-Pal., pt. 3, p. 98; Whitfield, 1883, Rep. Geol. Sur. Wis., vol. i, p. 160; Ulrich, 1890, Jour. Cin. Soc. Nat. Hist., vol. xiii, p. 173.
Leperditia canadensis, var josephiana Jones, 1858, Ann. Mag. Nat. Hist., ser. 3, vol. i, p. 341; also 1858, Geol. Surv. Can., Dec. 3, p. 94.
Leperditia fabulites, var josephiana Jones, 1881, Ann. Mag. Nat. Hist., ser. 3, vol. viii, p. 344.
Leperditia josephiana Jones, 1884, Ann. Mag. Nat. Hist., ser. 5, vol. xiv, p. 341.

This form agrees in size, shape, and general character with the type form so often described from strata of Middle and Lower Ordovician Age. Measurements of this form range from 8-11+mm. in length. It is found associated with very large forms of Isochilina (not figured herein). Examination of samples has not revealed it above the McLish, or Birdseye lime.

Type from Top Upper Birdseye or McLish, Sec. 2, T. 1 S., R. 7 E., zone 12—Northwest of Bromide, Oklahoma.

ISOCHILINA BULBOSA n. sp.

Plate V, figs. 2 a. b.

Carapace small, in side view sub-elliptical, length about twice the height, dorsal margin long, straight, ends nearly equally rounded, the posterior blunter and higher; hingement simple; valves equal; surface smooth, strongly and equally bi-convex as shown in end view, a short, prominent ridge roughly parallels the postero-ventral region. Length 1.985;* width 1.336.

Type near base of Oil Creek, on railroad 1 mi. north of Hickory, Oklahoma.

This species, characterized by the postero-ventral ridge, has been found only in a single limestone ledge in the Oil Creek at various localities.

APARCHITES PERFORATA n. sp.

Plate V, figs. 4 a. b.

Carapace sub-circular in side view, slightly longer than high, very slightly umbonate and shallow channeled above the hinge line, the umbo forming but a faint apex to an otherwise low and evenly arched dorsal margin, peripheral margin evenly rounded except for faint flattening antero-ventrally and postero-dorsally, thus producing a gentle backward swing to the carapace; equi-valved, hinge straight, hingement formed by slight groove in

*All measurements in m.m.

left valve, especially toward terminals, into which fits the beveled edge of right; surface evenly convex, very coarsely punctate, punctations coarser and more concentrated centrally. Length 0.810; width 0.616.

Type from zone 83 (1,325 feet below top of Simpson) Oil Creek formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains Sec. 25, T. 2S., R 1E.

Occurs only in the Oil Creek formation of the Simpson.

Occurring in conjunction with *Eridoconcha magnus,* this form makes a good marker. There are several varieties of this form differing in outline, and number and distribution of punctae. The sub-circular shape and centrally concentrated coarse punctae readily identify the type.

LEPERDITELLA BROOKINGI n. sp.

Plate III, figs. 2 a, b, c.

Carapace convex, scarcely oblique, oblong with long, straight hinge and shallow channel, well-marked dorsal angles, posterior less pronounced than anterior, ventral margin regularly arched, anterior height of valves but little less than posterior, posterior margin neatly rounded, anterior margin obliquely truncated in upper half, rather sharply rounded at the middle, valves rather strongly convex, position of greatest thickness sub-central; inequivalved, left but little larger than the right, overlap faint; surface smooth, shallow canal near contact in base of valves, more pronounced centrally, sometimes canal weathered out almost smooth. Length 1.071; width 0.664; thick. 0.502.

Type from zone 98 top (2,162 feet below top Simpson) Joins formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs only in Joins, so far ascertained.

The slight canal at the base of the carapace in this form suggests Ulrich's form, *L. canalis* from the Lower Trenton, Minneapolis, Minnesota. This form differs in being more elongate and possessing a longer hinge line; the ventral outline is more symmetrical and the basal canal is not so distinct as in the type. The canal is limited to the left valve in Ulrich's type, while it is present in both valves of the Joins form.

LEPERDITELLA COOPERI n. sp.

Plate III, figs. 1 a, b, c.

Carapace obliquely sub-ovate in side view, length about one and one-half times height, slightly higher posteriorly than anteriorly, dorsal margin straight and angles well marked, anterior margin sharply truncate at dorsal angle, sharply rounded at middle, thence a semi-circular margin ventrally to a point above the center posteriorly, thence obliquely rounded to post-dorsal angle, tumid, point of greatest thickness about the center, in end view ovoid, in both dorsal and end views practically equally bi-convex; hingement simple, straight; inequivalved, left slightly overlapping right; surface smooth.. Length 1.636; width 1.094; thick 0.770.

Type from zone 98 top (2,162 feet below top Simpson) Joins formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs only in Joins, so far ascertained.

This specimen is similar to *L. mundula* Ulrich in tumidity, but it dorsal view the latter does not present the wedge-shaped outline as does this type. It differs from *L. tumida* Ulrich in its longer hinge line, more sharply angled anterior region, and obliquely rounded postventral region.

LEPERDITELLA? DECKERI n. sp.

Plate XIV, figs. 5 a, b, c.

Carapace sub-elliptical, elongate, inflated, dorsal margin straight posteriorly, slightly arched centrally, elevated and recurved anteriorly into an evenly rounded "prow", postero-dorsal angle obliquely rounded, anterior, ventral, and posterior margins evenly rounded except for very slight obliqueness postero-ventrally; inequivalved, left valve overlapping right from anterior prow to postero-dorsal angle, overlap stronger ventrally and post-ventrally; hinge straight; surface smooth, convex, post-central region thickest, a large, rounded node lies inset just behind and below the recurved, anterior "prow". Length 1.397; width 0.855; thick. 0.712.

Type from zone 12 (177 feet below top Simpson) Bromide formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs only in the Bromide, so far ascertained.

The author places this form under the Genus Leperditella tentatively while searching for related specimens in older material. It has the typical left valve overlap of Leperditella and the posterior region is thickened as some of the Leperditellas.. The forward "prow" and rounded node are not characteristic of the genus. It is a rare form in the Bromide.

SCHMIDTELLA cf. AFFINIS Ulrich

Plate XI, figs. 4 a, b.

Schmidtella affinis Ulrich, 1892, The Geology of Minnesota, vol. 3, pt. 2, of the Final Report—Paleontology. p. 641, pl. XLIII, figs. 45-47.

This specimen is similar to the type from the Galena shales, Cannon Falls, Minnesota, in size, convexity, umbo, and hinge structure. It differs in that the ventral margin is not as highly arcuate as the type nor does the posterior margin protrude quite so far as shown in the type figure.

I do find the true type, *Schmidtella affinis*, in the Tulip Creek member with this variety. Length 1.118; width 0.907.

Type from top zone 32 (560 feet below top Simpson) Tulip Creek formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R 1E.

Occurs only in the Tulip Creek, so far ascertained.

ERIDOCONCHA SIMPSONI n. sp.
Plate XIV, figs. 1 a, b.
Plate XI, figs. 1 a, b, c, d.

