OKLAHOMA GEOLOGY notes

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Featuring:

- Tectonic Stylolites From the Arbuckle Anticline, Southern Oklahoma
- Special Oklahoma Centennial Series, Part 3: One Hundred Years Ago in Oklahoma, March 1907

—On the Cover

Photo by Stanley T. Paxton, U.S. Geological Survey.

Anyone driving through the Arbuckle Mountains of south-central Oklahoma along Interstate 35 (I-35) has observed the phenomenon known as *tombstone topography*. What appear as rows of gravestones in the hills on either side of the highway, are outcrops of mostly Ordovician limestone and dolomite. Tombstone topography results from differential weathering and erosion of alternating layers of hard and soft carbonate rocks that are steeply dipping into the ground. The sedimentary rocks in the Arbuckles consist of 15,000 ft of complexly folded and faulted limestone, dolomite, sandstone, and shale, which were deposited in shallow seas from the Late Cambrian through the Pennsylvanian (from roughly 490-290 million years ago). The structural complexity of the Arbuckles is easily observed in the deep road cuts of I-35, where the crumpled, broken rocks are exposed and provide evidence for several mountain-building episodes during the Pennsylvanian. The mountain-building processes in the Arbuckles are also responsible for the steeply dipping rocks that form the tombstone topography on the surface of the hillsides.

The geologic resources of the Arbuckles provide Oklahoma with a variety of industrial minerals that include the production of limestone, dolomite, industrial sand, granite, sand and gravel, shale, cement, and dimension stone. The Arbuckles are also the site of oil and gas production; and, in the past, the commercial extraction of iron ore, lead, zinc, and tar sands.

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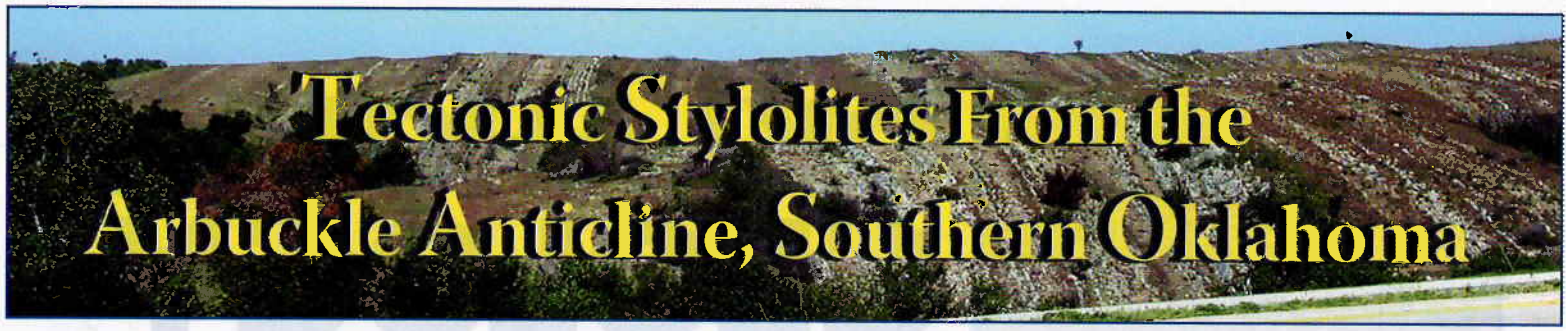

Tectonic Stylolites From the Arbuckle Anticline, Southern Oklahoma

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ABSTRACT

There are two styles of stylolites: conformable and *discordant*. Discordant stylolites develop with the stylolite surface *perpendicular* to bedding and with teeth perpendicular to the stylolite surface, but *parallel* to bedding. Discordant stylolites became known as *tectonic stylolites* because the axes of the teeth are *parallel to bedding* and the compressive stress **σ1**. By determining the orientation of the axis of stylolite teeth, one can determine the direction of **σ1** as the principal compressive stress.

This study measured 120 tectonic stylolites in the Arbuckle Anticline of southern Oklahoma. Arbuckle Group carbonates contained 110 of the 120 tectonic stylolites, of which 95 (86.4%) had "teeth" axes oriented northeast/southwest. Twelve tectonic stylolites (10.9%) had the axes of their teeth oriented northwest/southeast. Only three tectonic stylolites (2.7%) had the axes of their teeth oriented east-west. Also, ten stylolites were recorded from the Ordovician Viola Formation: seven oriented northeast/southwest, and three oriented northwest/southeast.

The average **σ1** for the Arbuckle set of 95 in the northeast quadrant was N. 45° E. (045°). The average **σ1** of the Viola-Arbuckle sets combined was N. 43° E. (043°) and are designated "Arbuckle orogeny stylolites."

The total northwest/southeast set of 12 tectonic stylolites had an average **σ1** of N. 53° W. (307°). Therefore, the two sets are nearly at right angles to each other, suggesting that two different stress fields are present. The northwest-trending teeth suggest a stress field from the southeast of the Arbuckle Anticline.

The few northwest-trending teeth beg another explanation. Use of a strain ellipsoid determined that the principal horizontal compression created extension fractures parallel to **σ1** and stylolite seams perpendicular to **σ1**. The extension fractures expanded at right angles to **σ1**, causing secondary compressive stresses to form (secondary) stylolite seams perpendicular to the original stylolites and parallel to the original **σ1**. Davis (1984) described this phenomenon on a strain-field diagram. Evidence from engineering mechanics indicates that orthogonal patterns of compressive zones do occur. Further studies are needed to determine how primary and secondary stylolites can be differentiated in the field.

Finally, no conclusion is drawn as to why the angles of inclination of the stylolites did not all return to 0° when the stylolites were rotated to their presumed original horizontal orientation.

Tombstone topography in the Arbuckle Mountains, southern Oklahoma. Photos by Galen W. Miller, Oklahoma Geological Survey Geologist.

INTRODUCTION

There are two thoughts concerning the mode of deformation of the Arbuckle Mountains in southern Oklahoma. One favors wrench faulting, or strike-slip tectonics (Dunham, 1955; Ham, 1955; Tanner, 1963; Tanner, 1967; Walper, 1970; Luke, 1976; Wickham, 1978; Wiltse, 1979; Carter, 1979; Haas, 1981; Grannath and Morgan, 1985; and Budnick, 1986). The second favors folding and over thrust faulting (Dott, 1934; Van Waterschoot van der Gracht, 1931; Lehman, 1945; Ham, 1955; Tomlinson and McBee, 1959; Hicks, 1971; Huffman and others, 1978; Denison, 1983; and Brown, 1984, 1991).

Geology of the Arbuckle Anticline

Location

The term "Arbuckle Mountains" is used herein as illustrated by the Oklahoma Geological Survey Map GM 31, *Geologic Map and Sections of the Arbuckle Mountains, Oklahoma* (Ham and others, 1990). The present study is concentrated on the "Arbuckle Anticline" (Fig. 1) on the western edge of Map GM31. The Arbuckle Anticline forms the greatest topographic relief in the Arbuckle Mountains between the towns of Davis and Springer, Oklahoma.

Stratigraphy

Detailed descriptions of rock units comprising the Arbuckle Anticline are found in Ham (1955). A stratigraphic column of rock units comprising the Arbuckle Anticline is given in Figure 2.

The Cambrian Colbert Rhyolite is the 'basement' core of the Arbuckle Anticline. Colbert outcrops occur in the East and West Timbered Hills. The Cambrian Timbered Hills Group unconformably overlies the Colbert; the Reagan Sandstone is the oldest sedimentary rock in the anticline.

The Timbered Hills Group is overlain by Cambrian and Ordovician Arbuckle Group carbonates, which are the focus of this study. The Arbuckle Group is overlain by the Ordovician Simpson Group.

All units shown in Figure 2 are overlain unconformably in various areas by the Pennsylvanian (Virgilian) Pontotoc Group. The Vanoss conglomerate is the basal unit of the Pontotoc.

Structural Style

Structurally, the Arbuckle Anticline (and its subsidiary folds) was thrust to the northeast on the Arbuckle Thrust (Brown, 1984), which is buried under alluvium of the Washita River, just north of the uplift. About 40

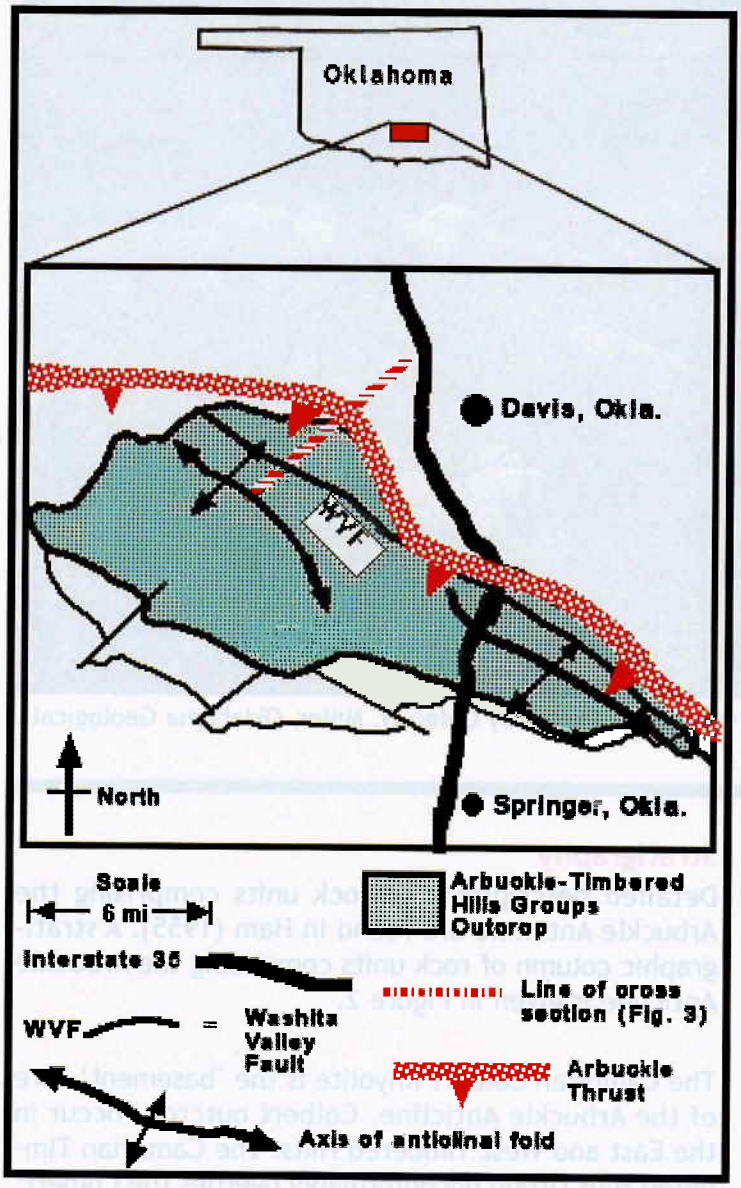

Figure 1. Generalized map of the Arbuckle Anticline modified after Ham, McKinley, and others (1990).

Stratigraphic Column for the Arbuckle Anticline

System	Series	Group	Formation
Penn.	Virgilian	Pontotoc	Vanoss cgl.
	Missouria Desmoinesian Atokan Morrowan		
Miss.	Chesterian Meramecian Osagian Kinderhookian		Goddard Springer sh Caney Sh Sycamore Ls Woodford Sh
Dev.		Hunton	Frisco Bois D'Arc Haragin Henryhouse Chimney Hill
Silurian			
Ordov.	Upper	Viola	Sylvan Sh Viola
	Middle	Simpson	Bromide Tulip Creek McLish Oil Creek Joins
	Lower	Arbuckle	W. Spring Creek Kindblade Cool Creek McKenzie Hill Butterly Dol Signal Mountain Royer Dol Ft. Sill Ls
Camb.	Upper	Timbered Hills	Honey Creek Ls Reagan Ss
	Middle 535 my	Basement	Colbert Rhyolite
pЄ	1.35 by		Tishomingo Granite

Vanoss cgl.

Figure 2. Stratigraphic chart for the Arbuckle Anticline is modified from Ham, McKinley, and others (1990).

petroleum wells have penetrated the Arbuckle Thrust. Well control has established that the thrust plane dips between 20° and 40° to the south and southwest. Subsurface information further demonstrates the northeast vergence of the Arbuckle Thrust (Fig. 3). The Washita Valley Fault (WVF) is exposed along the length of the anticline. The WVF is considered by many to be a major strike-slip fault, with about 30 miles of left-lateral offset. Brown (1984), however, has shown that the WVF is a back limb imbricate of the Arbuckle Thrust. The structural overhang (heave) of the Arbuckle Thrust is five to eight miles in width. Oil production comes from rocks in both the hanging wall and the footwall of the Arbuckle Thrust.

South- and southwest-directed thrusting is present along the south flank of the anticline; but the faults are generally blind (buried) along the south flank. Displacement along the south flank is less than that of the Arbuckle Thrust on the north flank.

The Cambrian basement (Colbert Rhyolite) was thrust northward over rocks as young as Pennsylvanian (Fig. 3). Cessation of the Arbuckle orogeny is indicated by deposition of the Vanoss conglomerate (Fig. 2). The Vanoss buried the crest of the Arbuckle Anticline on the northwestern plunge. That the Vanoss was ever deposited entirely over the anticline to the southeast is speculative.

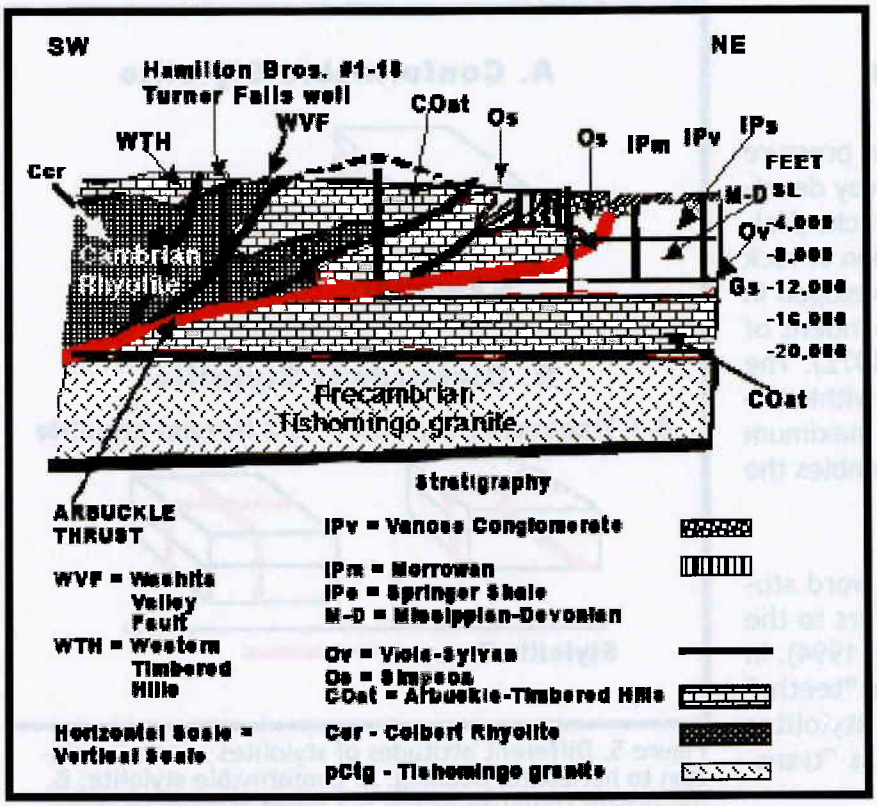

Figure 3. Structural cross section across the Arbuckle Anticline begins in the West Timbered Hills, south of the Washita Valley Fault (WVF) on the left. Well data indicate that the structural overhang of the Arbuckle Thrust is at least 7 miles.

Faulting, with slickensides, are well-exposed along the Interstate 35 corridor and in local rock quarries. The dominant sense of motion on features associated with the Arbuckle Thrust is reverse slip. Folding clearly illustrates the presence of "layer-parallel folding" and reverse faults that display "ramp and flat" geometry.

Paleostress Field

Present-day Stress Field

Where modern tectonic analogs exist, such as California, the mapping of recent changes in surface geology can provide information to determine the present stress field. Daily *in situ* stress measurements are made in California in an attempt to predict earthquakes.

Geologists are only now beginning to assess today's stress fields through the technique of borehole breakouts.

Arbuckle Orogeny Stress Field

In southern Oklahoma, where most of the Late Pennsylvanian tectonic disturbances occurred, the surface has been modified by erosion, vegetation, and human development.

Most major fault trends in southern Oklahoma are now known; however, the orientation of the stress field during the Arbuckle orogeny in Late Pennsylvanian (Virgilian) time is not agreed upon. Understanding the orientation of the stress field should play a vital role in determining the style of structural deformation that took place in the Arbuckle Mountains. The present study uses ***tectonic stylolites*** to determine the orientation of the Arbuckle orogeny stress field.

STYLOLITES

History

Geologists are constantly looking for tools or techniques that will solve complex structural problems. Early workers showed that tectonic stylolite measurements can help determine paleostress σ1 orientations, e.g., studies along the Front Range of Colorado (Blake and Roy, 1949). Workers later concentrated on the Big Bend area of southwest Texas (Decamp, 1981; Moustafa, 1988; Maler, 1990; and Erdlac, 1993 and 1994), where their investigations served as examples in applying tectonic stylolites to determine paleostress fields. Similarly orientations of tectonic stylolites may define the Arbuckle orogeny stress field of Pennsylvanian time.

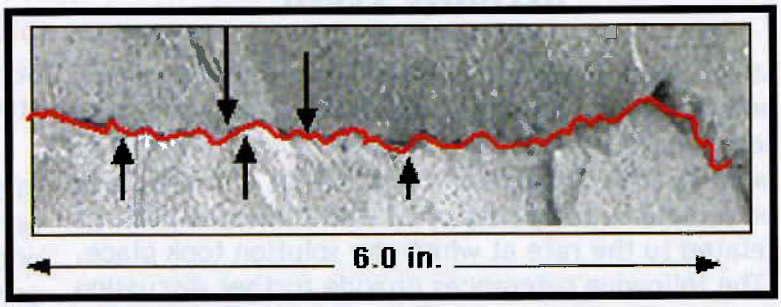

Figure 4. An example of stylolites from the Arbuckle Group in the Arbuckle Anticline shows that stylolite teeth are typically small (*photograph by P. S. Brown, 2005*).

Formation of Stylolites

The process of natural dissolution of rocks by pressure solution was determined after Henry C. Scorby developed the use of thin sections for studying rocks (Holmes, 1965). *Pressure Solution* is the dissolution of rock along "an irregular suture-like boundary developed in some limestones, which is generally independent of the bedding planes" (Whitten and Brooks, 1972). The surface of solution can have any orientation within the rock, and depends upon the orientation of maximum stress. The suture-like boundary (Fig. 4) resembles the sutures of a fossil ammonite.

The name *stylolite* comes from the Greek word *stulos*, which means 'pillar' or 'stalk', and refers to the "tooth-and-socket" structure (Erdlac, p. 167, 1994). In general, these structures are referred to as "teeth." Blake and Roy (1949) wrote about unusual stylolites not parallel to bedding, referring to them as "transverse" types.

Blake and Roy (1949) reconstructed the sequence of formation of transverse stylolites based on a series of exposures in the Front Range of Colorado south of Colorado Springs. In outcrops of the Cretaceous Timpas Limestone, they found areas where the rock layers were undeformed. They observed in these outcrops a number of vertical joints (fracture surfaces) in flat-lying beds, but found no stylolites. Then, they found layers where pressure solution had taken place on fracture surfaces (no stylolites formed yet). They then found layers that had undergone increased pressure solution, and stylolites were present in the position of the fracture surfaces in rocks that had been thrust and overturned. In all cases, the axes of the stylolite teeth were parallel to the direction of the compressive stress, (presumably $\sigma 1$).

Stylolite Teeth

Stylolite teeth arise from differential solution of rock on both sides of a fracture surface. The size of the teeth may relate to the volume of rock which has been dissolved (Blake and Roy, 1949); and they may be related to the purity of the limestone, or perhaps related to the rate at which the solution took place. (The following references provide further discussion about the formation of stylolites: Fletcher and Pollard, 1981; Guzzetta, 1984; Engelder and Marshak, 1985; and Bayly, 1986.) The tectonic stylolites observed in the Arbuckle Anticline are relatively small.

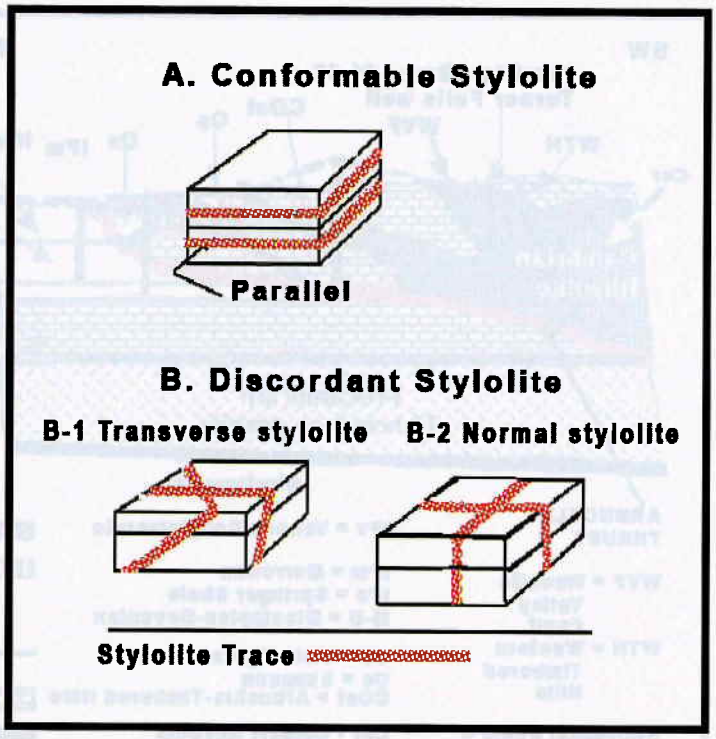

Figure 5. Different attitudes of stylolites shown in relation to horizontal bedding: A. conformable stylolite; B. discordant stylolites where B-1 shows transverse stylolites and B-2 shows normal stylolites.

Types and Styles of Stylolites

Dennis (1987) proposed six types of stylolites based on their orientations with respect to bedding. I shall follow Dennis' terminology.

Conformable Stylolites

Dennis (1987) called the layer-parallel types *conformable* stylolites (Fig. 5A). These will not be discussed further in this study.

Discordant Stylolites

Stylolites transverse to bedding are called *discordant* stylolites (Fig. 5B).

In discordant stylolites the surface of dissolution may be transverse or perpendicular to bedding planes. Stylolites which are perpendicular, or normal, to bedding are called *normal stylolites* (Fig. 5B-2). The teeth of normal stylolites are essentially parallel to bedding. Blake and Roy (1949, p. 788) stated that "the cone

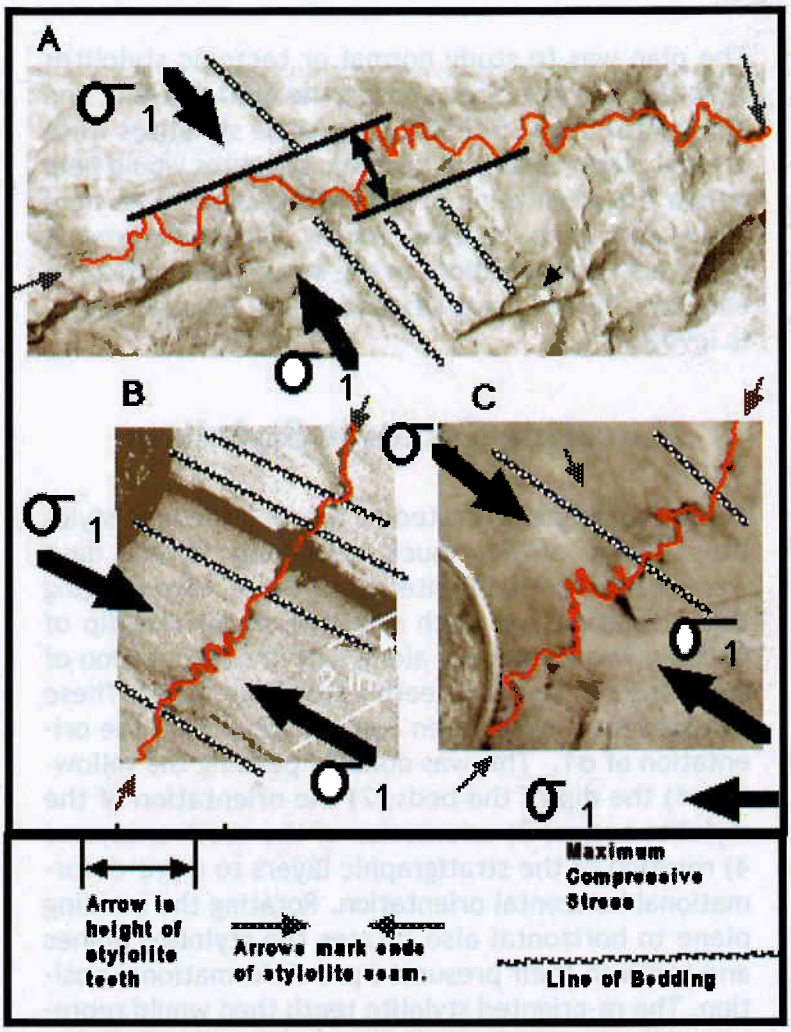

Figure 6. Discordant (normal) stylolites from the Arbuckle Anticline. Stylolites **A** through **C** are perpendicular to bedding. Teeth in **A** are unusually large for Arbuckle Group carbonates (approximately 2 in. high). Teeth in **B** and **C** are approximately 0.125 in. in height, and are typical of Arbuckle carbonates stylolites. [*Photograph A by P.S. Brown; photographs B and C by B. Sralla.*]

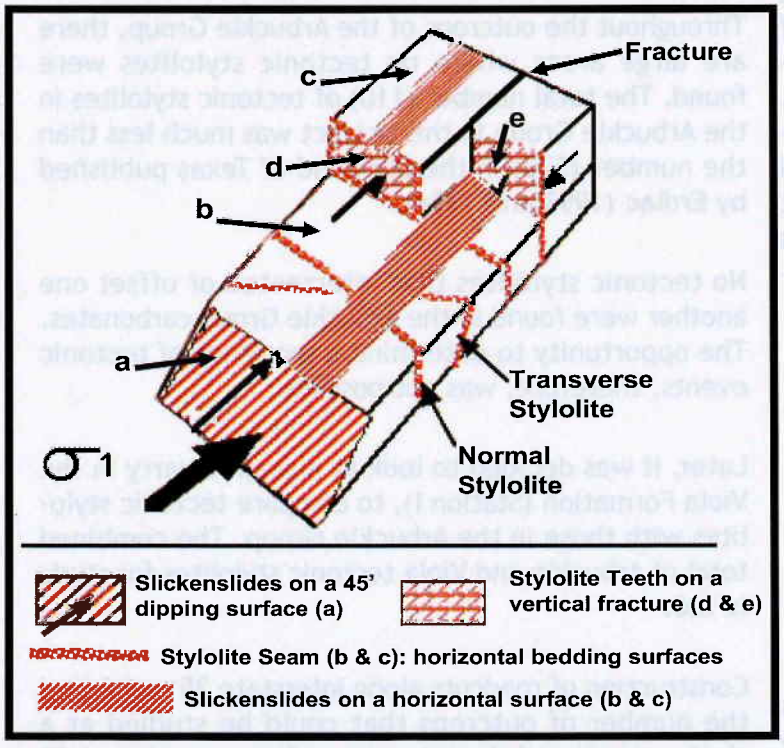

Figure 7. Block diagram showing the relationship between normal and transverse stylolites, including detachment slip zones, in limestones during deformation with pressure solution.

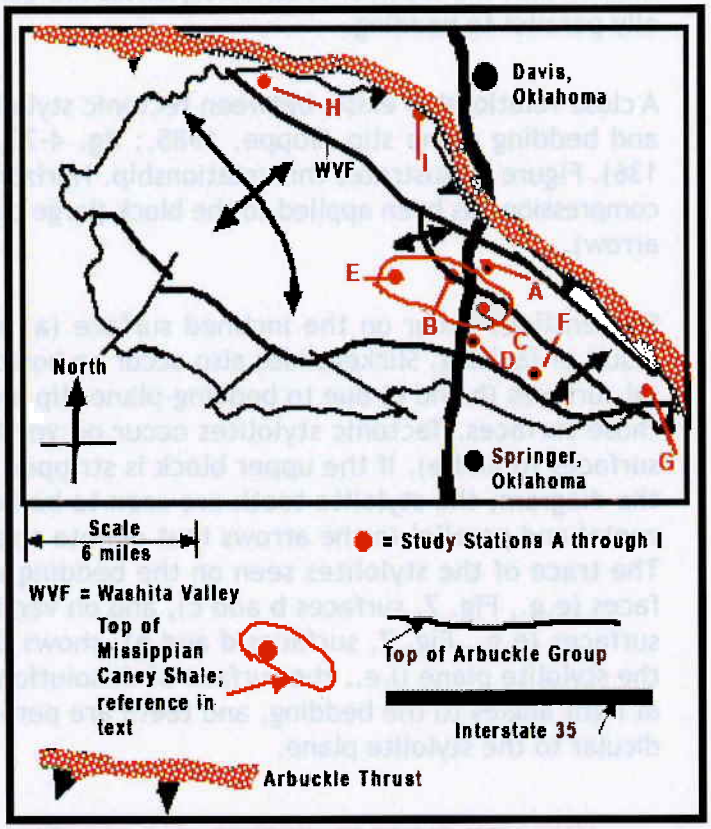

Figure 8. Generalized geologic map of the Arbuckle Anticline modified from Ham, McKinley, and others (1990). Nine stations show the sites at which tectonic stylolites were studied.

[tooth] axis is parallel to the orientation of the pressure" which formed the stylolites (usually **σ1**).

Tectonic Stylolites

Blake and Roy (1949), Dennis, (1987), and Erdlac (1994), as well as others now refer to "normal" stylolites as "tectonic" stylolites because stylolite teeth axes are parallel to the maximum compressive stress (**σ1**).

Figure 6 shows three different tectonic stylolites exposed in Arbuckle Group carbonates. Figure 6**A** shows a stylolite not perfectly perpendicular to bedding. However, Figure 6**B** (and 6**C**) shows stylolites at right angles to bedding. Even at the small scale of the photos, the relationship of stylolite teeth to bedding indicates that the teeth of tectonic stylolites are generally parallel to bedding.

A close relationship exists between tectonic stylolites and bedding plane slip (Suppe, 1985,; fig. 4-23, p. 136). Figure 7 illustrates this relationship. Horizontal compression has been applied to the block (large black arrow).

Slickenslides occur on the inclined surface (**a**) as a result of faulting. Slickenslides also occur on horizontal surfaces (**b** and **c**) due to bedding-plane slip along those surfaces. Tectonic stylolites occur on vertical surfaces (**d** and **e**). If the upper block is stripped off the diagram, the stylolite teeth are seen to be horizontal and parallel to the arrows that denote stress. The trace of the stylolites seen on the bedding surfaces (e.g., Fig. 7, surfaces **b** and **c**), and on vertical surfaces (e.g., Fig. 7, surfaces **d** and **e**), shows that the stylolite plane (i.e., the surface of dissolution) is at right angles to the bedding, and teeth are perpendicular to the stylolite plane.

TECTONIC STYLOLITES FROM THE ARBUCKLE ANTICLINE

Scope of the Problem

Tectonic stylolites can provide important paleostress information. It therefore was proposed to determine if these structures were present in the Arbuckle Anticline.

The plan was to study normal or tectonic stylolites from the Arbuckle Group across the Arbuckle Anticline along Interstate 35 (I-35). If tectonic stylolites were present, then measuring tectonic stylolites would help define the orientation of the compressive stress field active during the Arbuckle orogeny. The measurements might also find variations in the stress field across the anticline, as well as variations at different stratigraphic levels.

Locating Tectonic Stylolites

Initial efforts concentrated on locating tectonic stylolites in rocks of the Arbuckle Anticline. Several days were spent identifying sites to measure, then flagging those locations. At each site, the strike and dip of bedding was measured, along with the orientation of stylolites and stylolite teeth in the limestones. These measurements were then analyzed to obtain the orientation of **σ1**. This was done by plotting the following: 1) the dip of the beds; 2) the orientation of the stylolite seams; 3) orientation of the teeth axes; and 4) rotation of the stratigraphic layers to a pre-deformational horizontal orientation. Rotating the bedding plane to horizontal also rotates the stylolite planes and teeth to their presumed pre-deformational position. The re-oriented stylolite teeth then would represent the principal horizontal stress direction, **σ1**.

Throughout the outcrops of the Arbuckle Group, there are large areas where no tectonic stylolites were found. The total number (110) of tectonic stylolites in the Arbuckle Group in this project was much less than the number (572) in the Big Bend of Texas published by Erdlac (1993 and 1994).

No tectonic stylolites that intersected or offset one another were found in the Arbuckle Group carbonates. The opportunity to determine a sequence of tectonic events, therefore, was not possible.

Later, it was decided to look at a single quarry in the Viola Formation (Station I), to compare tectonic stylolites with those in the Arbuckle Group. The combined total of Arbuckle and Viola tectonic stylolites for study is 120.

Construction of roadcuts along Interstate 35 multiplied the number of outcrops that could be studied at a single crossing of the Interstate. Outcrops along I-35 are superior to those seen on U.S. Highway 77.

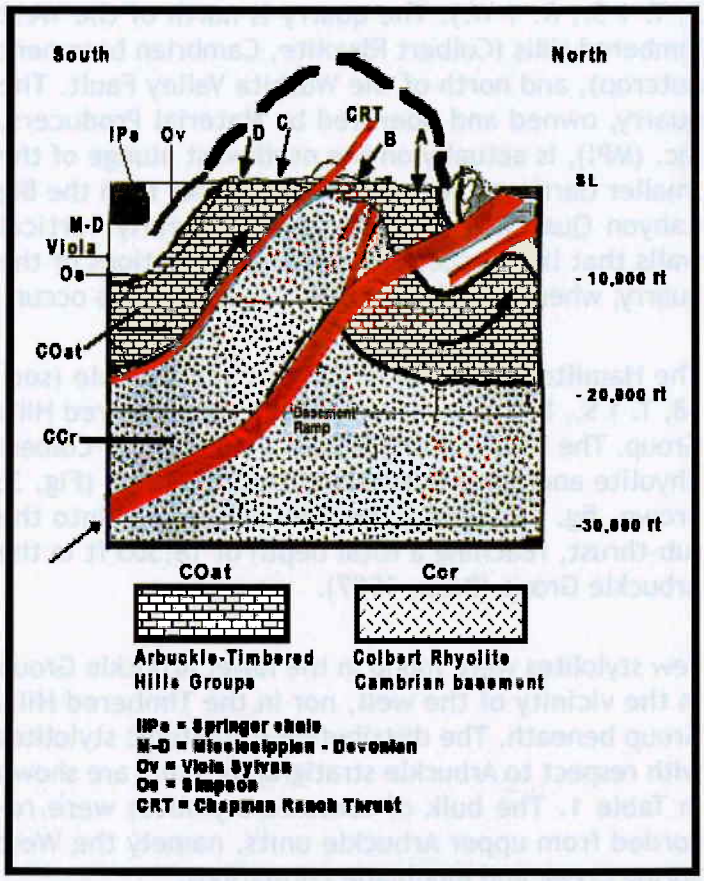

Figure 9. Cross section along I-35 corridor (Brown, 1991) based on surface geologic profile by Fay (1969). Stylolite Stations **A**, **B**, **C**, and **D** are data collection stations. The trace of the Viola limestone is restored to its position prior to erosion.