Carapace small, inflated, obliquely sub-ovate with prominent umbo slightly anterior to center, channel above hinge line wide and U-shaped, bluntly pointed dorsal margin, gentle slope behind umbo with but little umbonal relief, more abrupt slope in front of umbo with greater umbonal relief, posterior end wider and lower than anterior, slightly protruding and neatly rounded, anterior end rather abruptly rounded due to abrupt truncation above and recessive antero-ventral curve below, ventral margin gently rounded; hinge line straight, short, hingement formed by conjunction of rims with ligamental aid; surface marked by nine to ten strong, narrow growth rings separated by deep and narrow depressions, growth rings looser over posterior protrusion, pseudo-cardinal area marked by fine, parallel ridges representing margins of older growth rings. Length 0.595; width 0.502; thickness 0.446.

Type from top zone 16 (231 feet below top Simpson) Bromide formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs in Bromide and Tulip Creek formations of the Simpson.

Readily identified by the great number of narrow growth rings with relative small size, it makes a good marker. Possessing these characters, it is not easily confused with younger stages of other forms of Eridoconcha that occur associated with it and in older members of the Simpson. This form differs from *Eridoconcha rugosa* Ulrich (Maysville, Cincinnati, Ohio) in its abbreviated form, pointed apex, greater number of narrow growth rings, more prominent depressions between the growth rings, and pronouced inflation.

ERIDOCONCHA MAGNUS n. sp.

Plate V, figs. 3 a, b.

Carapace large, equilaterally and practically bilaterally symmetrical, length one and one-fourth times the height, anterior, posterior, and ventral margins evenly rounded, pronounced umbo forms central apex to dorsal margin and points anteriorly ever so slightly; hinge long and straight, hingement formed by conjunction of rims with ligamental aid, deeply channeled above hingle line at angles of approximately forty degrees; surface convex, marked by nine to eleven wide, flat, concentric growth rings gradually increasing in width as added, narrow and distinct depressions separate these growth rings, on the face of the high pseudo-cardinal area the growth rings appear as a series of straight, parallel lines or narrow ridges, the basal ones forming the latest hinge structure. Length 1.98; width 1.38.

Type from zone 85 (1404 feet below top Simpson) Oil Creek formation type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs only in the Oil Creek formation of Simpson.

This species of Eridoconcha is readily recognized by its size and shape and occurs in such abundance as to be a good marker, even in the field with the aid of a hand lens. Its younger stages are recognized by the long hinge line, ratio of length to height, and width of concentric growth rings. This species was not observed in samples of lower Ordovician age from other states due, no doubt to lack of material. A species of this rugged type suggests rather wide geographic range—we find it making up the complete substance of thin, limestone ledges.

PRIMITIOPSIS BASSLERI n. sp.

Plate XIV, figs. 2 a, b.

Plate XI, figs. 2 a, b, c, d.

Carapace sub-elliptical or sub-quadrate in side view, length approximately one and one-half times the height, slightly convex, thickest at the mid region, dorsal margin straight with subangular extremities, the anterior more rounded or obtuse, ventral margin gently arcuate, nearly parallel with the dorsal, anterior height of valves but little less than the posterior, free edges of the posterior and post-ventral margins of the shorter females bear short flanges that project backward and downard in conformity with the convexity of the carapace, posterior and ventral outline neatly rounded, but the projecting flanges conceal a recessive. obliquely rounded post-ventral region especially prominent in the female form, anterior end slightly projecting, rounded obliquely above and below, presenting a more pointed outline than the posterior; surface covered by beautiful reticulations which often have weathered smooth on the margins, mesial depression obscure, generally weathered smooth. Female: length, 0.772; width, 0.462; thickness, 0.328. Male: length, 0.9.27; width, 0.567; thickness, 0.405.

Type from top of zone 8 (98 feet below top Simpson) Bromide formation type section one-fourth mile west of Highwayy 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs in both the Bromide and Tulip Creek formations of the Simpson.

This form occurs in abundance in the Bromide and in less abundance in the Tulip Creek. The short female form is more common than the longer and slimmer male form. Both forms are generally weathered smooth along the margins, and strangely, too, often the right valve will be found weathered smooth while the left valve will show less wear. This form occurs in association with *Euprimitia sanctipauli* in the Bromide, from which it differs generically in possessing an obscure mesial depression instead of a true sulcus. The Primitiella form is also longer than the Euprimitia form. Ulrich has described *Euprimitia sanctipauli* from the Upper Trenton of St. Paul and I have it from the Decorah shale of Iowa; *Primitiella bassleri* was not found associated with it in those localities as in this instance. It differs from *Halliela labiosa* (Galena shales, Cannon Falls, Minnesota, in its greater length, fainter mesial depression, and finer reticulations.

DICRANELLA MACROCARINATA n. sp.

Plate XIV, figs. 3 a, b.

Carapace thick, robust, subcircular, but little longer than high, posterior end slightly higher than anterior due to presence of marginal border of "brood pouch", dorsal margin slightly arched near middle above straight hinge line due to umbonate-like projection of carapace, anterior end neatly rounded and projecting, posterior end obliquely rounded at postero-dorsal angle, evenly rounded and slightly projecting postero-ventrally, ventral margin evenly rounded except for antero-ventral angle of "brood pouch", this pouch is narrow, paralleling the posterior and ventral margins and conforming with the convexity of the surface; equivalved; surface convex, converging rather sharply into two nipple-like dorsal nodes or blunt spines, rounded, swollen at their bases, separated by a narrow, oblong depression, anterior spine larger, entire surface finely papillose, often weathered smooth. Length, 1.405; width, 0.053.

Type from zone 8 (98 feet below top Simpson) Bromide formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Section 25, T. 2S., R. 1E.

Occurs only in Bromide.

This form differs from *D. marginata* Ulrich, lower Trenton, Fountain, Minnesota, its nearest relative, in the greater convexity of carapace and more dorsal location of spines of the form herein described, and in the fact that the marginal rim conforms with the convexity of the carapace instead of projecting outward and downward as in Ulrich's form.

BROMIDELLA new genus

Slightly channeled, sub-ovate, highly spinose, straight-hinged form, characterized by a curved dorsal ridge that embraces a knob or blunt spine and a deep sulcus at its base anteriorly, bluntly pointed anteriorly, higher posteriorly, marginal rim or "brood pouch" postero-ventrally conforming to convexity of carapace; surface covered by spines and tubercles, larger spines projecting individually or in linear series from the anterior, ventral, and post-ventral margins.

Type: *Bromidella reticulata*, n. sp. Range: Ordovician.

This genus resembles some species of Eurychilina in its dorsal sulcus and posterior knob, but possesses additional characteristics of dorsal ridge and extreme spinosity. Only one species is thus far illustrated.

BROMIDELLA RETICULATA n. genus and sp.

Plate XIV, figs. 6 a, b.

Carapace obliquely and irregularly sub-ovate, flattened, sloping obliquely backward, outline of straight dorsal margin concealed by a spinose ridge except for a short anterior section, dorsal angles strong, upper part of anterior margin truncated almost at right angles, lower part strongly and obliquely sloping backward meeting an off-set ventral and post-ventral "brood pouch," margin of "pouch" evenly rounded, its symmetry broken by a post-ventral ridge of slightly projecting spines and a shorter, slightly higher, *en echelon*, projecting, calloused ridge behind the first and paralleling the posterior margin, postero-dorsal angle obliquely truncate, parallel with antero-ventral margin; hinge long, straight, hingement simple, groove in right and rim in left; surface strongly ornamented, a pronounced pustulose ridge rises in the anterior part of the carapace slightly below the dorsal margin, making a slight dorsal off-set it becomes emaciated and extends obliquely toward the centro-dorsal margin and projects beyond it, it roughly parallels the dorsal margin well past the mid-region where it makes a graceful right angled curve away from the dorsum, increasing in inflation it terminates near the posterior margin at a point above the mid-axis, this dorsal ridge embraces a short node or spine in its posterior curve, a deep, curved sulcus lies anteriorly at the base of the spine, three to four strong spines project obliquely forward from the anterior margin, two to three project obliquely outward and downward from the anterior portion of the "brood pouch", and two rows ventrally and post-ventrally from the "brood pouch" as already described, spines are stronger at the forward ends of all four series, shorter spines cover the entire carapace, being reduced to mere tubercles on the dorsal ridge. Length, 1.392; width, 0.934.