The geologic strip map made when the Interstate was under construction (Fay, 1969) was very useful in determining outcrop site locations. Outcrops along U.S. Highway 77 that wound through the anticline were also studied. Bedding-parallel stylolites were present at almost every location; however, tectonic stylolites were not always present.

Outcrops were grouped into stations, and labeled alphabetically beginning on the north flank of the anticline, across the crest, and down the south flank. Stations **A**, **B**, **C**, and **D** were along I-35. Stations **E**, **F**, **G**, **H**, and **I**, were located away from I-35. The location of each station is shown on the map in Figure 8.

Arbuckle Group carbonates crop out across the top of the Arbuckle Anticline, resulting in two sections of the upper units: one on the south flank, and another on the north flank. The Arbuckle Group extends along plunge to the northwest and southeast.

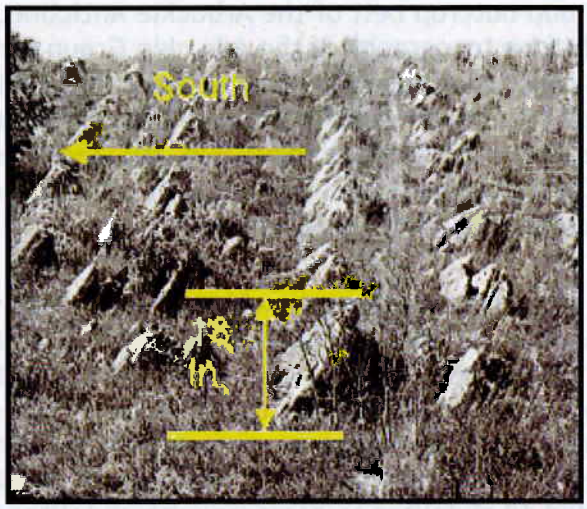

Figure 10. Photograph of tombstone topography along U. S. Highway 77, on the south flank of the Arbuckle Anticline (Fay, 1969). *Photo published by permission of the Ardmore Geological Society.*

A structural cross section (Fig. 9) was drawn along I-35 (Brown, 1991, p. 34) using the surface profile that Fay (1969) created while the highway was under construction. The cross section in Figure 9 demonstrates the distribution of the Arbuckle outcrop over the crest of the anticline; locations of stations **A**, **B**, **C**, and **D** are indicated.

The elevation of the top of the Viola limestone is restored to its position prior to erosion to approximately +13,000 ft at the crest of the anticline. The elevation of the top of the Viola at the No. 1 City of Ardmore well in Ardmore, Oklahoma, is -17,120 ft, making the total relief of the Arbuckle Anticline in excess of 30,000 ft!

Seventy-four field observations were made and recorded from stations **A**, **B**, **C**, and **D** along I-35.

Obtaining Two-Dimensional Coverage

After completing the study along the Interstate, additional work was necessary to provide two-dimensional coverage of the anticline. Two approaches could accomplish this while still restricting the project to the Arbuckle Anticline.

One approach would study all areas within the Arbuckle Group outcrop belt of the Arbuckle Anticline. The tombstone topography of the Arbuckle Group carbonates consists of outcrops generally less than 18 in. in height as a result of differential erosion of carbonate units along fractures and joints (Fig. 10). The outcrops on Chapman Ranch (stations **E** and **F**) yielded only 11 measurements in the extended area.

The second approach would widen the search by visiting various quarries throughout the uplift. Most quarries in the area, however, were in the Viola limestone. Only two quarries, Stations **G** and **H**, were in the Arbuckle Group. Both quarries were studied, yielding 25 stylolite measurements. One, Viola quarry, Station **I**, yielded 10 stylolites to compare with stylolites from the Arbuckle Group.

The Big Canyon Quarry at Crusher, Oklahoma, is on the southeast end of the Arbuckle Anticline (Station **G**; sec. 30, T. 2 S., R. 3 E.) where the Washita River cuts between the Arbuckle Anticline and the northwest plunge of the Tishomingo Uplift. The quarry has been closed for many years, but it is still owned by the Dolese Bros. Co. Permission for access was granted and the study was completed.

Another Arbuckle quarry is at the northwestern end of the Arbuckle Anticline (Station **H**; SE1/4SE1/4 sec. 2, T. 1 S., R. 1 W.). The quarry is north of the West Timbered Hills (Colbert Rhyolite, Cambrian basement outcrop), and north of the Washita Valley Fault. The quarry, owned and operated by Material Producers, Inc. (MPI), is actually on the northwest plunge of the smaller Garrison Creek Anticline. Deeper than the Big Canyon Quarry, the MPI Quarry has nearly vertical walls that limit access to the deeper portions of the quarry, where the older, lower, Arbuckle rocks occur.

The Hamilton Bros. #1-18 Turner Falls dry hole (sec. 18, T. 1 S., R. 1 E.) was spudded in the Timbered Hills Group. The hole was drilled into the Cambrian Colbert Rhyolite and penetrated the Arbuckle Thrust (Fig. 3; Brown, fig. 11, 1984). The hole was drilled into the sub-thrust, reaching a total depth of 18,505 ft in the Arbuckle Group (Beck, 1987).

Few stylolites were found in the lower Arbuckle Group in the vicinity of the well, nor in the Timbered Hills Group beneath. The distribution of tectonic stylolites with respect to Arbuckle stratigraphic units are shown in Table 1. The bulk of tectonic stylolites were recorded from upper Arbuckle units, namely the West Spring Creek and Kindblade Formations.

Dolese Bros. Co.'s Davis Quarry (Station **I**; secs. 11 and 14, T. 1 S., R. 1 E.), was studied to determine if Viola stylolite orientations would differ from those

TABLE 1

Table 1. Number of tectonic stylolites obtained from the Arbuckle Group carbonates.

Arbuckle Stratigraphic Units	NUMBER OF TECTONIC STYLOLITES								
	STATIONS								
	A	B	C	D	E	F	G	H	Total
West Spring Creek Fm Kindblade Fm	30			25	2		18	4	79
Cool Creek Fm McKenzie Hill Fm				11	1	5			17
Butterly Dol		1				3		3	7
Signal Mountain Fm		3							3
Royer Dol		1							1
Fort Sill Ls			3						3
TOTALS	30	5	3	36	3	8	18	7	110[a]

[a]Station I has 10 readings, but they were omitted from Totals because they were from the Viola limestone. Viola readings bring the GRAND TOTAL to 120 stylolites.

collected from the Arbuckle Group. (See Appendix 1, Station I).

Measuring Stylolite Data

Erdlac (1994) described three techniques that he used in his investigation in the Big Bend of South Texas. Maler (1990) measured orientations of both the pressure dissolution surfaces (or seam) and the axes of the stylolite teeth. Moustafa (1988) measured the trend of the plane of the stylolites, and assumed that stylolite teeth were at right angles to the seam. DeCamp (1981) plotted poles to the pressure solution surfaces, and assumed that stylolite teeth were represented by the 'poles' to the solution surface. Erdlac (1994, p. 169) decided to "record both the orientation of the plane of solution, and tooth orientation independently."

I followed the procedure of Erdlac (1994) in this study. It was observed early in the study that almost all the stylolite teeth were either perpendicular to the stylolite plane or within 5° of the perpendicular to the plane.

SOLVING FOR ORIENTATIONS

Calculations for a Single Station

Because the orientation of the axis of a stylolite tooth is nearly always perpendicular to the stylolite plane, the tooth axis can be represented by the pole to the plane of the stylolite seam (**Ps** in Fig. 11; Billings, 1972). It is necessary, therefore, only to plot the orientation of the two surfaces (bedding **B**, and stylolite seam **S**) and to calculate their poles (**Pb** and **Ps** in Fig. 11).

After the pole to bedding (**Pb**) and the pole to the plane of the stylolite (**Ps**) were plotted, all that remained was to return the bedding to horizontal by moving the pole to bedding (**Pb**) to the center of the net (move from **3** to **4** in Fig. 11). This eliminated the dip of the bedding and rotated the pole to the bedding (**PbR**). By moving the stylolite pole (**Ps**) by the same angular amount and direction of the bedding pole (move from **5** to **6** along a small circle in Fig. 11), the stylolite pole (**PsR**) would be in the pre-deformational position.

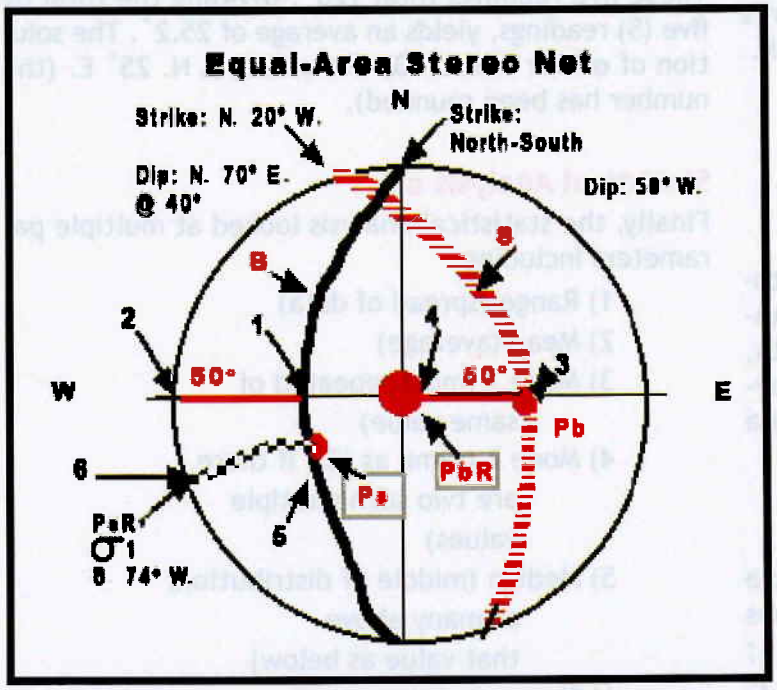

Figure 11. Diagram of an equal area stereo net showing two planes (great circles): **B** is the bedding plane and **S** is the stylolite plane. **Pb** is the pole to the bedding plane at point **3**. **Ps** is the pole to the stylolite plane at point **5**. **PbR** and **PsR** represent the positions of **Pb** and **Ps** respectively when bedding is rotated to the horizontal on the stereonet.

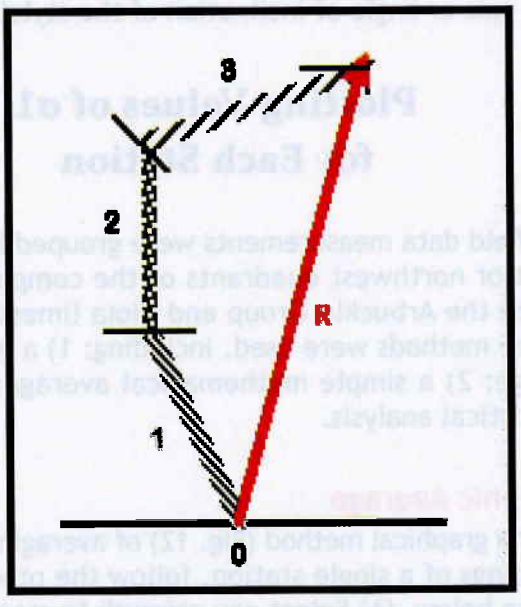

Figure 12. Method of graphic averaging for a single station (see text for explanation).

TABLE 2

Table 2. Comparison of graphic and mathematical averages, along with the mean, mode 1, median, and Swanson's mean values, in the northeast quadrant[a].

	Analysis		Statistical Analysis			
Station	Graphic	Math	Mean	Mode 1	Median	Swanson's Mean
A-1[b]	036°	034°	033°	025°	034°	033°
A-2[c]	045°	032°	037°	025°	035°	040°
B	023°	025°	025°	NA[d]	022°	023°
C	054°	055°	055°	NA[d]	057°	056°
D	043°	043°	044°	040°	048°	044°
E	065°	064°	064°	NA[d]	068°	065°
F	044°	047°	047°	045°	045°	048°
G-1[b]	050°	050°	050°	050°	050°	048°
G-2[c]	057°	053°	053°	050°	050°	051°
H	046°	050°	050°	050°	050°	049°
I	039°	032°	032°	035°	035°	033°

[a]Northeast quadrant values shown as azimuths.
[b]Stations A-1 and G-1 have one or more East-West readings included.
[c]Stations A-2 and G-2 have no East-West readings included.
[d]NA: Data not available, or insufficient.

tional position. The orientation (and inclination) of the rotated pole to the stylolite surface (**PsR**) represents the axis or angle of inclination of the stylolite tooth.

Plotting Values of σ1 for Each Station

All field data measurements were grouped into northeast or northwest quadrants of the compass. To analyze the Arbuckle Group and Viola limestone data, three methods were used, including: 1) a graphic average; 2) a simple mathematical average; and 3) a statistical analysis.

Graphic Average

In the graphical method (Fig. 12) of averaging multiple readings of a single station, follow the process steps given below. (A) Select any azimuth to start, e.g., **1**; (B) place azimuth **2** at the upper end of azimuth **1**; (C) next, place azimuth **3** at the upper end of azimuth **2**. Make sure to maintain the length and angle of azimuth **1**, **2**, and **3**. (D) Draw a line beginning at point **0** (the starting point of azimuth **1**) ending at the end of azimuth **3**. The line (**R**) is the resultant average of the three azimuths (**R** = 054° = **σ1** for Station **C**).

Simple Mathematical Average

The simple mathematical average is obtained by adding all the readings from a station, then dividing by the number of readings at the station. Using the data of the northeast quadrant of station **B** as an example, we have five compass readings:

1) N. 08° E.
2) N. 37° E.
3) N. 49° E.
4) N. 22° E.
5) N. 10° E.
6) 126° total

These five readings total 126°. Dividing the total by five (5) readings, yields an average of 25.2°. The solution of **σ1** for Station **B**, therefore, is N. 25° E. (the number has been rounded).

Statistical Analysis of σ1

Finally, the statistical analysis looked at multiple parameters including:

1) Range (spread of data)
2) Mean (average)
3) Mode 1 (most repeated of same value)
4) Mode 2 (same as (3), if there are two such multiple values)
5) Median (middle of distribution; as many above that value as below)
6) Skewness (asymmetric distribution)
7) Coefficient of skewness
8) Swanson's Mean and Standard of Error

A short summary of the statistical approach can be found in Appendix 2. All statistics are plotted in Appendices 3 and 4.

East-West Readings

Because the stylolites with east-west trending teeth do not fit into either the northeast or the northwest quadrants, the decision was made to plot the northeast quadrant with the 090° azimuths included (stations **A-1** and **G-1** in Table 2), and then to plot the 090° azimuths omitted (stations **A-2** and **G-2** in Table 2).

Similarly, the northwest quadrant was first plotted with the 270° azimuth readings included (stations **A-1** and **G-1** in Table 3), and then by the reading with the 270° azimuth readings omitted (stations **A-2** and **G-2** in Table 3).

Because there were only three east-west readings in the entire study area, the effect on the average of **σ1** was minimal.

TABLE 3

Table 3. Comparison of graphic and mathematical averages, along with the mean, mode 1, median, and Swanson's mean values, in the northwest quadrant[a].

	Analysis		Statistical Analysis			
Station	Graphic	Math	Mean	Mode 1	Median	Swanson's Mean
A-1[b]	330°	333°	333°	NA[e]	320°	332°
A-2[c]	300°	309°	306°	270°	317°	311°
B	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
C	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
D	315°	317°	317°	NA[e]	330°	321°
E	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
F[d]	290°	290°	—	—	—	—
G-1[b]	314°	309°	309°	NA[e]	313°	310°
G-2[c]	297°	299°	299°	NA[e]	295°	298°
H	322°	322°	322°	NA[e]	322°	322°
I	300°	306°	306°	NA[e]	286°	300°

[a] Northeast quadrant values shown as azimuths.
[b] #1 does not include any East-West readings.
[c] #2 includes at least one East-West reading.
[d] Only one reading taken.
[e] NA: Data not available, or insufficient.

DISTRIBUTION OF σ1 FOR THE ENTIRE ARBUCKLE ANTICLINE

Northeast Quadrant

Appendix 1 features the stylolite bearings (orientations) for all stations in the study. Data from Stations **A** through **H** contain 97 orientations in the northeast quadrant; and 4 are east-west orientations. Figure 13 illustrates the resultant **(R) σ1** value for the northeast orientations plotted by the graphic average method.

Northwest Quadrant*

Only five stations (**A**, **D**, **F**, **G**, and **H**) had northwest-oriented readings. The graphic average (Fig. 14) of the northwest quadrant is N. 54° W. (306°). The result of plotting the 15 northwest-oriented **σ1**s is that it raises the question: Why are there *any* northwest-oriented stylolite teeth in the Arbuckle Anticline? The larger number of northeast-oriented stylolite teeth suggests that a northeast-directed stress created them. So what created the northwest-oriented stylolite teeth? The two patterns of teeth are nearly orthogonal to each other, and suggest that two different stress fields were acting on the region. [***Northwest quadrant readings are highlighted in green in Appendix 1.**]

Comparison: Viola versus Arbuckle Results

The data (Station **I**, Appendix 1) from the Dolese Bros. Co. Davis Quarry southwest of Davis, Oklahoma (Station **I** at secs. 11 and 14, T. 1 S., R. 1 E.), has values from both the northeast and northwest quadrants. Ten

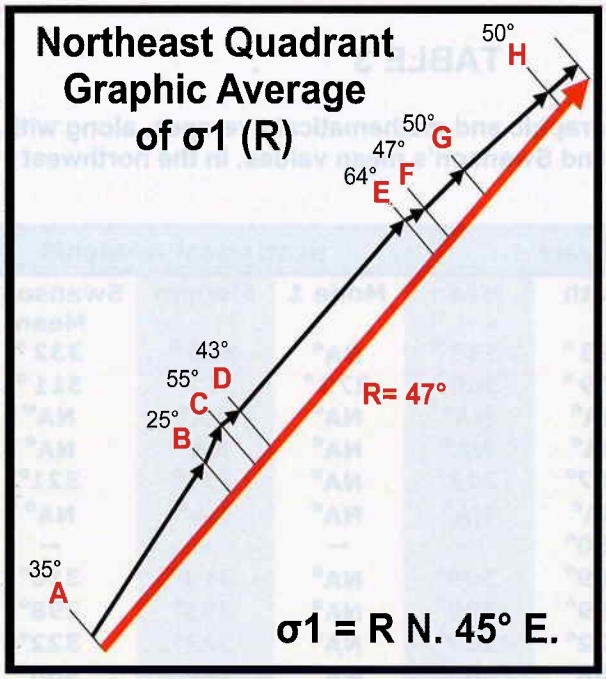

Figure 13. Resultant (R) σ1 value obtained through graphic averaging method. A σ1 value of N. 45° E. was derived for the northeast quadrant from all data stations, A through H, in the Arbuckle Anticline.

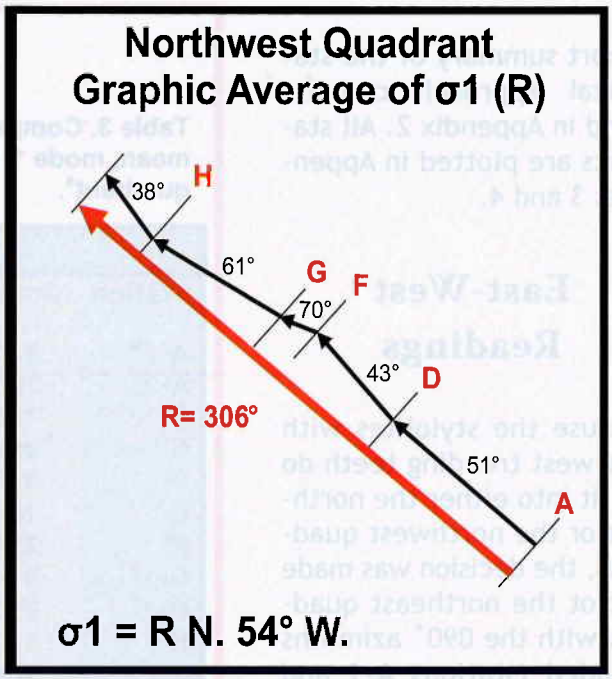

Figure 14. Graphic average for the northwest quadrant from data stations A, D, F, G, and H yields a σ1 of N. 54° W. or 306°.

readings were taken in the Ordovician Viola Formation. Seven readings were in the northeast quadrant and yielded a σ1 value of N. 41° E. (041°). Three readings were from the northwest quadrant (highlighted in green in Appendix 1), yielding a σ1 of N. 50° W. (310°). There is no apparent significant variation between the Viola and Arbuckle values, suggesting that the deformation of the Arbuckle Group and Viola Formation were concurrent.

Distribution of All Values

Figure 15 is a schematic representation of the resultant σ1 values of all 9 stations (Fig. 8). It shows the distribution of all σ1 values (both northeast and northwest quadrants) as they are dispersed over the entire Arbuckle Anticline. Zeros represent stations B, C, and E in which no tectonic stylolite teeth were oriented in the northwest quadrant.

DETERMINING A SINGLE σ1 VALUE FOR THE ENTIRE STUDY

The methods used to arrive at a single σ1 for the entire Arbuckle Anticline were a graphic plot and a simple mathematical average.

Northeast Quadrant

The northeast-oriented stylolite teeth have two statistical modes: 040° (N. 40° E.) and 044° (N. 44° E.). Their mean orientation is 044° (N. 44° E.). The graphic average shown in Figure 15 was constructed for the northeast quadrant and yields a resultant azimuth of 045° (N. 45° E.). The mathematical average for the entire Arbuckle Anticline was obtained by adding all σ1 values in the quadrant and dividing by the total number of stations, yielding a σ1 of 046° (N. 46° E.).

Northwest Quadrant

The data of the northwest quadrant are plotted using azimuths (Table 3).

The graphic average for the entire northwest quadrant is 306° (N. 54° W.) (Fig. 14). The mathematical average for the northwest quadrant was determined by dividing the total sum of azimuths (4,628°) by the total number of readings (15) to yield a σ1 of 309° (rounded; N. 51° W.).

TABLE 4

Table 4. σ1 for the Arbuckle Anticline.

Northeast Quadrant		Northwest Quadrant	
Graphic Average	Math Average	Graphic Average	Math Average
045°	046°	306°	309°

The statistical mean northwest orientation is 307° (N. 54° W.). Only fifteen readings fell into the northwest quadrant (Arbuckle and Viola units combined). Because of the small number of readings the value of σ1 may be unreliable.

Results show that there is a wide range of stylolite orientations in the study area, but they are oriented either northeasterly or northwesterly. They are also statistically normally distributed around mean azimuths of 044° (northeast quadrant) and 307° degrees (northwest quadrant). This is suggested by the following: (1) the closeness of the mean, median, and mode to each other; (2) the closeness of the arithmetic mean and Swanson's Mean to each other; and (3) skewness coefficients < 2.0.

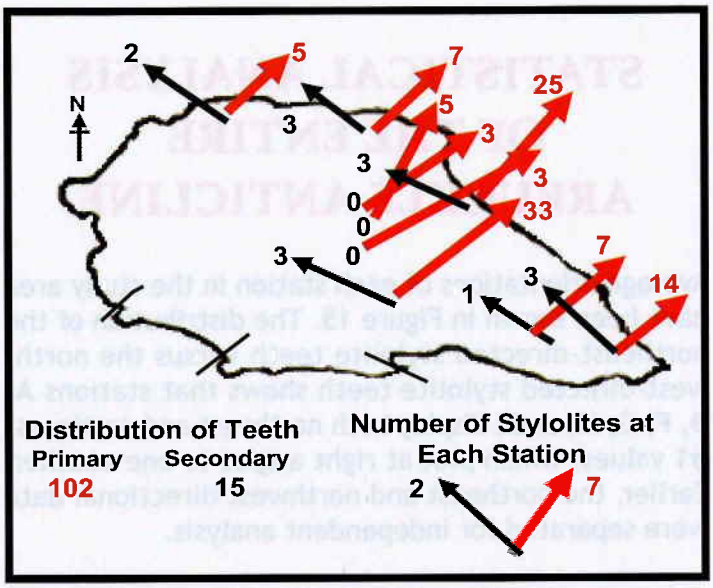

Figure 15. Schematic representation of the nine study stations and the orientations of σ1 at each. Stations B, C, and E had no tectonic stylolite teeth oriented in the northwest quadrant.

For the statistical analysis, values of the northeast and northwest quadrants were considered separately so that one quadrant would not distort the results of the other. Individual plots for the northeast quadrant are shown in Appendix 3, and plots for the northwest quadrant are shown in Appendix 4. Values for the entire Arbuckle Anticline are shown in Table 4.

TABLE 5

Table 5. Comparison of statistics by quadrant with omission or inclusion of the east-west readings indicated.

Statistical Analysis	Northeast Quadrant		Northwest Quadrant	
Omit or Include East-West Readings	090° Azimuths Omitted (#1)[a]	090° Azimuths Included (#2)[b]	270° Azimuths Omitted (#1)[a]	270° Azimuths Included (#2)[b]
Mean	042°	044°	301°	318°
Mode 1	040°	040°	NA[c]	270°
Mode 2	NA[c]	NA[c]	NA[c]	NA[c]
Median	043°	044°	317°	323°
Swanson's Mean	041°	042°	309°	315°

[a] #1 does not include any East-West readings.
[b] #2 includes at least one East-West reading.
[c] NA: Data not available, or insufficient.

The statistical results for the entire Arbuckle Anticline are shown in Table 5. The variation within each quadrant, based on the inclusion or omission of the east-west azimuths in the northeast quadrant, is minimal. It is concluded that the east-west azimuths had no more or less significance than any other single azimuth.

STATISTICAL ANALYSIS OF THE ENTIRE ARBUCKLE ANTICLINE

Average orientations of each station in the study area have been shown in Figure 15. The distribution of the northeast-directed stylolite teeth *versus* the northwest-directed stylolite teeth shows that stations **A**, **D**, **F**, **G**, **H**, and **I** display both northeast and northwest **σ1** values, which plot at right angles to one another. Earlier, the northeast and northwest directional data were separated for independent analysis.

Northeast Quadrant

Mode 1: The mode of the northeast quadrant is 040˚ (with a mean of 042˚ to 044˚, and a median of 044˚).

Northwest Quadrant

Mode 2: Because the values of the northwest quadrant are somewhat affected by the east-west reading, the mean of 306˚ will be used instead of the mode of 270˚.

Statistically, the two modes could indicate the following:

1) there were two independent stress fields, and that there was a gap in time or in space between the two fields, or
2) the orthogonal stress fields were simultaneous responses to the principal horizontal stress field (σ1).

Previously in this study, it was thought that the answer to the 'orthogonal pattern problem' was item 1 listed above; the Arbuckle orogeny and the Ouachita orogeny.

Erdlac (personal communication, 2006) and Davis (1984), however, discuss the development of an orthogonal pattern of stylolites that are created by a single maximum compressive stress. Davis presents a strain-field diagram (Davis, 1984, p. 349) relating all fractures and fracture-related structures (including stylolites) that can occur in a single outcrop. Erdlac

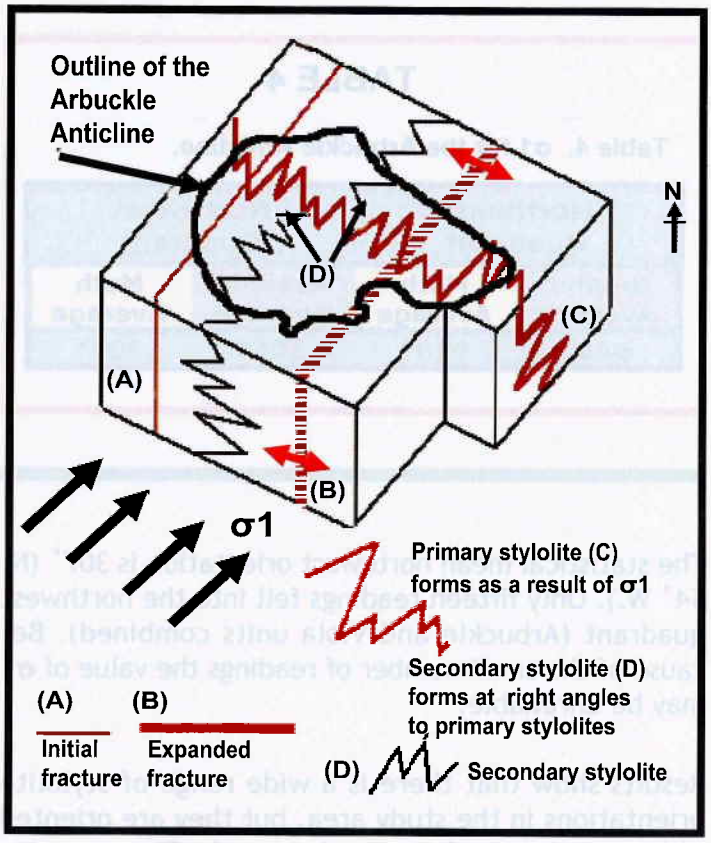

Figure 16. Fractures and fracture-related structures in a strain ellipsoid showing progression of fractures (**A**); to expansion of those fractures (**B**); to the development of stylolites (**C**); and to the development of secondary stylolites (**D**). Secondary stylolites result from local compressional stresses created by the expansion of extension fractures.

(personal communication, 2006) says that engineering mechanics suggest that orthogonal compressive stress can occur simultaneously.

Secondary Stress and Secondary Stylolites

In the analysis of the stress and strain ellipsoids, I determined that when compression acts on a body, it creates what are called *extension fractures* (parallel to **σ1**; Fig. 16). Theoretically, extension can be represented as secondary compressive stresses directed away from the extension fracture. So a secondary compressive stress might create a secondary stylolite pattern that would be orthogonal to the primary pattern. The question arises: "Would such secondary stresses be strong enough to cause stylolites?"

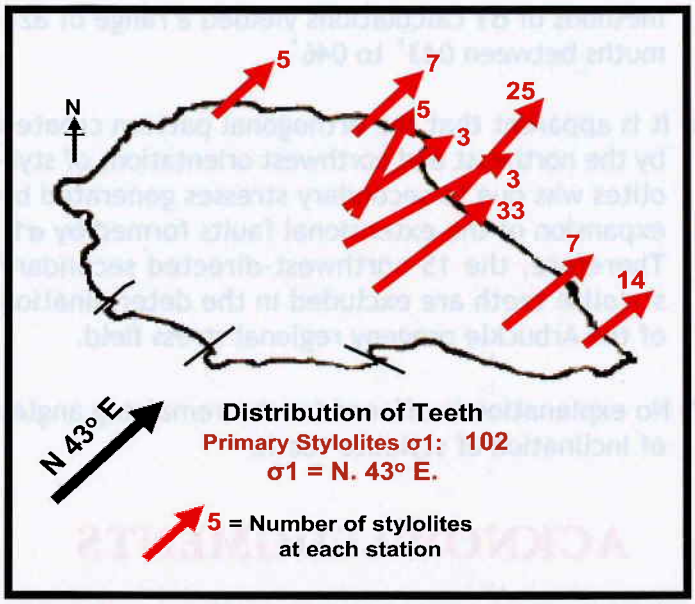

Figure 17. Summary of the number and distribution of all stylolites studied in this report. The number of northeast-directed stylolite teeth exceeded those of northwest-directed stylolite teeth.

SOLUTION OF THE ARBUCKLE REGIONAL STRESS FIELD

Discard the Northwest-oriented Teeth

I now believe that the 102 stylolite teeth oriented in the northeast quadrant were created by the maximum horizontal compressive stress (**σ1**; ~043˚) of the Arbuckle orogeny. The secondary compressive stress (Fig. 16) resulting from the expansion of extensional joints, would be oriented along the 306˚ azimuth, and was responsible for the development of the 15 secondary stylolites in the northwest quadrant. The secondary stylolites represent the second set of the orthogonal pattern. If a large number of secondary stylolites had formed, it would have been difficult to determine which was due to the primary **σ1** (the regional stress), and which was due to the secondary **σ1**. In this case, the 15 northwest stylolites have been determined as secondary to the regional stress field, so those readings were discarded from consideration of the regional stress field.

Final Solution for the Arbuckle Orogeny

The remaining stylolite teeth (all oriented to the northeast) represent the true orientation of the regional stress field of the Arbuckle orogeny, having an azimuth of 043˚ (Fig. 17).

Final Remarks Pertaining to the 'Angle of Inclination'

When bedding is rotated back to its original horizontal position, the inclination angles of the stylolites should have returned to zero degrees also, but they did not. Table 6 shows the frequency and 'angles of inclination' that remained after the original flatten-

TABLE 6

Table 6. Number of stylolites and Degrees (°) of Inclination Remaining After Flattening Beds in the Northeast Quadrant.

Number of Degrees Remaining After Flattening 50°	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°–11°
Frequency	4	1	5	1	9	4	4	4	4	1	8

Number of Degrees Remaining After Flattening 50°	12°–20°	21°–30°	31°–40°	41°–50°	>50°
Frequency	17	10	9	3	17

Inclination angles are divided into three groups:
1) Zero to 11 degrees
2) Twelve to 50 degrees
3) Greater than 50 degrees

ing was completed. Only four $\sigma 1$ values rotated back to zero degrees of inclination. Why all the others did not return to zero is a mystery. In Table 6, there are three clusters of inclination angles that are separated by two breaks between clusters of angles. One break occurs between 9° and 10°. Another break occurs at 50°. The third cluster contains 17 readings that exceed 50°.

No recognized "cross-folding" was observed in the Arbuckle Anticline; however, there were probably multiple episodes of folding during the Arbuckle orogeny. All folding episodes, or pulses, were probably caused by a similar orientation of stress fields. One possible folding episode could have been the Wichita orogeny (Saxon, 2005, personal communication). If the Wichita orogeny created northeast-oriented stylolite teeth, it would be very difficult to separate them from those of the Arbuckle orogeny. This paper offers no viable explanation for the phenomenon of the remaining angles of inclination.

CONCLUSIONS

1) Stylolites, which are perpendicular to stratigraphic bedding, are called tectonic stylolites, and can be used to determine the orientation of the principal horizontal stress direction ($\sigma 1$), as long as the enclosing strata are returned to their original horizontal position.

2) Orientations of $\sigma 1$ derived from 120 readings (Arbuckle Group and Viola Formation) taken at nine different localities, give a tentative, two-dimensional picture of the stress field covering the entire Arbuckle Anticline.

3) A total of 110 stylolite readings were calculated in the Arbuckle Group. Of these, 95 sets of stylolite teeth (86.4%) were oriented in a northeasterly direction; while 12 sets of stylolite teeth (10.9%) were oriented in the northwest quadrant; and 3 sets of stylolite teeth (2.7%) were aligned along an east-west direction.

4) Ten sets of $\sigma 1$ values were calculated from the Viola Formation: 70% were in the northeast quadrant, and 30% were in the northwest quadrant.

5) The preponderance of northeast-directed $\sigma 1$s is interpreted as representing the primary stress field of the Arbuckle orogeny (Virgilian). The various methods of $\sigma 1$ calculations yielded a range of azimuths between 043° to 046°.

6) It is apparent that the orthogonal pattern created by the northeast and northwest orientations of stylolites was due to secondary stresses generated by expansion of the extensional faults formed by $\sigma 1$. Therefore, the 15 northwest-directed secondary stylolite teeth are excluded in the determination of the Arbuckle orogeny regional stress field.

7) No explanation is offered for the remaining angles of inclination of stylolite teeth.

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I appreciate the assistance of the following in the Arbuckle region at the time of this study: Mr. A. C. Pletcher, Spade Cattle Company, and lessor of the Chapman Ranch for providing access; Mr. W. C. Pletcher for providing access to the Signal Mountain area; Dolese Bros. Co. and Material Products Inc. (MPI) for access to their quarries.