Type from zone 8 (98 feet below top Simpson) Bromide formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs in the Bromide and Oil Creek formations, so far ascertained.

This species was found in abundance in the Bromide in association with *Dicranella macrocarinata* and in the Oil Creek 60-75 feet below the McLish contact. In both instances it was the most characteristic specimen in the assemblage.

KRAUSELLA ARCUATA Ulrich

Plate XIV, figs. 4 a, b, c.

Krausella arcuata Ulrich, 1892, The Geology of Minnesota, vol. 3, pt. 2, of the Final Report—Paleontology. pp. 692-693, pl. XLIV, figs. 47-53.

The low anterior dorsal arch, slight overlap, and low position of the posterior spine characterize this form. The posterior spine is generally lower than illustrated here; sometimes occurring on a line with the ventral margin. This form was found abundant at outcrop in zones 12 to 14; 177 feet to 226 feet below the top of the Simpson. Ulrich lists it from the lower third of the Trenton shales at Minneapolis, Minnesota; lower Trenton limestone at Mineral Point, Wisconsin, and Dixon, Illinois; and Birdseye limestone at Highbridge, Kentucky. Measurements of the Bromide form and Trenton form from Minneapolis correspond very closely, the Bromide form being slightly smaller. Length, 1.474; width, 0.745; thickness, 0.591.

Type from zone 12 (177 feet below top Simpson) Bromide Formation from type section one-fourth mile west of Highway 77, Arbuckle Mountains, Sec. 25, T. 2S., R. 1E.

Occurs only in the Bromide, so far ascertained.

PRIONODUS ACULEATUS Stauffer[17]

Plate XI, fig. 3.

[17] *Prionodus aculeatus* Stauffer, 1930. Conodonts from the Decorah shale: Journal of Paleontology, vol. 4, No. 2, p. 126, pl. 10, fig. 12.

This form occurs abundantly in the Tulip Creek formation of Oklahoma and examination so far finds it limited to that member. Stauffer has described this form from the lower part of the Decorah shale from the University of Minnesota campus, Minneapolis, Minnesota.

The distinguishing characteristics of the form are as follows: high, strong basal bar very slightly reinforced dorsally and ventrally, this bar terminating into an evenly curved elongate, anterior cusp, this cusp followed by two to three smaller ones. which in turn are followed by two to three stronger ones curving slightly backwards. Others may exist behind these on perfect specimens.

There is some doubt concerning the definite generic establishment of this form. Prionodus proper has the strongly developed anterior cusp noted in this form, but instead of a rounded, evenly curved basal bar the type genus has an "undenticulated downward projection" similar in shape to the cusp above. Forms of the Decorah and Tulip Creek type are rare in the literature, Hinde[18] having described and figured a form in 1879 similar to it and Stauffer[19] describing and figuring forms of this type in 1930.

DREPANODUS ARCUATUS Pander

Plate V, figs. 1 a, b.

Drepanodus arcuatus Pander, 1856. Monographie der Fossilen Fische des Silurischen Systems der Russich-Baltischen Gouvernements, St. Petersburg, p. 20, pl. 1, figs. 2, 4, 5, 17, 30, 31.

Drepanodus arcuatus Hinde, 1879, Geol. Soc. London Quarterly Journal, vol. 35, p. 357, pl. 15, figs. 7, 8.

Drepanodus arcuatus Grabau and Shimer, 1910, North American Index Fossils, Invertebrates, vol. 2, p. 245, figs. 1537 d, e.

Drepanodus arcuatus Parks, 1923, The Stratigraphy and Paleontology of Toronto and Vicinity, Part 3, Gastropods, Cephalopods and Vermes. Thirty-first Annual Report, Ontario, Dep't. of Mines, vol. 31, part 9, p. 36, pl. 6, figs. 21, 22.

This simple-toothed, gently curved form has been described from the Lower Ordovician from numerous localities. It is recognized by the curvature, roundness of outside edge and keel on inside edge (illustration typical).

This form was found in several samples of Oil Creek age. Straighter forms are found in the basal sand of the Tulip Creek, so-called Wilcox sand.

18. Hinde, Prionodus elegans (Pander): Geo. Soc. London Quarterly Journal, vol. 35, p. 358, pl. 15, fig. 10. 1879.

19. Stauffer, Cordylodus, Prionodus, Belodus, sps. Conodonts from the Decorah shale: Journal of Paleontology, vol. 4, no. 2, pl. 10, figs. 7, 12, 13, 19, 20. 1930.

SIMPSON ELSEWHERE

Toward the east in the Ouachita Mountains of southeastern Oklahoma, the Blakely sandstone,[20] Womble sandstone and Bigfork chert are probably equivalent to some parts of the Simpson, but no details of equivalency have been worked out.

The Tyner shale and Burgen sandstone[21] exposed in the vicinity of Tahlequah, Oklahoma, doubtless represent some parts of the Simpson and it is most probable that they represent middle and lower parts of that group. Some evidence has been found to suggest Black River age for part of them but other evidence would place part of Tyner and all of Burgen in the Chazy[22].

The Simpson has long been recognized in the sub-surface of various parts of Oklahoma and doubtless the best classification that could be made on subsurface evidence was made by White in 1926 and republished two years later[23], but the Simpson is so extremely variable in its outcrops that it is impossible with the restricted time at hand to attempt any detailed correlation of the outcropping parts with the subsurface extensions to the north. The subsurface development of the Simpson in central Oklahoma has been studied especially by Weirich[24] and Cram, and the former of these men has made an isopachous map of the Simpson and a graphic cross-section correlating the Simpson of Oklahoma City with that of the Cushing field.

In the wells in the Seminole region the dense limestones and dolomites with two related sandstones seem to be most like the middle formation of the Simpson, the McLish, as it may be seen in outcrop in the eastern and northeastern parts of the Arbuckle Mountains. The upper or Seminole sand probably represents one of the intraformational sands of the McLish and the basal sandstone or "true Wilcox", as it has been called, seems to correlate best with the soft sand at the base of the McLish and the glass sand at Roff.

Levorsen has given a brief description of the Simpson[25] as it occurs in the wells of Seminole County and a diagram showing changes in the character of the Simpson from south to north.

In his paper on the Oklahoma City oil field Charles gives a

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20. Honess, C. W., Oklahoma Geol. Survey Bull. 32, Pt I, pp. 58-80, 1923. Gould, C. N., Oklahoma Geol. Survey Bull. 35, pp. 29-31, 1925.
21. Ulrich, E. O., Oklahoma Geol. Survey Bull. 40, Pt. 3, pp. 537-38, 1930.
22. Cram, I. H., Oklahoma Geol. Survey Bull. 40, Pt. 3, pp. 538-548,1930.
23. White. L. H., Oklahoma Geol. Survey Bull. 40, Vol. 1, pp. 29-32, 1928.
24. Weirich. T. E., Am. Assoc. Pet. Geol. Bull. Vol. 14, pp. 1507-1513, 1930.
25. Levorsen, A. I., Oklahoma Geol. Survey Bull. 40, Vol. 3, pp. 307-311, 1930.

brief description of the Simpson and a structural section, though it is largely undifferentiated.[26]

Udden[27] and Twenhofel[28] recognized Black River Ordovician in the wells of Western Kansas in 1926 and 1927.

Mrs. Edson[29] recognized Simpson in the wells in central Kansas in 1929 and gave a correlation table of lower and middle Ordovician.

Later McClellan[30] described the Simpson in the subsurface of Kansas suggesting Black River age for it.

Doubtless parts of the Simpson also are equivalent to the St. Peter sandstone, the Joachim limestone, and the Jasper limestone of Arkansas[31].

Simpson has been recognized in the Big Lake oil field in Reagan County, Texas[32], in a well below 8500 feet, and most of it there has been assigned to Chazy,[33] which is middle or lower Simpson. Also in the Marathon uplift of Brewster County in southwestern Texas both Chazy[34] and Black River have been recognized and these doubtless represent some parts of the Simpson of Oklahoma.

It may be noted that Tyner and Burgen formations of northeastern Oklahoma probably represent part of the Simpson; that the McLish is equivalent to the Middle Chazy throughout the full length of the Appalachian region; and that the Bromide formation is the approximate equivalent of the Plattin of Missouri and the Platteville of Illinois, Iowa and Wisconsin, and Black River of Minnesota.

SUMMARY

1. The Simpson is exposed in 24 different outcrops and these have been mapped and differentiated.
2. The Simpson is changed from a formation to a group and divided into five formations representing sedimentary cycles.
3. Three formations have wide distribution in the Arbuckle Mountains and two are local, so that there are five formations

26. Charles, H H., Am. Assoc. Pet. Geol. Bull. vol. 14, pp. 1521-23, 1930.
27. Udden, J. A., Am. Assoc. Pet. Geol. Bull. Vol. 10, pp. 634-35, 1926.
28. Twenhofel, W. H., Am. Assoc. Pet. Geol. Bull. vol. 11, pp. 49-53, 1927.
29. Edson, F. C., Am. Assoc. Pet. Geol. Bull. vol. 13, pp. 441-458, 1929.
30. McClellan, H. W., Am. Assoc. Pet. Geol. Bull. vol. 14, pp. 1540-41 and Fig. 2, 1930.
31. Croneis, Carey, Arkansas Geol. Survey, Bull. 3, pp. 26-29, 1930.
32. Harlton, B. H., Am. Assoc. Pet. Geol. Bull. vol. 14, No. 5, pp. 616-18, 1930,
33. Lowman, S. W., Am. Assoc. Pet. Geol. Bull vol. 14, pp. 798-806, 1930,
34. King, R. K., Program Am. Assoc. Pet. Geol. San Antonio, Texas, p. 8, March, 1931.

in the middle, western, and northwestern areas, but only three in the eastern and northern parts.

4. The Simpson has more limestone and shale in the southern and western parts of the mountains and more sandstone in the middle, eastern, and northern parts. Dolomites occur only in the eastern and central areas, and primarily in the McLish formation. A birdseye-like limestone has a distribution similar to the dolomites except that it is found also at the north end of the Criner Hills.

5. The Simpson varies in thickness from over 2300 feet on the south side on Sycamore Creek, to 1650 feet on Colbert Creek southwest of Davis, to 900 feet at the north edge of Bromide, and 628 feet on the P. A. Norris ranch.

6. Of the five formations of the Simpson group, the Joins is correlated with basal Chazy, the Oil Creek with Lower Chazy, the McLish with Middle Chazy, the Tulip Creek with the very uppermost Chazy and lowermost Black River, and the Bromide with Black River.

7. While the more typical large species of the McLish fauna of the eastern and central parts of the Arbuckle Mountains have not been found in the western part of the mountains, the cystid zone *Paleocystites tenuiradiatus* extends throughout the mountains a short distance above the McLish sand. Also, in what seems to be a transitional section 8 miles southeast of Sulphur the McLish fauna occurs in the midst of limestones which had formerly been assigned to the Falls formation. This indicates the general equivalency of this body of rocks including the "Burgen" sand and associated shales and limestones above it, and justifies the dropping of the name "Falls formation" and the extension of the McLish formation throughout the mountains[35].

35. Since the completion of this part of this publication by the senior author, Dr. E. O. Ulrich has gone over a number of the more critical sections of the Simpson Group in the Arbuckle Mountains and Criner Hills. While admitting the widespread extension of the Bromide formation throughout the Arbuckle Mountains, he would retain the name Criner for upper Simpson at Rock Crossing in the Criner Hills, and retain the term Falls for that body of rocks in the western part of the mountains which the author thinks the field relations show to be practically equivalent to the McLish of the eastern part. Because of the necessity of publishing at once, the author regrets that there probably is not time to check additional evidence in the field. Also, he regrets the lack of opportunity to compare with type forms several of the species identified. He further regrets the lack of time to identify more forms, and particularly the inability to section and study more of the numerous bryozoa. It will be a source of gratification to those interested to know that Dr. August Foerste is beginning this summer a detailed study and description of the Cephalopoda of the entire Simpson Group.

LATER NOTE. The senior author has checked over the evidence in the field again, and suggests that the two sandstones and a conglomerate in the western part of the mountains serve to tie in more closely the phsyical characteristics of the McLish of the western region with the McLish of the east. Also, the relatively low position of the McLish fauna in the section eight miles southeast of Sulphur precludes the idea of placing the McLish above what was temporarily called "Falls".

Futhermore, besides the numerous zones mentioned which relate the Bromide at

Rock Crossing in the Criner Hills with that in the Arbuckle Mountains, Dr. Ruedemann has recently identified DIPLOGRAPTUS MAXWELLI from a zone 35 feet below the top of the Bromide on Cool Creek northeast of Springer, the same as the type form at Rock Crossing in the Criner Hills. Also, in the same graptolite zone in the Criner Hills a TETRADIUM CELLULOSUM has been found which occurs near the top of the Bromide on the P. A. Norris ranch south of Franks. These are but two more reasons for doipping the term "Criner" and for calling the rocks of both regions Bromide.

8. The Simpson basal conglomerate probably represents a slight erosional interval, but it rests with apparent conformity on the Arbuckle limestone in the western and southwestern parts of the mountains, but a hiatus occurs at this horizon in the eastern and northeastern parts of the mountains. Locally, at least, it is unconformable beneath the Viola and there are hiatuses within the Simpson at the top of the Oil Creek and at the top of the McLish. (Fig 2).

9. The Simpson and Viola have been re-mapped and formation contacts have been more accurately located. Many thousand acres of middle and upper Simpson, which had formerly been mapped as Viola, are shown for the first time as the McLish and Bromide formations of the Simpson.

10. The evidence from the thickness, nature, and distribution of the sediments and the unconformities, points clearly to a region to the northeast of the Arbuckle Mountains as the land mass from which terrigenious materials of the Simpson formations were derived; and the hiatuses at the base, above the middle, and at the top of the Simpson, indicate that this northeastern land mass, and the northern and northeastern parts of the Arbuckle mountain area were elevated and part of the Simpson deposits were eroded away during these stages of elevation.