I thank Dr. Richard Erdlac for providing me copies of his papers on stylolites in southwest Texas, and for the conversations we had. Also, I thank Dr. Chris Saxon for his suggestions about the "angle of inclination" problem.

I thank Dr. Vince Cronin of Baylor University for making the first runs of the computer statistical analyses of the stylolites.

Special thanks go to Mr. Steve Decker of Chevron-Texaco (Houston) for his insistence to include the statistical data! (Appendix 2)

Last, but not least, my greatest appreciation goes to my wife, Claretta Brown, who was my field partner and "gate-opener."

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APPENDICES

APPENDIX 1.

Orientations of Sigma One (σ1) Derived From Tectonic Stylolites From the Arbuckle Anticline.

I-35 CORRIDOR
{North to South}

STATION A

(Location: NE1/4 sec. 36, T. 1 S., R. 1 E.;
S1/2, sec. 31, T. 1 S., R. 2 E.).
Due East-West Notation is Written: E—W

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
A-01	N. 44° E.	13°	W. Spring Crk-Kindblade
A-02	N. 14° E.	51°	W. Spring Crk-Kindblade
A-03	N. 43° E.	10°	W. Spring Crk-Kindblade
A-04	N. 25° W.	70°	W. Spring Crk-Kindblade
A-05	N. 25° E.	02°	W. Spring Crk-Kindblade
A-06	N. 45° E.	36°	W. Spring Crk-Kindblade
A-07	N. 34° E	10°	W. Spring Crk-Kindblade
A-08	N. 40° E.	60°	W. Spring Crk-Kindblade
A-09	N. 23° E.	04°	W. Spring Crk-Kindblade
A-10	N. 18° E.	04°	W. Spring Crk-Kindblade
A-11	N. 26° E.	05°	W. Spring Crk-Kindblade
A-12	N. 40° E.	04°	W. Spring Crk-Kindblade
A-13	N. 47° E.	14°	W. Spring Crk-Kindblade
A-14	N. 36° E.	71°	W. Spring Crk-Kindblade
A-15	N. 44° E.	40°	W. Spring Crk-Kindblade
A-16	N. 14° E.	00°	W. Spring Crk-Kindblade
A-17	N. 10° E.	84°	W. Spring Crk-Kindblade
A-18	N. 34° E.	10°	W. Spring Crk-Kindblade
A-19	N. 08° W.	09°	W. Spring Crk-Kindblade
A-20	N. 75° E.	22°	W. Spring Crk-Kindblade
A-21	E. --- W.	30°	W. Spring Crk-Kindblade
A-20	N. 75° E.	22°	W. Spring Crk-Kindblade
A-21	E. --- W.	30°	W. Spring Crk-Kindblade
A-22	N. 30° W.	16°	W. Spring Crk-Kindblade
A-23	N. 73° E.	10°	W. Spring Crk-Kindblade
A-24	N. 08° E.	33°	W. Spring Crk-Kindblade
A-25	N. 08° E.	06°	W. Spring Crk-Kindblade
A-26.	E.--- W.	14°	W. Spring Crk-Kindblade
A-27	N. 60° E.	00°	W. Spring Crk-Kindblade
A-28	N. 37° E.	01°	W. Spring Crk-Kindblade
A-29	N. 40° E.	---	W. Spring Crk-Kindblade
A-30	N. 10° E.	24°	W. Spring Crk-Kindblade

STATION B

(W1/2, sec. 6, T. 2 S., R. 2 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
B-01	N. 08° E.	24°	Butterly
B-02	N. 37° E.	34°	Signal Mountain
B-03	N. 49° E.	02°	Signal Mountain
B-04	N. 22° E.	50°	Signal Mountain
B-05	N. 10° E.	70°	Royer ?

STATION C

(W1/2, SW1/4, sec. 6, T. 2 S., R. 2 E)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
C-01	N. 70° E.	--	Ft. Sill Limestone
C-02	N. 57° E.	04°	Ft. Sill Limestone
C-O3	N. 39° E.	07°	Ft. Sill Limestone

STATION D

(E1/2, SE1/4, sec. 13, T. 2 S., R. 1 E.;
NE1/4 sec. 24, T. 2 S., R. 1 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
D-01	N. 04° E.	61°	Cool Creek-McKenzie Hill
D-02	N. 40° E.	05°	Cool Creek-McKenzie Hill
D-03	N. 36° E.	07°	Cool Creek-McKenzie Hill
D-04	N. 60° E.	06°	Cool Creek-McKenzie Hill
D-05	N. 38° E.	06°	Cool Creek-McKenzie Hill
D-06	N. 36° E.	19°	Cool Creek-McKenzie Hill
D-07	N. 58° E.	10°	Cool Creek-McKenzie Hill
D-08	N. 58° E.	42°	Cool Creek-McKenzie Hill
D-09	N. 48° E.	09°	Cool Creek-McKenzie Hill
D-10	N. 60° E.	04°	Cool Creek-McKenzie Hill
D-11	N. 60° E.	00°	Cool Creek-McKenzie Hill
D-12	N. 34° E.	07°	W. Spring Crk-Kindblade
D-13	N. 64° E.	14°	W. Spring Crk-Kindblade
D-14	N. 50° E	32°	W. Spring Crk-Kindblade
D-15	N. 28° E.	08°	W. Spring Crk-Kindblade
D-16	N. 64° E.	04°	W. Spring Crk-Kindblade
D-17	N. 23° W.	52°	W. Spring Crk-Kindblade
D-18	N. 23° E.	04°	W. Spring Crk-Kindblade
D-19	N. 40° E.	05°	W. Spring Crk-Kindblade
D-20	N. 04° E.	04°	W. Spring Crk-Kindblade
D-21	N. 62° E.	21°	W. Spring Crk-Kindblade
D-22	N. 40° E.	02°	W. Spring Crk-Kindblade
D-23	N. 48° E.	02°	W. Spring Crk-Kindblade
D-24	N. 53° E.	03°	W. Spring Crk-Kindblade
D-25	N. 63° E.	23°	W. Spring Crk-Kindblade
D-26	N. 41° E.	17°	W. Spring Crk-Kindblade
D-27	N. 65° E.	---	W. Spring Crk-Kindblade
D-28	N. 56° E.	00°	W. Spring Crk-Kindblade

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
D-29	N. 56° E.	70°	W. Spring Crk-Kindblade
D-30	N. 79° W.	30°	W. Spring Crk-Kindblade
D-31	N. 20° E.	04°	W. Spring Crk-Kindblade
D-32	N. 10° E.	04°	W. Spring Crk-Kindblade
D-33	N. 30° E.	---	W. Spring Crk-Kindblade
D-34	N. 42° E.	05°	W. Spring Crk-Kindblade
D-35	N. 28° W.	54°	W. Spring Crk-Kindblade
D-36	N. 48° E.	12°	W. Spring Crk-Kindblade

EAST AND WEST OF I35 CORRIDOR

STATION E

(SW1/4 NW1/4 sec. 18, T. 2 S., R. 2 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
E-01	N. 55° E.	40°	W. Spring Crk-Kindblade
E-02	N. 68° E.	10°	Cool Creek-McKenzie Hill
E-03	N. 70° E.	---	W. Spring Crk-Kindblade

STATION F

(secs. 16 and 21, T. 2 S., R. 2 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
F-01	N. 70° W.	40°	Cool Creek-McKenzie Hill
f-02	N. 45° E.	17°	Cool Creek-McKenzie Hill
F-03	N. 40° E.	14°	Cool Creek-McKenzie Hill
F-04	N. 48° E.	20°	Cool Creek-McKenzie Hill
F-05	N. 10° E.	15°	Cool Creek-McKenzie Hill
F-06	N. 74° E.	10°	Butterly through Ft. Sill
F-07	N. 45° E.	72°	Butterly through Ft. Sill
F-08	N. 68° E.	06°	Butterly through Ft. Sill

NW and SE PLUNGE-ENDS OF UPLIFT

STATION G

DOLESE "BIG CANYON" ARBUCKLE QUARRY

(sec. 30, T. 2 S., R. 3 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
G-01	N. 11° E.	40°	W. Spring Crk-Kindblade
G-02	N. 22° W.	50°	W. Spring Crk-Kindblade
G-03	N. 50° E.	--	W. Spring Crk-Kindblade
G-04	N. 10° E.	11°	W. Spring Crk-Kindblade
G-05	N. 70° E.	23°	W. Spring Crk-Kindblade
G-06	N. 50° E.	34°	W. Spring Crk-Kindblade
G-07	N. 68° E.	64°	W. Spring Crk-Kindblade
G-08	N. 66° E.	80°	W. Spring Crk-Kindblade
G-09	N. 42° E.	53°	W. Spring Crk-Kindblade
G-10	N. 44° E.	08°	W. Spring Crk-Kindblade
G-11	N. 29° E.	08°	W. Spring Crk-Kindblade
G-12	N. 80° E.	14°	W. Spring Crk-Kindblade
G-13	N. 61° E.	28°	W. Spring Crk-Kindblade
G-14	N. 47° W.	74°	W. Spring Crk-Kindblade
G-15	N. 84° W.	14°	W. Spring Crk-Kindblade
G-16	E. --- W.	20°	W. Spring Crk-Kindblade
G-17	N. 88° E.	29°	W. Spring Crk-Kindblade
G-18	N. 36° E.	02°	W, Spring Crk-Kindblade

STATION H

WEST TIMBERED HILLS---MPI Quarry

(se1/4 se1/4 sec. 2, T. 1 S., R. 1 W.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
H-01	N. 09° E.	20°	W. Spring Crk-Kindblade
H-02	N. 39° W.	10°	W. Spring Crk-Kindblade
H-03	N. 50° E.	11°	W. Spring Crk-Kindblade
H-04	N. 60° E.	05°	W. Spring Crk-Kindblade

Turner Falls Well Site

(sec. 18, T. 2 S., R. 2 E.)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
H-05	N. 37° W.	83°	Butterly through Ft.Sill
H-06	N. 82° E.	---	Butterly through Ft.Sill
H-07	N. 48° E.	15°	Butterly through Ft.Sill

Viola Limestone

STATION I

DOLESE'S DAVIS QUARRY

(secs. 11, and 14, T. 1 S., R. 1 E.

same as: S. W. DAVIS OIL FIELD)

Sample No.	Bearing of σ1	Angle of Inclin.	Stratigraphic Unit Containing Stylolites
I-01	N. 35° E.	05°	Viola Limestone
I-02	N. 40° E.	27°	Viola Limestone
I-03	N. 35° E.	05°	Viola Limestone
I-04	N. 28° E.	10°	Viola Limestone
I-05	N. 26° E.	05°	Viola Limestone
I-06	N. 50° E.	56°	Viola Limestone
I-07	N. 09° E.	46°	Viola Limestone
I-08	N. 06° W.	06°	Viola Limestone
I-09	N. 74° W.	13°	Viola Limestone
I-10	N. 82° W.	05°	Viola Limestone

APPENDIX 2.

STATISTICAL ANALYSIS

The following summary was written by:
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Basic Statistics

Basic statistics were computed to help describe and summarize some of the central tendencies and variations observed in the stylolite orientations. Be aware that statistics computed from a small number of samples are likely to be poor estimates of the nature of the larger population from which they are collected.

The results are divided into two groups: (1) stylolites in the Arbuckle Group within the entire study area; and (2) stylolites at individual locations within the study area. Within each group, the statistics are grouped into northeasterly- or northwesterly-oriented stylolites. Finally, where groups contain measurements with east-west orientations, statistics are presented that both include and exclude these data points. Statistics that include east-west measurements in the northeast quadrant, assume an azimuth value of 090°. Statistics for groups in the northwest quadrant, assume an azimuth value of 270°.

The tables (Appendixes 3 and 4) provide statistics for both normally and log normally distributed data for groupings with more than three samples. This offers users a clearer description of the central tendencies and variations in the data.

Skewness is a measure of the asymmetry of the data around the sample mean. A normal distribution is symmetrical around its mean. A log normal distribution is not. If skewness is negative, the data are spread out more to the left of the mean than to the right. That is, more northerly or westerly (lower azimuth) in the northeastern or northwestern quadrant, respectively.

If skewness is positive, the data are spread more easterly or northerly (higher azimuth) in the northeast or northwest quadrants, respectively. The skewness of a normal distribution is zero.

Swanson's Mean provides a good approximation to mean values for modestly skewed distributions (Hurst, Brown and Swanson, 2000). Swanson's rule defines the mean as 0.3P10 + 0.4P50 + 0.3P90, where P10, P50, and P90 are values occurring at the 10th, 50th and 90th percentiles, respectively. Skewness coefficient (skewness/standard error of skewness) is a measure of whether the skewness of a distribution is significant. A skewness coefficient is considered significant if the absolute value of the ratio is greater than 2. The standard error of skewness is estimated using the Tabachnick and Fidell (1996) formula: [6/N]2, where N is the number of samples.

Application of Statistics to Stylolites From the Arbuckle Anticline

Mathematically, one uses the mean (or average) to summarize the data, but uses the *mode* to represent the *dominant value* in the data. In the case of the Arbuckle Anticline, the data tell us that when we calculate *average* directions it is appropriate to use the standard equation [Sum of values/number of values], because the *data are normally distributed*. So this number (average) correctly reflects the true nature of the measurements. In a normal distribution, the *mean* (average), the mode (most frequently occurring value), and the *median* (midpoint of values sorted in ascending order) are the SAME, or NEARLY THE SAME, making the geological history interpretation of the Arbuckle Anticline a lot simpler and straight forward.

If the statistics told us that the data were log normally distributed, it would have meant that, rather than a bell-shaped curve, the histogram of data values was 'skewed' to the right or left. The histogram would have one 'short tail' and one 'long tail'. We would then need to use a different formula to compute *mean*, recognizing that mean, mode, and median are *not the same*. The mode would be the number to use when talking about *compressive deformation*, NOT the 'average'.

In the case of the Arbuckle Anticline, the [stylolite] measurements suggest that the directional data [Σ1] are *normally distributed*.

The results suggest that although there is a wide range of orientations in the study area, stylolites are oriented either northeasterly or northwesterly. They are also essentially normally distributed around mean azimuths of 044° and 307°, respectively (Decker, 2006, personal communication).

Mean is roughly the same as *median*, which is roughly the same as *mode* for this data. Whatever tectonics are recorded by the stylolites they represent either:

(1) a single event, or

(2) multiple events

that lined up relatively parallel with one another. This implies that the regional tectonic forces had not changed from one event to another. The author's interpretation is most like item (2), above.

APPENDIX 3.

Summary of Statistics of Stylolites Individually at all Locations Within the Study Area

Northeast Quadrant*

(Stylolite Teeth Oriented in a NE-SW Direction)

* NOTE: Stations with East-West Azimuth of Stylolite Teeth are shown two ways: 1) with 090 azimuth *included* with the plot; and 2) with 090 azimuth *omitted* from the plot.

STATION A-1: NE

Azimuth statistics of stylolite teeth oriented NE-SW. Azimuths of 090 are omitted.

Statistical Analysis	Statistics
[26 Samples; Range 67°]	
Mean	033°
Mode 1	025°
Mode 2	034°
Median	034°
Skewness	0.7°
Skewness Coefficient	1.5
Swanson's Mean	
Mean	033°
Standard Error	0.5°

STATION A-2: NE

Azimuth statistics of stylolite teeth oriented NE-SW. Azimuths of 090 are included.

Statistical Analysis	Statistics
[27 Samples; Range 82°]	
Mean	037°
Mode 1	025°
Mode 2	040°
Median	035°
Skewness	1.0°
Skewness Coefficient	2.1
Swanson's Mean	
Mean	040°
Standard Error	0.5°

STATION B: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[5 Samples; Range 41°]	
Mean	025°
Mode 1	NA
Mode 2	NA
Median	022°
Skewness	0.5°
Skewness Coefficient	0.5
Swanson's Mean	
Mean	023°
Standard Error	1.1°

STATION C: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[3 Samples; Range 31°]	
Mean	055°
Mode 1	NA
Mode 2	NA
Median	057°
Skewness	0.5°
Skewness Coefficient	0.3
Swanson's Mean	
Mean	056°
Standard Error	1.4°

STATION D: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[33 Samples; Range 61°]	
Mean	044°
Mode 1	040°
Mode 2	060°
Median	048°
Skewness	-0.8°
Skewness Coefficient	-1.9
Swanson's Mean	
Mean	044°
Standard Error	0.4°

STATION E: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[3 Samples; Range 15°]	
Mean	064°
Mode 1	NA
Mode 2	NA
Median	068°
Skewness	-1.6°
Skewness Coefficient	-1.1
Swanson's Mean	
Mean	065°
Standard Error	1.4°

STATION F: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[7 Samples; Range 64°]	
Mean	047°
Mode 1	045°
Mode 2	NA
Median	045°
Skewness	-0.6°
Skewness Coefficient	-0.6
Swanson's Mean	
Mean	048°
Standard Error	0.9°

STATION G-1: NE

Azimuth statistics of stylolite teeth oriented NE-SW. Azimuths of 090 are omitted.

Statistical Analysis	Statistics
[14 Samples; Range 78°]	
Mean	050°
Mode 1	050°
Mode 2	NA
Median	050°
Skewness	-0.3°
Skewness Coefficient	-0.4
Swanson's Mean	
Mean	048°
Standard Error	0.7°

STATION G-2: NE

Azimuth statistics of stylolite teeth oriented NE-SW. Azimuths of 090 are included.

Statistical Analysis	Statistics
[15 Samples; Range 80°]	
Mean	053°
Mode 1	050°
Mode 2	NA
Median	050°
Skewness	-0.2
Skewness Coefficient	
Swanson's Mean	
Mean	051°
Standard Error	

STATION H: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[5 Samples; Range 73°]	
Mean	050°
Mode 1	NA
Mode 2	NA
Median	050°
Skewness	-0.1
Skewness Coefficient	
Swanson's Mean	
Mean	049°
Standard Error	

STATION I: NE

Azimuth statistics of stylolite teeth oriented NE-SW. No stylolite teeth with 090 azimuths were recorded in this station.