MINERALOGICAL CHARACTER

By

Clifford A. Merritt

The writer wishes to acknowledge the valuable assistance rendered by Messrs. Joseph Minton, William Plaster, and Reginald Gregory, in analyzing the samples, the results of which are recorded in the tables of this article.

It was decided at the commencement of this work, to analyze samples gathered from various measured sections of the Simpson group and determine the percentage amounts of calcite, dolomite, and material insoluble in hydrochloric acid, that is the non-calacerous material, and study the composition of this latter noting whether it was silt or quartz, the degree of rounding of the latter mineral, etc. Futhermore, the rock textures were to be studied in thin sections. These plans were carried out and the results are given in this article. After completing the analyses of the type described above, the writer was informed of the work of H. S. McQueen in which the material insoluble in hydrochloric acid is analyzed in a somewhat different fashion, the finest material being removed, and more emphasis being placed on certain minerals, notably chert and on certain structures, notably oolites and dolocasts, than in the method the author had been using. Consequently it was decided to re-analyze the Simpson samples according to this newer procedure and to incorporate the results, together with the others in this article. Therefore the discussion of the mineralogical character of the Simpson group is divided into two parts. In the first part the original analysis and the results obtained are discussed, and in the second part the "Insoluble Residue" method and results are given.

QUANTITATIVE METHOD FOR DETERMINING THE CALCITE, DOLOMITE, AND NON-CALCAREOUS MATERIAL IN A ROCK

The numerous beds of the Simpson group and the limited time at the writer's disposal made it impossible to analyze the samples in the ordinary chemical manner, which is a time consuming procedure. Furthermore, a high degree of accuracy is not essential, for local variations affect the composition and an individual sample has little value except as a type. For these reasons, a quicker though less accurate method than the conventional one was used.

The writer in a previous article[36] has described a rapid quantitative staining method for the determination of the calcite, dolomite, and acid insoluble material in a sedimentary rock, but as this method is somewhat inaccurate it has been discarded in favor of a slower, but still rapid titration analysis, which has a higher degree of accuracy. The titration is based on the well known fact that hydrochloric acid attacks both calcite and dolomite whereas acetic acid reacts only with the former mineral. The amount of calcite therefore, can be determined by treating the sample with acetic acid and then titrating the excess acid with a base. The dolomite is not altered by this acid and consequently can be determined quantitatively by the later use of hydrochloric acid on the residue from the above treatment and the subsequent titration of the unused acid against a base. The quantity of acid insoluble material in the sample can be computed from the data obtained in the above procedure.

The details of this method may be outlined as follows:

1. Weigh out 1 gram of the sample, which has been crushed and screened through the 60 and caught on the 80 mesh screen

36. Decker, Charles E., and Merritt, Clifford A., Physical characteristics of the Arbuckle limestone: Oklahoma Geol. Survey Circ. No. 15, p. 47, 1928.

and transfer this quantity to a test tube provided with a stopper.

2. Add 10ccs. of approximately N. standardized acetic acid; cork ths test tube and allow to stand until the effervescence, caused by the action of the acid on the calcite ceases, usually a few hours. It is essential to cork the test tube in order to prevent loss of the acid through evaporation.

3. Titrate the unused acetic acid against approximately N. standardized sodium hydroxide, using phenolphthalein as indicator. From this data compute the percentage of calcite present in the sample. Phenolphthalein instead of litmus, is used as indicator, for the latter is affected by carbonic acid.

4. Decant the neutralized solution and then to the residue add 2 ccs. of concentrated hydrochloric acid and allow to stand until the effervescence, produced by the action of the acid on dolomite, ceases.

5. Titrate the unused hydrochloric acid against the standardized sodium hydroxide, as previously, and compute the percentage of this mineral present in the sample, remembering that dolomite is a double salt with the composition $CaMg\ (Co._3)_2$.

6. Calculate the percentage of the acid insoluble residue by subtracting the sum of the calcite and dolomite percentages from 100. Observe the residue under the binocular microscope and determine the minerals present, the size of the quartz grains and their degree of rounding, etc.

Acetic acid was chosen in preference to dilute hydrochloric acid as the reagent to remove the calcite, as it was found by experiment that the latter acid, even when diluted to 0.5%, still attacked dolomite which had passed through the 60 mesh screen, whereas acetic acid, being a weaker acid as shown in the following table, did not affect this mineral. Coarse fragments of dolomite are not attacked by cold dilute hydrochloric acid, but to use larger than 60 mesh fragments is impractical, as this would necessitate a lengthy period of time to complete the reaction.

Acid	*Avidity*
Nitric	100
Hydrochloric	100
Sulphuric	49
Oxalic	24
Tartaric	5
Acetic	3

The avidity of the acid also depends on the degree of ionization; concentrated acetic acid being so little ionized that it will not attack the most finely powdered calcite. By experiments, a dilution of this acid to N. strength has been found suitable for use in the above method of analysis.

The stock solutions of acetic acid and sodium hydroxide were standardized in the conventional manner, namely by titrating these reagents against one another and then the acid against weighed anhydrous sodium carbonate. The hydrochloric acid was standardized by titrating against the sodium hydroxide solution.

MINERALOGICAL GENERALIZATIONS

For the benefit of those readers who are more interested in the broader relationships than in the details of the formation, an attempt will be made to generalize the mineralogical data tabulated in the preceeding tables.

DOLOMITE

The percentages of dolomite present in the new subdivisions of the Simpson group are shown in the following table:*

Section	*Ardmore-Davis Highway*	*Nebo*	*West Spring Creek*
	BROMIDE FORMATION		
Maximum	20%	12%	14%
Minimum	0%	0%	0%
Average	3%	3%	6%
	TULIP CREEK FORMATION		
Maximum	23%	8%	20%
Minimum	0%	0%	0%
Average	2%	1%	5%
	McLISH FORMATION		
Maximum	24%	20%	17%
Minimum	0%	0%	5%
Average	5%	2%	13%
	OIL CREEK FORMATION		
Maximum	8%	14%	17%
Minimum	0%	3%	0%
Average	3%	7%	8%
	JOINS FORMATION		
Maximum	16%	0%	9%
Minimum	0%	0%	7%
Average	5%	0%	8%

A consideration of the above table shows that dolomite is not abundant in the Simpson group, the average amount being 5 percent, the maximum 24 percent and the minimum 0 percent. However, a high content of dolomite (70 percent) is found in

*When this table was made the dolomites in the McLish in the Eastern part of the mountains had not been analyzed as noted below the table.

the cap rocks of the monadnocks (McLish formation) on the west side of the Delaware Creek in the vicinity of Coatsworth school, and likewise in the McLish, especially in the P. A. Norris section. Also dolomites in the Simpson have been noted in well samples from Seminole, Holdenville, Stroud, Cushing, Okemah,[37] and other districts, and consequently the above three sections are not representative in their dolomite content of all Simpson rocks. The variation of the dolomite content along the strike and whether it is primary or secondary in origin are problems which must be answered before the dolomite content will be of much value for correlative purposes except perhaps for local work.

In thin section, the dolomite is seen to be present in well developed rhombs, 0.5 to 0.05 mms. wide, which commonly are iron stained.