Statistical Analysis	Statistics
[7 Samples; Range 41°]	
Mean	032°
Mode 1	035°
Mode 2	NA
Median	035°
Skewness	-0.6°
Skewness Coefficient	-0.7
Swanson's Mean	
Mean	033°
Standard Error	0.9°

APPENDIX 4.

Summary of Statistics of Stylolites Individually at all Locations Within the Study Area

Northwest Quadrant*

(Stylolite Teeth Oriented in a NW-SE Direction)

* NOTE: Stations with East-West Azimuth of Stylolite Teeth are shown two ways: 1) with 090 azimuth *included* with the plot; and 2) with 090 azimuth *omitted* from the plot.

STATION A-1: NW

Azimuth statistics of stylolite teeth oriented NW-SE. Azimuths of 270 are omitted.

Statistical Analysis	Statistics
[3 Samples; Range 35°]	
Mean	333°
Mode 1	NA
Mode 2	NA
Median	320°
Skewness	0.7°
Skewness Coefficient	0.5
Swanson's Mean	
Mean	332°
Standard Error	1.4°

STATION A-2: NW

Azimuth statistics of stylolite teeth oriented NW-SE. Azimuths of 270 are included.

Statistical Analysis	Statistics
[5 Samples; Range 82°]	
Mean	306°
Mode 1	270°
Mode 2	NA
Median	317°
Skewness	-0.1°
Skewness Coefficient	
Swanson's Mean	
Mean	311°
Standard Error	1.1°

STATION B: *—NW

*There were no readings of stylolite teeth oriented NW-SE for this station.

STATION C: *—NW

*There were no readings of stylolite teeth oriented NW-SE for this station.

STATION D: NW

Azimuth statistics of stylolite teeth oriented NW-SE. No stylolite teeth with azimuths of 270 were recorded in this station.

Statistical Analysis	Statistics
[3 Samples; Range 56°]	
Mean	311°
Mode 1	NA
Mode 2	NA
Median	332°
Skewness	-1.7°
Skewness Coefficient	-1.2
Swanson's Mean	
Mean	321°
Standard Error	1.4°

STATION E: *—NW

*There were no readings of stylolite teeth oriented NW-SE for this station.

STATION F: NW

Azimuth statistics of stylolite teeth oriented NW-SE.

Statistical Analysis	Statistics
[1 Sample*; Range NA]	
Mean	290°
Mode 1	NA
Mode 2	NA
Median	290°
Skewness	NA
Skewness Coefficient	NA
Swanson's Mean	
Mean	290°
Standard Error	NA

**There was only one reading at this station; therefore, the values are suspect.*

STATION G-1: NW

Azimuth statistics of stylolite teeth oriented NW-SE. Azimuths of 270 are omitted.

Statistical Analysis	Statistics
[3 Samples; Range 62°]	
Mean	309°
Mode 1	NA
Mode 2	NA
Median	313°
Skewness	-0.6°
Skewness Coefficient	-0.4
Swanson's Mean	
Mean	310°
Standard Error	1.4°

STATION G-2: NW

Azimuth statistics of stylolite teeth oriented NW-SE. Azimuths of 270 are included.

Statistical Analysis	Statistics
[4 Samples; Range 68°]	
Mean	299°
Mode 1	NA
Mode 2	NA
Median	295°
Skewness	0.5°
Skewness Coefficient	0.4
Swanson's Mean	
Mean	298°
Standard Error	1.2°

STATION H: NW

Azimuth statistics of stylolite teeth oriented NW-SE. No stylolite teeth with azimuths of 270 were recorded in this station.

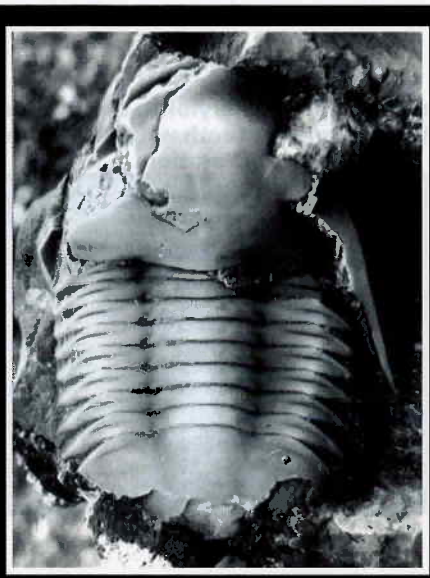
Statistical Analysis	Statistics
[2 Samples; Range 2°]	
Mean	322°
Mode 1	NA
Mode 2	NA
Median	322°
Skewness	NA
Skewness Coefficient	NA
Swanson's Mean	
Mean	322°
Standard Error	1.7°

STATION I: NW

Azimuth statistics of stylolite teeth oriented NW-SE. No stylolite teeth with azimuths of 270 were recorded in this station.

Statistical Analysis	Statistics
[3 Samples; Range 76°]	
Mean	306°
Mode 1	NA
Mode 2	NA
Median	286°
Skewness	1.7°
Skewness Coefficient	1.2
Swanson's Mean	
Mean	300°
Standard Error	1.4°

Correction: The figure on page 155 of the Winter 2006 *Oklahoma Geology Notes*, v. 55, no. 4, was incorrectly identified as "Figure 5" – it should have been labeled "Figure 7." Correspondingly, the reference to Fig. 5 in the first paragraph on page 156 should have read Fig. 7.



New OGS Publication

Bulletin 149: Trilobite Biostratigraphy and Correlation of the Kindblade Formation (Lower Ordovician) of Carter & Kiowa Counties, Oklahoma

A new publication in the Oklahoma Geological Survey's Bulletin series is now available.

Bulletin 149: Trilobite Biostratigraphy and Correlation of the Kindblade Formation (Lower Ordovician) of Carter & Kiowa Counties, Oklahoma, by James Loch is now available.

The cost of Bulletin 149 is $8, with an additional postal charge of 20% ($2 minimum) if mailed. To obtain a copy, call the OGS publications sales office at (405) 325-3031, email them at ogssales@ou.edu, or stop by the sales office at 2020 Industrial Blvd., Norman.

—Special Oklahoma Centennial Series

A Hundred Years Ago in Oklahoma March 1907

Compiled by
Kenneth V. Luza
Oklahoma Geological Survey, 2007

Oklahoma City in 1909, New State Brewing Company, center, and Williamson-Halsell-Frasier wholesalers' building, left center. *Oklahoma Geological Survey Collection, Western History Collections, University of Oklahoma.*

Oklahoma began a yearlong centennial celebration in January 2007. A monthly summary of the following articles and/or wire-service stories provides some insight into what took place locally, nationally, and worldwide in 1907. Some period photographs are included to show what Oklahoma looked like 100 years ago. Articles and information about geology and mineral resources are emphasized. Articles, or their abridged versions, were abstracted for republication from **The Daily Oklahoman** *(now* **The Oklahoman***), an Oklahoma City newspaper, unless otherwise specified. Every effort was made to preserve the original tone and expression of each feature. In some cases typesetting errors may have been overlooked and may have led to misinterpreting the reporter's meaning or intent.*

The Daily Oklahoman *had a daily average circulation of 19,414 in March 1907. The newspaper was published daily except for Monday; and cost 5¢ at the*

newsstand or 45¢ per month when delivered by carrier. **The articles are republished with permission from *The Oklahoman*.**

In March, 1907, prairie hay sold for a record high $12 per ton, and the wheat crop was threatened by a green bug infestation. On March 15, the Constitutional Convention recessed until April 1. Committee members were preparing the Constitution for ratification by a vote of the people. Oil sold for 41¢ per barrel, and new oil fields were discovered near Cleveland and Bristow. Several new oil wells were discovered in the Glenn Pool. Coal-mine disasters were reported from Germany and Kentucky. In mid-March, Oklahoma had record-breaking heat. March 18, 19, and 20 had record high temperatures of 89°, 97°, and 92°, respectively, that still stand today. On March 4, a fourth record high temperature was set at 84°, which was repeated in 1938. Local geologist L. Howell Lewis attributed the heat wave to a newly discovered comet, speculating that the earth would be destroyed by fire from the comet. His comments created near panic in the State. The State Fair committee could not decide on a site, and their fund raising campaign was several thousand dollars short of the final amount needed to operate the fair. The baseball season opener between Epworth University and the University of Oklahoma took place in Norman.

Friday, March 1, 1907, p. 1

RICH GAS FLOW IS STRUCK AT SAPULPA

WELL SPOUTS 75,000,000 FEET PER DAY SUPERIOR DRY GAS

Sapulpa, I.T., Feb. 28.—What is said to be the richest gas well in the mid-continent district was brought in yesterday by the Reese Oil Company of Independence, Kansas, on the Poloke allotment, five miles distant east from this city and a short distance north of Glenn Pool.

The strike was made at a depth of 1,300 ft, and today the flow attained a flow of 75,000,000 [cubic] ft and so far has baffled all attempts at capping the well. The flow is the finest dry gas, superior to any other that has been secured in the territory field.

March 1, 1907, p. 1

GET 500 BARREL WELL

Tulsa, I.T., Feb. 28.—A 500 barrel oil well was brought in today in the Bird Creek Pool of the Cherokee Nation.

March 1, 1907, p. 4

The Overholser Opera House presents Weber & Field's $25,000 production "HOITY-TOITY" on Sunday March 3rd. Prices: 25¢ to $1.50.

Saturday, March 2, 1907, p. 1

TORNADO WIPES OUT AN ARKANSAS TOWN

Little Rock, Arkansas, March 1.—A special to the *Arkansas Democrat* from Hope, Arkansas, says that a destructive tornado struck the town of Washington late last night and almost literally wiped it out of existence.

Sunday, March 3, 1907, p. 2

TERRIFIC STORM HAS CAUSED BIG DAMAGE

New Orleans, March 2.—Northern Louisiana, and western Mississippi have for two days experienced the worst storm of the winter, the disturbance manifesting itself in torrential rains, fatal electric displays, and cyclonic winds. At least one death was caused by the storm in Mississippi, and thousands of dollars damage has been done.

March 3, 1907, p. 3

OKLAHOMA WHEAT OUTLOOK GOOD; AVERAGE IS REDUCED

Guthrie, Okla., March 2.—All indications in the Oklahoma wheat belt point to the harvesting of a mammoth crop this coming season. The acreage is not so large as usual, and in some instances it is cut in two in comparison with last year, but the

Harvesting wheat on the 101 Ranch, Kay County. *Oklahoma Geological Survey Collection, Western History Collections, University of Oklahoma.*

general average decrease may be safely estimated at 20 per cent. This seems to be the opinion of William Baird, the wheat king of Grant County; Joseph Norris, who holds a similar title in Logan County; and W. E. Gorton, one of the most extensive grain dealers in Pawnee County and the Osage Indian Nation.

March 3, 1907, p. 10

PRAIRIE HAY IS SELLING AT $12

HIGHEST PRICE THE FEED STUFF HAS EVER BROUGHT IN THE TERRITORY

HAY IS GROWING SCARCE

New Crop Will Not Be Cut Until July,

Four Months Distant, and Price Rising

Prairie hay was sold upon the streets of Oklahoma City during the past week at $12 a ton, the highest price that dealers can recall since the farmers of this county have been offering this product. Hay is not coming to market in wagons fast enough to supply the demand, and dealers have been compelled to ship many carloads in from other points. Farmers are about through marketing hay, having only about enough left on their farms to feed their stock until the new crop matures in July.

March 3, 1907, p. 11

POLITICAL POWERS DECREED REJECTION OF OLIVER'S BID

President of Canal Construction Company Tells How Roosevelt Obeyed Orders

Augusta, Georgia, March 2.—"We are down and out," said J. B. McDonald, president of the Panama Construction Company, in discussing the rejection of the bid of W. J. Oliver for the construction of the Panama Canal.

"I cannot see why our bid should have been rejected, except that it is due to the far reaching machinations of political influences that have worked against all bids that threaten the actual construction of the big canal. It is hardly necessary to say that those interests are those of the trans-continental railroads."

March 3, 1907, Magazine Section, p. 2

Wobbling of Earth's Poles Causes Volcanic Eruptions

The remarkable phenomenon of the wobbling of the earth's poles [is] on account of the suggestion that it may have something to do with the recent

extraordinary prevalence of great earthquakes and volcanic eruptions.

Independently of that suggestion, however, the unsteadiness of the poles possesses great interest. It shows that the earth is subject to disturbances that were hardly dreamed of a generation ago, and it gives some support to the idea that the axis of rotation of our globe may have experienced great changes in the past, and may possibly undergo considerable change in the future.

The well-known fact that at some period in the past the Arctic lands enjoyed a tropical climate and were inhabited by an abundance of animal and vegetable life could be accounted for upon the supposition that at that time the axis of the earth pointed in a different direction from that which it has at present.

March 3, 1907, Magazine Section, p. 6

President Roosevelt to Settle Prolonged Dispute Between Oklahoma and Iowa Sac and Fox Indians

Guthrie, Okla., March 2.—The announcement from Washington that President Roosevelt has taken into his own hands the final settlement of the prolonged financial dispute between the Oklahoma and Iowa Indians of the Sac and Fox tribes is very pleasing to the tribal members here, as they have ready for filing with the court of claims, to which court President Roosevelt has recommended the matter for settlement, a correctly drawn statement of their case as prepared carefully by the late Moses Keokuk, chief of the tribe for whom the city of Keokuk, Iowa, was named.

Tuesday, March 5, 1907, p. 7

BIG SMELTER TO BE ERECTED NEAR CACHE

CAPITALISTS PLAN TO TREAT ORE FROM WICHITA MOUNTAIN MINES

Cache, Okla., March 4.—The largest smelter ever planned for erection in the Wichita Mountains for handling

Teacher and students in western Oklahoma, *ca* 1889. *Forbes Collection, Western History Collections, University of Oklahoma.*

gold, copper, and zinc ore is to be erected this year a short distance north of Cache. A party of capitalists visited here last week and announced their intentions, but refused to permit the publication of their names at this time. Honest miners, who have spent thousands of dollars and several years of earnest toil, are yet confident of the success of the mining ventures of the Wichitas.

Wednesday, March 6, 1907, p. 1

PLAN GREAT ENGINEERING WORK

TO SHORTEN RIVER CHANNEL

Property owners east and southeast of the city [Oklahoma City] have made up one-half the fund necessary for the purpose, the county commissioners agreeing to furnish the remaining half of the fund, and on March 12 the contract will be let for the straightening of the channel of the North Canadian River east of the city.

It is estimated that the cut to be made will cost $2,500. The ditch will be one mile in length and will shorten the flow of the river by nearly five miles. The improvements will accelerate the flow of the stream and greatly assist in the rapid disposal of the sewage that empties into the river at a point immediately east of the city.

March 6, 1907, p. 8

Downey, Thomas & Young, corner of Broadway and Grand Avenue, is offering go-carts [baby strollers] at last year's prices. "We anticipated the raise and bought our Go-Carts early. If you are interested in a Go-Cart this Spring, it will pay you to see our line before you buy." **50 DIFFERENT PATTERNS FROM $2.50 TO $20.00.**

Saturday, March 9, 1907, p. 7

WATERWORKS PLANT NEARS COMPLETION

DAM ALL BUT FINISHED—FIRES WILL BE STARTED NEXT WEEK

The dam in the river at the new waterworks plant is nearing completion and Mayor Messenbaugh yesterday stated that fires would be started in the engines of the plant the first of next week. "There has been much criticism of the present waterworks superintendent, but he has been doing some excellent work. Recent test made of two and one-half miles of mains developed only nine leaks, and this is considerably under the allowance for such work."

March 9, 1907, p. 8

SAYS SEISMIC JAR EXPOSED THIS MAN

LONG-WANTED CRIMINAL DISCOVERED THROUGH FRISCO DISASTER

Rome, March 8.—The earthquake at San Francisco has given rise to one of the strangest incidents ever recorded in criminal annals. In 1881, a party of young men came into lawless conflict with several politicians and police in the country outside Florence. Two policemen were killed and several of the men responsible were sentenced to penal servitude. One of them, named Riccione Olinto, fled the country.

Nothing in the way of a clue to his place of refuge could be gleaned, and in time he was forgotten by the authorities. By roundabout means, however, the fugitive seems to have succeeded in letting his family know that he has settled in San Francisco, and was making a fortune. There was no regular correspondence, and, with characteristic secretiveness in such matters, the family kept their knowledge to themselves.

The earthquake, however, changed their position, and actuated, no doubt, by motives of self-interest not wholly unconnected with the missing man's property, his relatives openly set on foot inquiries as to his fate.

Curiosity not unnaturally communicated itself to the police, and they also instituted inquiries, which have formally established the fact that Olinto is really one of the wealthiest

men of San Francisco. His wealth, however, is not likely to save him unless he can manage once more to lose himself. The Italian foreign office is stated to have lodged a formal request for his arrest and extradition.

March 9, 1907, p. 9

GREEN BUG BUSY

REPORTS OF DAMAGE TO FALL SOWN CROP PUTS WHEAT UP

TEXAS CROP ALMOST RUINED

Corn Market Bullish—Oats Touch New High Mark For the Season

Chicago, March 8.—Confirmation of the reports of serious damage to the fall sown crop by the "green bug" today, the May delivery closed at a net gain of 7/8¢. Corn was up 1/8¢. Oats were 1/8 to 1/4¢ higher. Provisions were unchanged 10@12 1/3¢ higher.

The rally in the wheat pit occurred about the middle of the session. A report of a St. Louis trade journal confirmed much that has been said regarding the damage done by the "green bug" to winter wheat in Texas, Oklahoma, and Indian Territory. It was conceded by this authority that the crop in Texas was almost totally ruined.

May wheat opened 1/4 to 3/8¢ lower at 76 3/8¢ to 76 1/2¢, sold at 76 ¼ @ 3/8¢ and then advanced to 77 3/4¢.