CALCITE

The texture of the limestone is not uniform throughout the group, nor is any particular portion of the Simpson characterized by any special texture, in fact several distinct types occur in the same slide.

The percentages of calcite in the various beds have been given in the detailed sections and require no further comment here.

QUARTZ

The quartz of the Simpson varies in size from 0.2 to 2.0 mms. diameter, often several sizes being present in the same sample. Quartz, less than 0.02 mms. diameter undoubtedly is present but this fine variety is classed with the minute grains of white mica, kaolin etc., under the general heading of silt, as it is impracticable to differentiate these minerals. The quartz varies from 0 to 100 per cent in the different beds. The mineral exhibits all degrees of rounding, the finer material usually being more angular than the coarser. Many of the grains, but not all, show etching, pitting, and secondary growths. Chert is not abundant but is present in some samples.

Further details concerning the quartz and chert will be found in the section under Insoluble Residues.

GLAUCONITE

Glauconite is present in small quantities in many of the shales and limestones, to which rocks it imparts a greenish hue. In some cases however, this tint is due to chlorite or to a mixture of glauconite and chlorite. In no sample was this potassium

37. White, Luther H., Subsurface distribution and correlation of the pre-Chattanooga (Wilcox sand) series of northeastern Oklahoma: Oklahoma Geol. Survey. Bull. 40-6, p. 16, 1926. Levorsen, A. I., Geology of Seminole County, Oklahoma Geol. Survey, Bull. 40, vol. 4, 308, 1930.

silicate found to be abundant, rarely forming one per cent of the rock. The mineral is found in all the formations of the Simpson group but appears to be limited to certain portions of these as will be brought out later in describing the Insoluble Residues.

OTHER MINERALS

Pyrite, sometimes altered to limonite, is present in many specimens as also are pyrolusite dendrites. Clastic fragments of feldspars are noticed but are not abundant.

INSOLUBLE RESIDUES

The term "Insoluble Residue" has been used by McQueen[38] to designate that material remaining after digesting the rock with hydrochloric acid, thus the term includes the non-calcareous material, shale, chert, quartz, pyrite, glauconite, etc. He finds the residues from different Missouri formations have distinctive characteristics which are constant over wide areas and that correlations can be made on this basis. This method of correlation appears to have given excellent results in Missouri and it was with the hope that it would yield similar results in the Simpson formation that the writer undertook this phase of the work.

OUTLINE OF THE PROCEDURE USED TO OBTAIN INSOLUBILE RESIDUES

The method used by the author is similar to that used by McQueen and consequently his description of the procedure with minor modifications, is given in the following outline.

1. Crush approximately 25 grams of the hand specimen through a 10-mesh screen and place the ground material in a 250 cc. beaker. If the specimen is a drill cutting, crushing is usually unnecessary. Samples smaller than the above can be used, with good results, if larger pieces are not available.

2. Cover the sample with 50 ccs., 50 percent commercial hydrochloric acid, adding the acid slowly so as not to allow the effervescence to force the liquid out of the beaker. Where a large number of samples are being run at one time, time is saved by pouring the acid from a one-gallon bottle equipped similarly to the ordinary wash bottle.

3. Allow the sample covered by the acid to stand over night in order to give time for complete solution of the carbonate material. If however the results are desired as soon as possible, the reaction may be speeded up by placing the beaker on a sand

38. McQueen, H. S., Insoluble residues as a guide in stratigraphic studies: Missouri Bureau of Mines, Appendix, 1, 56th. Biennial Report, 1931.

bath. If the sample contains a large amount of dolomite even the latter method will require several hours for complete digestion to take place. After the sample ceases to effervesce it is removed from the sand bath, as excessive heating forms a gelatinous precipitate and also gypsum crystals. The latter crystals are due to the reaction of the sulphuric acid in the commercial acid and the limestones. The difficulties above mentioned do not occur if the sample is left in the acid over night without heating. Likewise they can be avoided by using chemically pure acid but when one treats hundreds of samples the cost of such acid is considerable.

4. The digested sample is washed once with tap water and then decanted. This removes the finest material which may have prevented complete digestion. Acid then is added again and the sample allowed to stand in the cold or heated on the water bath until effervescence ceases. This double treatment with acid seems essential for complete removal of the carbonate material, especially is this true if the samples are highly dolomitic.

5. After the second acid treatment the sample is washed and decanted several times to remove the fine material, silt, etc., always allowing time for the coarser parts of the residue to settle before decanting. This is important as this fine material will obscure the residue and experience has shown that it is easy to underwash but difficult to overwash most residues.

6. The washed sample is allowed to dry on the sand bath and is then ready for study under the ordinary binocular microscope.

The specimen may be filed away if a permanent record is desired. Small glass vials, fitted with corks are convenient for this purpose. Small triangular pans, 5 by 3 inches and one-fourth inch deep, painted black and with an opening at one end of the triangle are useful to contain the sample during microscopic study.

PRELIMINARY DATA ON THE INSOLUBLE RESIDUES OF THE SIMPSON GROUP

The result of the study of the insoluble residues of the Simpson group have been generalized as much as possible and in such form are tabulated below for the Ardmore-Davis section.

The descriptions of the residues are given in the ordinary mineralogical terms, with the exception of the world "dolocast". This word is used by McQueen to describe the rhombohedral depressions left in the shales and the cherts when dolomite crystals are dissolved out by the acid.

TABLE XI.

DATA ON INSOLUBLE RESIDUES OF SIMPSON GROUP

No. of Bed	Thickness Feet	Characteristics
		BROMIDE FORMATION
Top to top of 12*A	156**	*Quartz*, sausage shaped, coarse with glassy and milky bands. Residues of beds No. 1 and 6 mostly this type of quartz, but it i present in minor amounts in some of the others. *Chert* present in small amounts only, some milky with corrugal tions (plications of brachipods), some spongy with fine dolocasts- *Shale* mostly gray, earthy, with fossil imprints, especially horizonta. and vertical sections of bryozoan zooecia which show dolocasts. Bed 12 has many fragments of fossils, brachiopods, as well as bryozoans. Shale is sometimes platy and red. *Residue**B small, usually less than 5 per cent.
Top 12 to top 14	22	*Shale* green, gray, or red, platy. *Residue* 100 per cent.
Top 14 to base 21	111	*Residue* is like that from top to top of 12, only the residues consisting entirely of sausage shaped quartz are absent, but such quartz is present in small amounts in some of the beds. Fenestelloid bryozoans are present as well as the other types.
22	57	*Quartz* aggregates of fine to coarse grains cemented together by a red shale. Quartz grains are etched and pitted. *Shale* red containing a few bryozoans of fenestelloid type. *Residue* 20%, *B
23	28	*Shale* red, platy, also some large pieces which are dense white. *Glauconite* a few grains, rounded, small. *Chert* greasy, spongy with fine dolocasts. *Residue* 10-30%.
Top 24 to base 25	52	*Quartz* a sand consisting of medium sized grains aggregated together, secondary growths. *Residue* 100%.
		TULIP CREEK FORMATION
Top 26 to base 41	221	*Quartz* small grains often aggregated together, sometimes showing secondary growths. *Shale* platy, red green or gray, some white dense large pieces. Fenestelloid and other bryozoans,. *Chert* rather uncommon, greasy, spongy with dolocasts. *Glauconite* few, rounded small grains. *Residue* 10-70%.
Top 42 to base 51 Zone includes pure sand and interbedded shales. The sands belong to the so-called WILCOX.	174	*Quartz* medium to coarse, secondary growths. *Shale* platy, green red and black, the black is irregular in shape. *Residue* large, in case of the sands it is 100%.
		McLISH FORMATION.
Top 52 to base 60	93	*Quartz* fine to coarse, latter pitted and etched, some secondary growths. Sometimes the quartz is in aggregates. *Shale* platy, red gray or irregular white, with dolocasts, few fossils. *Chert* not common, spongy dolocasts, greasy gray. *Glauconite* few, dark, greasy and also few white, cemented aggregates *Residues* 10-20%.
Top 61 to base 73	150	*Quartz* fine to coarse, sometimes in aggregates, often colored. *Shale*, platy green, gray or red, few fossils, some black irregular pieces. *Chert* greasy, spongy, coarse dolocasts, often a greenish tint. Some fossils, often shell-like. *Residue* 10-70%.