Sunday, March 10, 1907, p. 1

MANY DELEGATES APPROVE DESIGN

GREAT SEAL OF THE NEW STATE

Clever Combination of Symbols

Jap E. Peddicord, chief committee clerk of the constitutional convention, has designed a great seal for the state of Oklahoma that has met with approval of practically all of the delegates to the convention, and probably

Williamson-Halsell-Frasier wholesalers' shipping dock, *ca* 1908. *Heck Collection, Western History Collections, University of Oklahoma.*

will be adopted as the great seal of the State.

March 10, 1907, p.10

Wheat Valuations Rank Third

Is Beaten by Corn and Cotton

Guthrie, Okla., March 9.—Although Oklahoma Territory has in the past made a record in an agricultural line more on her wheat growing than any other grain, yet the fact remains that at the present time the wheat valuations in the territory rank third, beaten by both corn and cotton. The wheat, according to the annual report of C. A. McNabb, Secretary of the Oklahoma Board of Agriculture, amounts to $10,986,451; the corn valuations to $12,436,557; and cotton heads the list with $14,688,600. They are, however, very close contenders for first rank.

March 10, 1907, p. 15

TOO MUCH RAIN CAUSED CAVE IN

The rains of Friday caused a serious cave-in along that part of the great storm sewer excavation in front of the Richards-Conover building on First Street, and the weight of the falling earth broke a six-in. gas main. The break occurred at 5 o'clock yesterday morning.

A watchman, who mistook the escaping gas for water, approached the break for a closer inspection by the aid of a lantern. The gas ignited and for a time there was an illumination resembling a miniature reproduction of the eruption of Vesuvius.

The March 10, 1907 edition had two sections titled "New State Section." The first had articles devoted to counties in the new state with photographs of local attractions. The second had articles about schools, colleges, and flour mills; and Oklahoma City's churches, hotels, merchants, and cafes. Numerous photographs of office buildings and prominent people were included in the second section.

March 10, 1907, New State Section (2), p. 6

CRESCENT GROCERY

For the past year this store has been one of the most reliable places in Oklahoma City to buy table and household necessities. The firm is composed of Mr. John Lloyd, who came here from Salina, Kansas, one year ago, and Mr. J. D. Thomas, also from Salina, who has made Oklahoma City his home for the past six years. A force of twelve clerks wait upon their patrons, and every district of the city is reached by the extensive delivery system. The store occupies quarters at 207 Main Street, the dimensions of which are 25 x 110 ft. Thousands of new people are continually coming to Oklahoma City, and whether their stay be long or short, they at once make a demand for food products. This firm makes a specialty of Heinz's 57 varieties of pickles, preserves, etc., as well as the famous Casino brand of canned goods. Any who have not traded with Crescent Grocery should give the firm a trial at once and receive the best quality of goods for their money.

A story about Crescent Grocery (Crescent Market) appeared in **The Oklahoman** *on June 9, 2007 (section B, p. 1 and 6). J. Wyatt opened the store as J. L. Wyatt Grocery on the day of the Land Run, April 22, 1889. Wyatt sold to Simmons & Forsberg Grocers in 1895. John Thomas and John Lloyd bought it in 1906 and renamed it the Crescent Grocery, after the crescent moon, the international symbol for food. In 1927, Thomas moved the store to Plaza Court at NW 10th Street and Walker Avenue, where it remained until the 1960s. The store is now in Nichols Hills. Art L. Pemberton bought into the store in 1942; and his grandson, Robert Pemberton, is a third-generation owner.*

Wednesday, March 13, 1907, p. 1

RICH COAL LANDS TO BE OPENED TO ENTRY

Washington, March 12.—In a letter to Secretary Garfield today, President Roosevelt has directed a modification of the orders issued under his direction last year withdrawing certain

lands from coal entry.

Conformably to the President's directions, about 28,000,000 acres of coal lands will be immediately opened as rapidly as the Geological Survey can make the proper examinations.

March 13, 1907, p. 4

BECOME OIL CARRIER

WILL BUILD BIG OIL TANKS ALONG LINE THROUGH RICH FIELD

Jenks, I. T., March 12.—J. F. Holden, general manager of the Midland Valley Railroad, has issued a statement in which he says that the Midland Valley is to be made an oil road, and beginning April 1 there will be two oil trains daily running from Jenks to Panama, I. T., where the oil will be turned over to the Kansas City Southern Railroad to be hauled to refineries at Beaumont, Texas.

Friday, March 15, 1907, p. 1

CONVENTION IS TO ADJOURN TODAY

Delegates Work Far into the Night to Finish Task

BUILDERS ARE JUBILANT

Recess To Be Taken to April 1 When Constitution Will Be Signed

Guthrie, Okla., March 14.—Tomorrow will mark the close of the actual work of constitution building for the State of Oklahoma.

Wearied by their constant labor, but jubilant over the triumphant charter of the people's rights the result of their combined efforts, the delegates are in session, working far into the night in committee of the whole to consider and revise the ordinance providing for the election for the ratification of the constitution and the election of all officers provided for therein.

March 15, 1907, p. 7

GREAT OIL WELL AT CLEVELAND IS FOUND

Tulsa, I. T., March 14.—Excitement was created in oil circles by a report today that a

Gold miner's cabin in the Wichita Mountains, 1909. *Oklahoma Geological Survey Collection, Western History Collections, University of Oklahoma.*

750-barrel well at the remarkable depth of 2,600 ft has been brought in on the Meadows [farm] near Cleveland, Oklahoma.

The well, it is said, has been in the process of drilling for a long time, once being abandoned, and is the deepest well in the mid-continent oil territory. It may usher in a new territory and another great period of excitement about Cleveland, once a famous oil center.

Saturday, March 16, 1907, p. 6

MANY LAND SUITS DECIDED BY RULING

SUPREME COURT DECISION BELLE FOSTER CASE SETTLES CONTROVERSIES

Muskogee, I. T., March 15.—A Supreme Court decision has been given in the case of Belle Foster of Mill Creek, which declares that the Secretary of the Interior has no right to cancel her allotment after she has received a patent to it. Forty acres were involved. Petition was filed to reserve this land from allotment for townsite purposes. This was denied by the Secretary of Interior. Then Belle Foster filed on the land. She received her certificate and patent. Later the Secretary, upon reconsidering, changed his mind and wanted to withhold the land from allotment, deeming it necessary for the welfare of the town. Belle Foster refused to give up the allotment and the court held that the Secretary could not cancel it. This is an important Indian Territory decision because there are similar cases now pending in which towns are interested.

Sunday, March 17, 1907, p. 1

136 MEN MEET AWFUL FATE IN THREE MINE DISASTERS

Forbach, Germany, March 16.—An explosion of firedamp in an underground shaft of a coal mine near here, late last night, resulted in the death of nearly 100 miners and the injury of many others. Six of the miners who were in the shaft at the time of the explosion are still missing. One hundred and seventeen others escaped into adjoining galleries. The mine is located in the Alsace-Lorraine region of Germany.

CONTINUED ON PAGE 2

March 17, 1907, p. 2 — CONTINUED FROM PAGE ONE

136 LIVES LOST IN 3 MINE DISASTERS

Saarloius [*sic,* Sarrbrücken], Rhenish [*sic,* Rineland?], Prussia, March 16.—Twenty-two miners were killed this morning at one of the Gerhard coal mines. They were descending one of the shafts in a cage when the cable broke near the top and the miners plunged down several hundred ft. They all met with instant death.

The mine belongs to the Prussian government, which has already begun an official inquiry into the accident.

Norton, Virginia, March 16.—An explosion occurred in the mines at Greenbough [Kentucky] this morning after several miners had entered. The mine is seven miles northeast of Norton and is owned by Bond and Bruce of Wise. As far as can be learned, eleven miners were killed.

March 17, 1907, p. 2

FLOOD LOSSES MANY MILLIONS

PITTSBURGH CONDITIONS ALLEVIATED AS RAGING RIVER WATERS SUBSIDE

MANY DEATHS ARE REPORTED

Pittsburgh, March 16.—After three days of business stagnation caused by a rise in the Monongahela, Allegheny, and Ohio Rivers, which inundated over ten square miles of this county, conditions have about assumed their normal trend and by Monday a complete resumption will be possible.

The water is receding even more quickly than it rose. With the exception of the lowlands below the city, the river has subsided to its natural course. The loss in the Pittsburgh district is estimated at $10,000,000. Reports from up-river points increase the damage in western Pennsylvania to at least $15,000,000. A score of persons are known to have met death in the floods.

March 17, 1907, New State Section, p. 1

Presents the New State Constitution

Some Salient Features of the New Constitution

Initiative and referendum.

Nomination of all state, county, district, and township officers by primaries.

Prohibition of succession in state offices.

Submission of the prohibition question to the people of the whole state.

Elective state corporation commission.

Two-cent passenger fares.

Forbidding railway companies from owning any productive agency of a natural commodity.

Fellow servant law.

Prohibiting corporations from owning more land than is absolutely necessary in the operation of their business.

Prohibition of issuance of watered stock; books of corporations made subject to inspection at all times.

Appointment of commission to negotiate purchase of the segregated mineral lands in Indian Territory, valued at many millions of dollars.

Fixing legal rate of interest at six per cent and contract rate at ten per cent.

Compulsory and separate school system.

Labor and arbitration commission.

Commission of charities and corrections.

Agricultural Commission.

Oil, Gas, and Mines Commission.

Dividing state into 75 counties, 21 judicial districts, 41 senatorial districts, and 105 legislative districts.

State seal adopted.

Requiring majority vote to amend the constitution.

March 17, 1907, New State Section, p. 4, column 3

GEOLOGICAL SURVEY

Section 1. The legislature shall provide by law for the establishment of a state geological and economic survey.

March 17, 1907, New State Section, p. 5, column 3

MINES AND MINING, OIL AND GAS

Section 1. The office of Chief Inspector of Mines, Oil and Gas, is hereby created, and the incumbent of said office shall be known as the Chief Mine Inspector. The term of said office shall be for four years, and no person shall be elected (or appointed) to said office unless he shall have had eight years actual experience as a practical miner, and such other qualifications as may be prescribed by the legislature. The Chief Mine Inspector shall perform the duties, take the oath, and execute the bond prescribed by the legislature.

Section 2. The legislature shall create mining districts and provide for the appointment or election of assistant inspectors therein, who shall be under the general control of the Chief Mine Inspector, and the legislature shall define their qualifications and duties and fix their compensation.

Section 3. Boys under the age of 16 years, and women and girls shall not be employed underground, in the operation of mines; and, except in cases of emergency, eight hours shall constitute a day's work underground in all mines in the state.

Tuesday, March 19, 1907, p. 7

WILD SCRAMBLE ON RICH OIL LAND

DISCOVERY NEAR CLEVELAND BELIEVED TO BE FORERUNNER OF BIG FIND

Tulsa, I.T., March 18.—Following the discovery of oil on the Meadows farm near Cleveland, Oklahoma, there is a big scramble for leases in that section of the county. Prominent operators from this place are getting leases and available land within a wide radius of the newest oil field in the new state.

The Meadows well gives evidence of being a great producer and is believed to be the forerunner of another great oil pool. When drilled into deep sand, oil operators predict it will make from 750 to 1,000 barrels daily of oil which has tested 43 (?) gravity, a high-grade product.

The Big Wolf Company, composed of Wisconsin men, own the well and lease.

Wednesday, March 20, 1907, p. 1

Old Sol Sends Mercury Soaring to Midsummer Height All Over State

TEMPERATURE CLIMBS UP TO 97

Equals Heat of the Warmest Day of Last Summer

HUMANITY UNPREPARED

Winter Togs Quickly Sloughed As Golden Rays Say Summer Is Here

A 97-degree temperature was registered yesterday at the United States Weather Bureau at 2 o'clock.

It was exactly that hot on the warmest day of last summer, but the people were caught napping yesterday with woolens and other winter togs still in vogue. The relative humidity was 57 %.

Coatless and collarless men were seen everywhere and a few peak-a-boo waists, each with a woman in it, were observed on the streets.

Not alone did the people of Oklahoma City suffer. From all parts of both territories and Texas came reports of unusually high temperatures. A breeze came up during the evening, and those who were fortunate enough to have rooms with south exposure were able to sleep last night. Despite the fact that it was predicted that the unseasonable day was a "storm-breeder," the stars shone brightly all night.

March 20, 1907, p. 1

INTENSE HEAT PREVAILS

Thomas, Okla., March 19.—Intense heat has prevailed here for three days. The thermometer registered 99 [degrees] at 3 o'clock this afternoon. A dry wind is blowing from the south.

Cotton yard in southern Oklahoma. *Forbes Collection, Western History Collections, University of Oklahoma.*

March 20, 1907, p. 1

TULSA SIMMERS

Tulsa, I. T., March 19.—Today was a record-breaking hot one for this season of the year, the thermometer standing 94 [degrees] in the shade. Vegetation is a month in advance of last year.

Thursday, March 21, 1907, p. 1-2

COMET TAIL GIVES HEAT

PROF. L. HOWELL LEWIS EXPLAINS REASONS FOR THE PRESENT WEATHER

Prof. L. Howell Lewis, 215 West Thirteenth Street, Oklahoma City, who, for 25 years has devoted himself to a study of geology, having long been in the government employ, located at Dallas, Texas, declares that the unseasonable weather of the last few days is attributable to the falling of the Matteucci Comet. He predicts that the thermometer may register 140 degrees above zero on March 28.

If this comet should reach the earth on March 28, as has been predicted, Prof. Lewis says the world will be destroyed; that rocks and stone will be melted as though they were so much wax and that all vegetable life will be destroyed by fire.

The extreme heat, for which Prof. Lewis gives his scientific reasons, continued yesterday, although the weather was not quite so warm as on Tuesday. The Oklahoma City weather bureau reported 63 degrees at 7 a.m. and 82 degrees at 7 p.m., with a mean temperature of 76. Warm winds from the south prevailed throughout the day. Cooler weather is predicted for today.

This is what Prof. Lewis says concerning causes for present atmospheric conditions: "Yes, the scientific world is certainly all agog, anent [about] the great newly discovered comet by Prof. Matteucci of the Vesuvius Observatory. There is no question that the Matteucci comet exists just as has been said, with all of its grandeur and all-sweeping horror alike connected with it. Certainly, if it reaches the earth, as has been calculated it should, about March 28th, the earth would be destroyed in the twinkling of an eye for it is definitely known that no sub-

CONTINUED ON PAGE 2

March 21, 1907, p. 2 — CONTINUED FROM PAGE ONE

COMET TAIL GIVES HEAT

stance can stand the enormous heat generated by so prodigious a body as this is said to be. Stones of the hardest character and the most solid metals would melt and flow like water, thus instantly putting to an end all animal and vegetable life which belongs to terra firma. From all reports it would seem that the distinguished Prof. Matteucci has made his astronomical calculations with a degree of accuracy, as to the speed his comet is approaching the earth. Calculating that the speed is just so much per diem and at that rate will cross the orbit of the earth about the last days of this month. Surely, if it does, all he says regarding the destruction of the earth will inevitably follow. Of course, astronomers know nothing of this comet, therefore, they have no positive data from which they can base their calculations as to what will occur."

March 21, 1907, p. 5

DEPOSIT OF CLAY IN WATER PIPES

WORKMEN DECLARE CITY WATER SUPPLY HAS BEEN CONTAMINATED

A workman, who was employed in the laying of the new water mains on North Walker Street, declared yesterday that while the work was in progress the pipe was left open and during a hard rain was filled for several hundred ft with a heavy deposit of clay. When work was resumed, he said no attempt was made to clean out the dirt, and it is still in the main.

When the 20-in. main on Second Street was put in place, there was scarcely a joint of it that had not laid in a slime of green scum and mud for weeks according to this laborer. It is feared that material and other germs were deposited and will result in sickness among the users of city water after the new plant is put in operation.

Women geology students collecting fossils at White Mound in the Arbuckle Mountains, 1909. *Oklahoma Geological Survey Collection, Western History Collections, University of Oklahoma.*

Friday, March 22, 1907, p. 8

EPWORTH AND NORMAN TO PLAY SATURDAY

OKLAHOMA CITY FANS WILL GO TO BALL GAME IN AUTOS

The Epworth University baseball team has arranged a game with the University of Oklahoma for Saturday on Boyd Field in Norman. It will be the first game of the season. Coach Cy Young of Epworth is giving his men final instructions this week and expects to put up a stiff contest.

The State University has practically the same team it had last year, and is considered the fastest college bunch in the southwest. Roscoe Walker, their catcher, is out of the game on account of an injury received in practice.

As usual, the Sooners are brim full of confidence and predict that they will have a walkaway with the Methodists. Epworth is making her debut in college baseball this season.

Several parties of Epworth students and admirers have engaged autos for the trip to Norman and it is likely that a large crowd will witness this first athletic contest.

Sunday, March 24, 1907, p.1

MANY FEAR COMET'S COMING

Scientist Thinks That Earth Will Survive

"There need be no alarm over the probable destruction of the earth by the Matteucci comet" said Prof. L. Howell Lewis, yesterday afternoon.

Prof. Lewis was besieged by frightened and inquiring interested persons all day who wanted to know when the comet would be likely to come in

CONTINUED ON PAGE TWELVE

March 24, 1907, p. 12 — CONTINUED FROM PAGE ONE

BELIEVES COMET WILL SPARE WORLD

contact with the earth. Near a hundred letters were received from alarmed individuals over the territory for further information concerning the Matteucci Comet.

The comet is at present speeding toward the earth at many thousands of miles per minute, which would bring it within the radius of the earth's atmosphere near April 1, 1907. Prof.

L. Howell Lewis said yesterday to ***The Oklahoman***: "Since my article on the Matteucci Comet the phone connected with my studio has been ringing constantly from some inquiring individual wishing to know something of this mysterious monster, which is said will destroy the world on some day during the latter part of this month. All grades of people from the school boy and school girl to men of highest education alike are in a high or low degree interested. If anyone has, on account of fear of bodily harm, been overly exercised, I wish through the medium of your paper to present my apology and again assure them that, in my humble opinion, at the present at least, there is no apparent cause for alarm. Indeed, we should get nearer the bridge before we attempt to cross it. For, as I said in my previous statement through your columns, the Matteucci Comet, though it may be moving thousands of miles per minute in its mad flight through space, today, tomorrow, or in the next moment it may be attracted by some larger heavenly body and swing around it for many days, finally changing the course of its orbit entirely, then shooting into space and perhaps never be heard of by man again."