*A—Numbers refer to number of zones in Table IV.
*B—Percentages given are those of the insoluble residues studied and as the finest material has been washed away these figures do not correspond with those in the previous table.
**Inches disregarded, so that totals of zones, formations, and groups differ slightly from those in table IV.

TABLE XI.—(Continued)

No. of Bed	Thickness Feet	Characteristics
Top 74 to base 77	134	*Quartz* fine, irregular aggregates. *Chert* greenish, spongy, dolocasts. *Glauconite* few grains, rounded. *Residue* 20%.
78 So-called TYNER SHALE	8	*Quartz* fine to medium, rounded. *Shale* platy, green, red or gray. Few fossils. *Residue* small.
Top 79 to base 80	34	*Quartz* fine, aggregated together. *Residue* small.
81 So-called BURGEN SAND	55	*Quartz* medium sized, secondary growths, irregular aggregates. *Residue* 100%.
		OIL CREEK FORMATION
Top 82 to base 85	107	*Quartz*, often in aggregates. *Shale* platy, green, gray, red. *Chert* gray, spongy, dolocasts, some sponge spicules. *Residue* small to 60%.
86	22	*Chert* milky, compact, common. *Shale* dark, greasy, glassy. *Residue*, small.
Top 87 to base 89	171	*Quartz* fine. *Shale* gray, brown, irregular, some platy, many fossils, especially coiled gastropods. *Chert* gray, spongy, dolocasts. *Residue* small.
Top 90 to base 91	313	*Quartz* coarse, frosted, pitted, also fine rounded grains. *Shale* platy, red, gray, green, and black irregular pieces, some white dense fragments, with dolocasts. Some fossils. *Chert* greenish gray, coarse dolocasts, and greasy chert with dolocasts. *Glauconite* few coarse grains, some are honeycomb in appearance. *Chlorite*? fragments, platy, irregular. *Residue*, small.
92 to base 94	68	*Quartz* coarse, secondary growths. *Residue* 90%.
		JOINS FORMATION
Top 95 to base 102	295	*Quartz* fine to medium, rounded, etched, pitted. *Chert* spongy, coarse dolocasts. *Glauconite*, honeycomb structure, few. *Fossils* few. *Oolites* few, greasy, dark (0.5 mm. dia.)

CONCLUSIONS

The West Spring Creek section yields somewhat similar residues to those described above, but residues from sections in the eastern part of the Arbuckle Mountains have more sand. Attempts to correlate beds from the eastern sections of the Arbuckle mountains with those of western sections have not been very successful though certain ones like the top bed and the siliceous fossil beds seem to hold fairly well.

As mentioned previously in this article, many beds of the Simpson group are quite variable both in physical and faunal content, even along the strike and consequently in these one would not expect the insoluble residues to be constant. However, other beds are uniform over wide areas and insoluble residues likewise appear constant. To date the work has not progressed far enough to know how valuable such correlations will be. It may be found that some of the residues are constant over wide areas, but it is certain that such will not be the case for all residues. Only an empirical study of Simpson samples gathered from wells of widely separated areas will prove or disprove the value of this method of correlation. Such samples are now being gathered and studied by the author.

The study of the Insoluble Residues of the Simpson group is still in the embryonic stage and the above outline must be considered in the light of a progress report.

DESCRIPTION OF THIN SECTIONS

In the following descriptions the numbers of the thin sections correspond to those used in the Springer detailed section.

The identification of the minerals in the thin section presents few difficulties. Quartz and calcite are recognized readily. Dolomite in the form of rhombs is seen best by using convergent light and lowering the polarizer.

2. *Calcite* ,in two forms, (a) minute grains forming most of the slide, dark colored and containing considerable silt, (b) rounded grains consisting of a mosaic of coarser material, probably sections of fossils.

Quartz, a few minute grains, 0.05 mm. diam.

3. The slide consists of extremely minute calcite grains difficult to determine. A veinlet of calcite, 0.05 mm. diam. wide is present.

Magnetite, a few small, black, opaque grains.

4. *Calcite,* in three forms, (a) coarse grains showing cleavage and twinning, (b) minute grains difficult to distinguish, dark colored, (c) several sections of fossils, many seem to be bryozoans and brachiopods.

5B. Similar to No. 3.

6. *Calcite,* in three forms, (a) irregular grains showing cleavage, (b) finely crystalline, (c) sections of fossils.

Quartz, sub-rounded to rounded, 0.1 to 0.2 mm. diam., a few with inclusions.

Glauconite, several grains of a greenish, isotropic, nonpleochroic mineral, probably glauconite.

Magnetite, numerous grains, 3 per cent.

7. Similar to No. 4.

10B. *Calcite,* in three forms, (a) coarse grains showing cleavage, (b) very fine grains, (c) iron-stained sections of fossils.

Dolomite, many small rhombs, 0.05 to 0.12 mm. long, iron-stained.

15. *Calcite,* in three forms, (a) coarsely crystalline, limonite-stained, (b) a few large grains, 1.0 mm. long, showing cleavage, (c) sections of fossils, some of these appear to be brachiopods, one large section of a brachiopod shows fibrous calcite parallel to the ridges, fibres 3 mm. long.

Quartz, 0.12 to 0.2 mm. diam., sub-angular to semi-rounded, many with inclusions of zircon and other minerals.

Feldspars, one semi-rounded grain of microcline, a few grains of plagioclases.

Magnetite, many small grains.

Limonite, common as a stain, one isotropic limonite mass 1.0 mm. diam.

16A. *Calcite,* in three forms, (a) very fine grained, (b) a few larger grains showing cleavage, (c) sections of fossils which often are iron-stained at the edges.

Quartz, 0.05 to 0.2 mm. diam., angular to sub-rounded, many with inclusions.

Magnetite, several grains.

18. *Calcite,* in two forms, (a) grains 0.08 to 0.25 mm. long, showing cleavage, (b) sections of fossils.

Quartz, 0.05 to 0.15 mm. diam., angular.

19B. *Calcite,* in three forms, (a) very fine grains, difficult to distinguish, (b) larger grains showing cleavage, (c) sections of fossils, many iron-stained.

Quartz, 0.05 to 0.1 mm. diam., angular.

Magnetite, several grains.

20. *Calcite,* in three forms (a) coarsely crystalline, showing cleavage or twinning or both, (b) grains 2.0 mm. long, iron-stained at edges and showing optical continuity with the surrounding calcite, as demonstrated by the continuity of the cleavage lines, (c) sections of fossils.

Quartz, slightly iron-stained, 0.5 mm. diam., and smaller.

23A. *Calcite* in two forms, (a) very fine grained, iron-stained, (b) sections of fossils.

Quartz, 0.08 to 0.2 mm. diam., semi-angular.

Dolomite, iron-stained rhombs, 0.1 to 0.25 mm long.

Glauconite, angular to rounded, green grains, 0.1 mm. diam., 10 per cent.

30. *Calcite,* in two forms, (a) angular to rounded grains, 0.12 mm. diam. (b) fine grained, iron-stained, containing considerable silt.

Quartz, 0.15 mm. diam., semi-angular, partly iron-stained.

Feldspars, several grains.

Glauconite, green grains, 0.15 mm. diam.

38A. Calcite, in three forms, (a) sections of fossils, (b) finely crystalline, containing considerable silt, (c) coarsely crystalline, showing cleavage.

Dolomite, iron-stained rhombs, 0.1 mm. long.

53B. *Calcite,* in two forms, (a) coarsely crystalline, showing cleavage, (b) sections of fossils.

Quartz, a few angular grains, 0.15 mm. diam.

54. Similar to No. 53, only small quantity of glauconite is present also.

57B. Similar to Nos. 53, and 54. A small amount of dolomite present.

58. *Calcite,* in two forms, (a) finely crystalline, (b) sections of fossils.

Quartz, 0.1 to 0.3 mm. diam., angular to rounded.

Dolomite, many rhombs, 0.06 mm. long, iron-stained

Glauconite, a few grains present.

60B. *Calcite* in two forms (a) coarsely crystalline, showing cleavage, (b) sections of fossils.

Quartz, 0.1 to 1.0 mm. diam., semi-rounded to rounded.

Dolomite, many rhombs, 0.08 mm. long, iron-stained.

Glauconite, a few grains, 0.1 mm. diam.

68. *Calcite,* in three forms, (a) coarsely crystalline, showing cleavage and twinning, (b) secondary growths around the grains, cleavage lines are continuous through the periphery of the grains, (c) sections of fossils.

Quartz, a few rounded grains, 0.1 mm. diam.

70. *Calcite,* fine-grained.

Quartz, angular to rounded, 0.5 to 2.0 mm. diam. A few crystal faces apparent and some of the quartz is in interlocking crystals.

Mica, a few shreds of muscovite.

Pyrite, a few cubes.

72. Calcite, coarsely crystalline, showing twinning and cleavage.

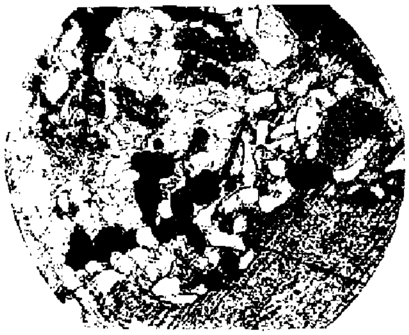
Quartz, 0.1 mm. diam., angular to rounded.

75. *Calcite,* in three forms, (a) coarsely crystalline, showing cleavage and twinning, (b) mosaic of fine crystals, 0.1 mm. diam., (c) sections of fossils.

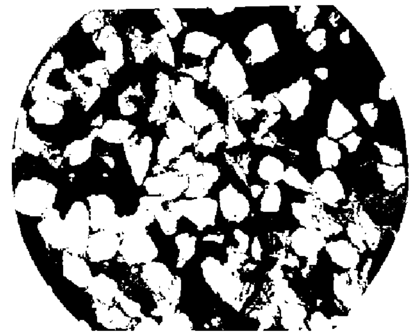
Quartz, 0.1 to 0.2 mm. diam., semi-rounded.

Dolomite, iron-stained rhombs, 0.07 mm. long, and smaller.

84 *Calcite,* in two forms, (a) mosaic of grains, 0.2 mm.



23 A

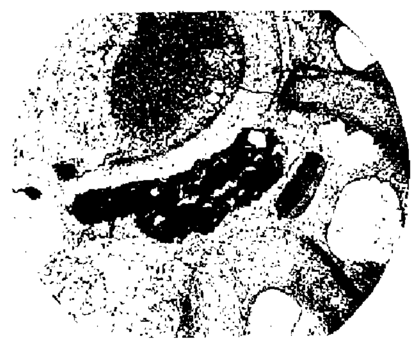


30

54

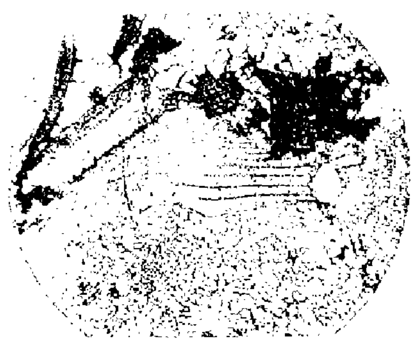
57 B

58



60 B

68



89

PHOTOMICROGRAPHS OF THIN SECTIONS X 40

23A. Limestone containing angular to semi-rounded quartz (white) and glauconite (black)
30. Limestone containing angular quartz.
54. Secondary growths around calcite grains. Note the continuity of the cleavage lines through the periphery of the fragment. A considerable quantity of quartz is present.
57B. Fine grained limestone containing a few iron-stained rhombs of dolomite.
58. Fossils and detrital quartz in a limestone.
60B. Iron-stained dolomite rhombs, coarse rounded quartz and glauconite (black) in a limestone. (The numbers correspond to those in Table IV.)
68. Coarsely crystalline limestone showing twinning and cleavage lines.
89. Iron-stained rhombs of dolomite in a mosaic of fine calcite grains.

diam., showing cleavage and twinning, (b) sections of fossils.

87. *Calcite,* in three forms, (a) finely crystalline, (b) mosaic of crystals, 0.2 mm. diam., (c) sections of fossils.

Quartz, a few grains, 0.1 mm. diam., semi-rounded.

Dolomite, a few rhombs.

89. *Calcite,* in two forms (a) mosaic of small grains, 0.1 mm. diam., containing considerable silt, (b) sections of fossils.

Dolomite, several iron-stained rhombs.

90. *Calcite,* in three forms, (a) coarsely crystalline, showing cleavage and twinning, (b) sections of fossils, (c) finely crystalline, containing considerable silt.

Quartz, 0.2 to 0.5 mm. diam., rounded.

Dolomite, a few iron-stained rhombs.

91. *Calcite,* in three forms, (a) coarsely crystalline, showing cleavage and twinning, (b) sections of fossils, (c) finely crystalline containing considerable silt.

Limonite, considerable present as a stain.

96. Calcite, in four forms, (a) coarsely crystalline, showing cleavage and twinning, (b) finely crystalline, (c) mosaic of crystals, 0.1 mm. diam., (d) sections of fossils.

Quartz, a few grains, 0.3 mm. diam., rounded.

Dolomite, a few rhombs, 0.2 to 0.5 mm. long, iron-stained.

98. The major part of this slide consists of fine silt-like material with a few sections of calcareous fossils scattered throughout the ground mass.

102. *Calcite* ,in two forms, (a) coarse grains of fine material, showing cleavage and twinning, (c) sections of fossils.

Quartz, 0.5 to 0.8 mm. diam., rounded.

Feldspar, one grain, 1.0 mm. diam., partially altered to sericite

Limonite, present as a stain.