March 24, 1907, p. 1 and 12

Lewis Interview Is Much Discussed

The Oklahoman has received scores of letters from persons living in all parts of the two territories commenting upon the interview published a few days ago with Prof. L. Howell Lewis, in which Prof. Lewis discussed the possibility of the earth being destroyed by fire from the Matteucci Comet.

March 24, 1907, p. 13

An advertisement for Rambler automobiles reads:

We will furnish REPAIRS FREE FOR ONE YEAR from date of sale upon all future sales of Rambler Cars, except on tires and breakage due to collision. Now "sit up" and "take notice."

No other firm in the southwest has ever had sufficient confidence in the goods they sold to guarantee them for sixty days and only for defective parts. How different!

Outside of all this we have the strongest, largest, best, and handsomest $1,000 two-cylinder and $2,000 and $2,500 four-cylinder cars ever built. What is the secret?

March 24, 1907, p. 22

Each Sunday **The Oklahoman** *had a section in the newspaper devoted to activities at various Colleges and Universities.*

STATE UNIVERSITY

Norman, Okla., March 22.—A number of students in the department of geology expect to go on a camping trip to the Arbuckle Mountains soon. Prof. Gould takes his classes on this trip each year. There is said to be no place in the Mississippi Valley where so many and varied kinds of geological formations may be seen in a single locality, as within a few miles of the town of Dougherty. It is planned to take tents, bedding, and cooking utensils, and hire a man with a team and wagon to haul the camp from place to place. The students will walk 20 to 25 miles a day over the hills studying the structure of the rocks.

Tuesday, March 26, 1907, p. 1

GAS WELL FLAMES 200 FEET IN AIR

COUNTRY FOR MILES AROUND SAPULPA ILLUMINATED—IT ROARED LIKE A TORNADO

Sapulpa, I. T., March 25.—With a roar like that of a tornado, a mountain of flame 200 ft high burst out of the side of a small hill two miles north of Sapulpa Saturday night. Rocks and particles of dust were thrown high in the air and the country was illuminated for miles around.

The inhabitants of the city were at first panic stricken and thought that they were staring at the tail of the Matteucci Comet.

March 26, 1907, p. 1

Oklahoma City's Water Pipes Burst

When water was turned into the three miles of 24-in. water mains leading from the new

water works plant to the city Saturday night, and a nominal pressure was applied from the pumps at the old pumping station, the main burst in four different places between Lee Avenue and the Olie Street car line, flooding that section of Second Street and causing a hasty shut down of the pressure.

The water was turned into the 24-in. main from a 10-in. pipe leading from the old water system. A pressure of probably 80 pounds at the pumping station was used in the test, according to the statement of H. H. Johnston, chairman of the water committee of the city council.

This pressure, passing through a 10-in. main into a 24-in. main would be reduced materially, and the actual pressure applied to the bursted pipes was probably less than forty pounds to the square in.

In each instance where a leak was discovered by the spouting up of a fountain of water, the 24-in. pipe, which is supposed to stand a pressure of 500 pounds to the square in., was found to have split wide open, like a paper bag.

Workmen were immediately hurried to the scene of the various breaks inside the city limits and no pains were spared to mend the breaks as quickly as possible.

Wednesday, March 27, 1907, p. 9

NINE HORSES BURNED IN FIERCE MINE FIRE

Deadwood, South Dakota, March 26.—A fierce fire is burning in the 600-ft level in the Homestake Mine at Lead, and it may become necessary to flood that part of the workings to put out the flames.

A dozen miners were caught back of the point where the fire started and were rescued with difficulty. A number of them had been overcome by gas and smoke. Nine horses have been burned to death.

Western Pacific Tea Company making deliveries in buggies in Oklahoma City, 1908. *Heck Collection, Western History Collections, University of Oklahoma.*

The fire started last evening in the stables at the 600-ft level and spread quickly to the timbered stopes between the Highland Shaft and the Star hoist. No miners, except a few to fight the fire, were allowed to enter the mine today.

March 27, 1907, p. 13

OIL LEASE MEN RACE FOR RICH CONTRACT

Muskogee, I. T., March 26.—C. E. Holderman and Bud Brow, two prominent oil lease men of the territory, left here last night on a race to Leavenworth, Kansas, to see a Creek freedman who is in the federal prison at that place to get a lease on his allotment. The Negro owns 160 acres of land near the Glenn Pool and it is very valuable. It has been impossible to locate the owner of the land, until Holderman and Brown discovered about the same time that he was in the penitentiary, and then they commenced a race to see who could get to him and get a lease contract signed. They represent rival oil companies.

Thursday, March 28, 1907, p. 4

GREAT FLOW OF OIL FOUND AT BRISTOW

BRISTOW GAS COMPANY OPENS GOOD GUSHER IN NEW TERRITORY

Tulsa, I. T., March 27.—From a report received here tonight a new oil field has been discovered at Bristow 30 miles southeast of the Glenn Pool, as result of explorations for gas by the Bristow Gas Company.

The report says it is throwing oil over the tip of the derrick, which is an indication of a good producer, probably greater than 100 barrels. Recently another attempt was made to find gas in that locality, but after drilling 2,000 ft the well was abandoned. It may be that another good pool has been opened, one of several, which it is believed will be discovered between the Glenn Pool and the Texas line within the course of a few months.

March 28, 1907, p. 7

COMET WILL NOT HIT THE EARTH

WORLD WILL BE SAVED THIS TIME IS THE MESSAGE

"The world will be saved from destruction by the Matteucci Comet," said Prof. L. Howell Lewis yesterday. Prof. Lewis received a communication from the department of agriculture at Washington saying that the Matteucci Comet had been deflected in its mad flight toward earth and would be eventually absorbed by the sun.

Ever since Prof. Lewis' first article in connection with this phantom monster of the air, inquiries have poured into ***The Oklahoman*** office asking for further information. Great excitement prevailed in the Negro settlements in Indian Territory. At Fort Gibson and Westville, Negroes all quit work and held open meetings each evening, praying that the world be spared and the comet deflected.

Today was when the astronomers estimated that the comet would reach the earth providing its course was not changed. The continued warm weather of the past two weeks was a sign to the superstitious that the end of the world was near at hand and many believed that the prophecy of the Bible that the world would be destroyed by fire, was about to be fulfilled.

It was reported that the first view of the comet would be at 4 o'clock yesterday morning just above the horizon. Numerous Oklahoma City citizens looked furtively in that direction during the small hours of the morning and felt relief when the dull gray of the morning sky was not broken by the flash of Matteucci's tail.

Friday, March 29, 1907, p. 3

Barth & Meyer clothing store on 122 West Main Street read: We Want You and Your Friends to Visit the B. & M. This week to View the Greatest Collection of Good Clothes Ever Shown Under One Roof in Oklahoma City. It makes no difference regarding your size or what particular hobby you have concerning your suit we can strike your fancy perfectly fit you for our vast assortment of new creations, a price range of $10, $15, $18.50, $20, and up to $35.

March 29, 1907, p. 14

OPEN THIRTEEN NEW OIL WELLS IN WEEK

REMARKABLE DEVELOPMENT TO MAKE GLENN POOL REGION A WORLD BEATER

Tulsa, I. T., March 28.—Thirteen new wells, none under 200 barrels, is the record of the Glenn oil field the past week. Of this number, two are 1,000 barrelers, two 800, two 600, and one 400 barreler.

The Glenn Pool has grown from an 80-acre tract to almost 8,000 acres of proven territory in little over a year. It is the most remarkable oil field in the world, discovered from the fact the production is uniformly large, the grade is high, and the wells are natural producers, but few, even among the oldest wells requiring the pump and not then until producing by natural flow for many months. The fact that these wells are naturals makes it possible for oil to be produced at some profit. Were it necessary to pump in all cases with oil at 41 cents, all wells would be operated at a loss or at a margin so narrow that it would not pay.

Saturday, March 30, 1907, p. 2

Wise-Moist Coal and Lumber Co. in Oklahoma City offered Henryetta coal for sale. The advertisement stated that it was cheaper, cledner, and ignites quicker. Capacity of the mines was 1,000 tons daily.

March 30, 1907, p. 10

BIG EXCITEMENT OVER RICH FIND

GREAT OIL WELL BROUGHT IN

IN VIRGIN TERRITORY NEAR MUSKOGEE

Muskogee, I. T., March 29.—An oil well was brought in on the Alex Evans farm, three miles south of Muskogee late last night, and an entirely new field was opened up. The well is owned by a local company and the oil was found at 1,750 ft. As soon as the oil sand was reached the torches were put out and the well capped. The oil sand will be drilled in tonight or tomorrow.

The oil is the same high grade as was discovered in Muskogee two years ago, but this pool is 600 ft deeper than the pocket found in the city limits. This well was located upon the advice of Prof. Gould, head of the Oklahoma Territory Geological Survey, who made a detailed examination of geological formations in Indian Territory last fall. He told the oil men if they would drill deep enough where the well was brought in today, they would find the main pool of the pocket that was drilled in here two years ago. The town is filling up with oil men, and the price of leases is jumping hourly.

Sunday, March 31, 1907, Second News Section, p. 8

OIL LEFT AFTER "JOHN D." GETS HIS

INDIAN TERRITORY INDEPENDENT PIPE LINES WILL BE WELL SUPPLIED

Muskogee, I. T., March 30.—There is every indication that by the time the two independent pipelines to the Gulf are completed, there will be enough oil production in the Sapulpa-Mounds field to furnish all the oil that can be handled by both lines and at the same time give the Standard as much oil as it is now taking.

It is stated on good authority that in a single day last week the oil production in this field was increased nearly 7,000 barrels. This was done by bringing in a half dozen different wells in the district. Since actual construction work has commenced on the pipelines, every operator has commenced trying to bring as much production as he can by the time the pipelines commence taking oil.

March 31, 1907, Magazine Section, p. 3

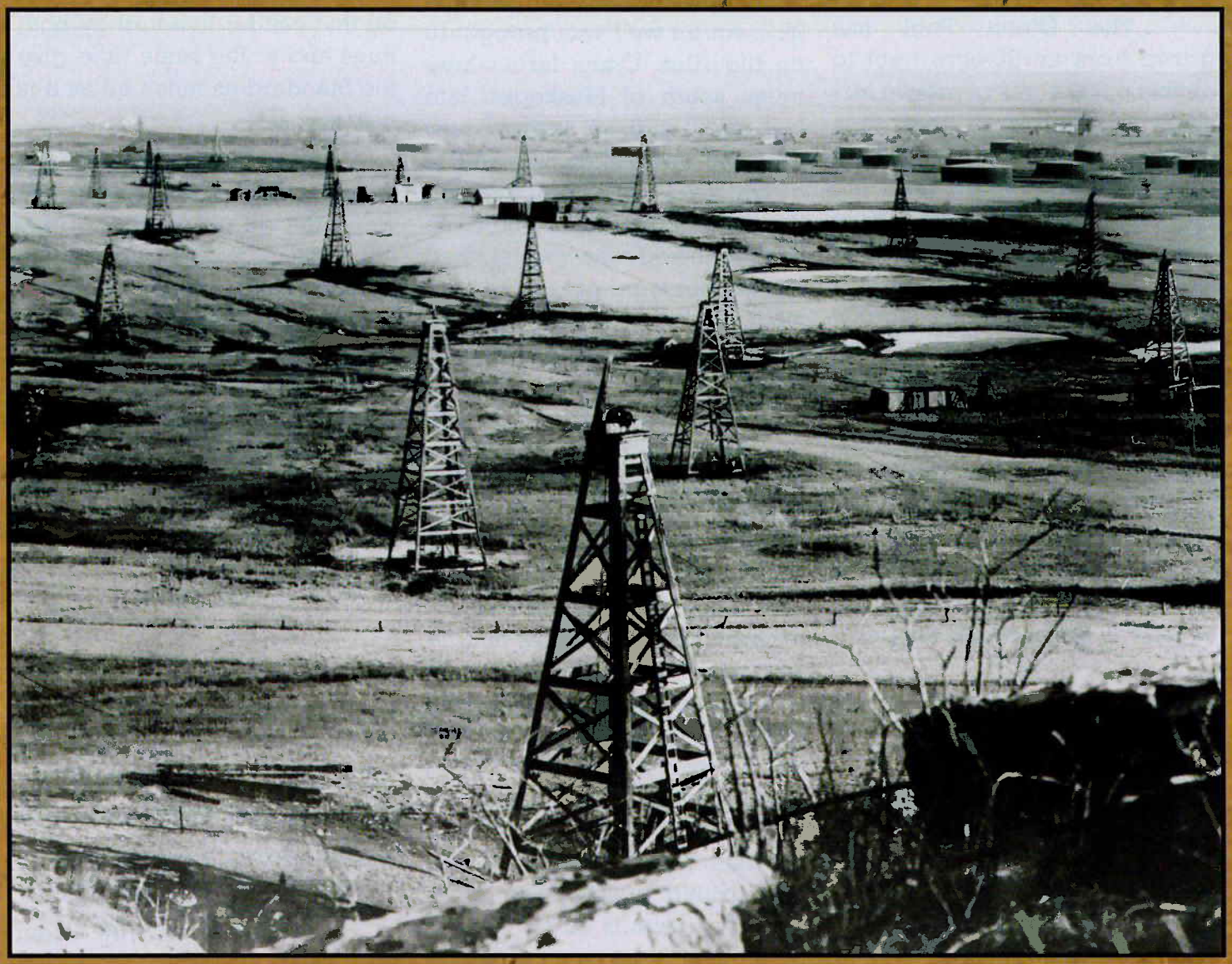
KITCHENER PLANS A QUAKE-PROOF HOUSE

WILL PUT UP A JAMAICA HOME OF DRAIN PIPE

London, March 30.—Col. Henry E. C. Kitchener, Lord Kitchener's oldest brother, who resigned from the British army

several years ago to become a banana planter in Jamaica, is now in England purchasing material for the construction of an earthquake-proof house. Col. Kitchener's residence in the suburbs of Kingston was badly damaged by the recent upheaval.

He decided to build a house with walls composed of rows of drain pipes placed on end and filled with cement, with a casing of cement on the outside and thin wood inside. He declared this combination will resist any earthquake.



Oil derricks in the Glenn Pool. *Oklahoma Geological Survey Collection, Western History Collections, University of Oklahoma.*

—Upcoming Meetings

2007

OCTOBER

6—9 AAPG Rocky Mountain Section 56th Annual Meeting, *Exploration Discovery Success*, October, Snowbird, Utah. Information: website: http://www.aapg.org/meetings/index.cfm#sections.

18 Oklahoma Oil & Gas Trade Expo, Oklahoma City, OK. Information: Oklahoma Commission on Marginally Producing Oil and Gas Wells (MWC), phone: (405)604-0460 or (800)390-0460; website: www.marginalwells.com.

28—31 Geological Society of America, Annual Convention, *Earth Sciences for Society — Beginning of the International Year of Planet Earth,* Denver, Colorado. Information: Geological Society of America, P.O. Box 9140, Boulder, CO 80301; (303) 447-2020; fax (303)357-1071; e-mail: meetings@ geosociety.org. Website: http://www.geosociety.org/meetings/2007/.

NOVEMBER

6—9 14th Annual International Petroleum Environmental Conference, Houston, Texas. Information: The University of Tulsa, Continuing Engineering & Science Education, 600 S. College Avenue, Tulsa, OK 74104; phone: (918)631-3088. E-mail: cese@utulsa.edu.

10—14 Society of Petroleum Engineers (SPE) Annual Conference and Technical Convention, Annaheim, Calif.. Information: SPE, 1888 North Market St., Frederick, MD 21701; phone (301)694-5243 or (866)229-2386; website: http://www.spe.org/atce/2007.

2008

FEBRUARY

TBA Oklahoma Aggregates Association (OKAA) "Aggregates Day at the Capitol", Oklahoma State Capitol Rotunda. Information: OKAA, Jim Rodriguez; phone (405)524-7680; website: http://www.okaa.org.

TBA Oklahoma Aggregates Association (OKAA) 7th Annual Meeting and Field Trip, Clarion Meridian Convention Center, Oklahoma City, Okla.. Information: meeting, Jim Rodriguez, (405)524-7680; fieldtrip, Stan Krukowski, (405)325-3031. Website: http://www.okaa.org.

MARCH

6 Granite Wash Workshop, Moore Norman Technology Center; Norman, Okla.; information: Oklahoma Geological Survey; phone (405)325-3031 or (800)330-3996. E-mail: mjsummers@ou.edu; website: http://www.ogs.ou.edu.

12 Geographical Information Systems (GIS) Day at the Capitol, Oklahoma State Capitol Rotunda. Information: Shellie Willoughby, (405)521-4828; e-mail, shelliew@okcc.state.ok.us.

MAR 29—APRIL 1 Geological Society of America (:GSA) South Central Section Meeting, Hot Springs, Arkan. Information: e-mail, jbconnelly@ualr.edu; website: http://www.geosociety.org.

APRIL

17 ScienceFest Oklahoma, Oklahoma City Zoo. Information: Karla Beatty, (405)521-6788; e-mail, karlab@okcc.state.ok.us.

20—23 American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, San Antonio, Texas. Information: AAPG Convention Department; P.O. Box 979; Tulsa, OK 74101-0979 USA; 1(888) 945-2274 ext. 617 (U.S. / Canada); 1(918) 560-2617. Web site: http://www.aapg.org/.

MAY

11—16 44th Forum on the Geology of Industrial Minerals, Oklahoma City, Okla.; information: Stan Krukowski, Oklahoma Geological Survey; phone (405)325-3031 or (800)330-3996. E-mail: skrukowsi@ou.edu.

JUNE

18 Horizontal Drilling Workshop, Moore Norman Technology Center; Norman, Okla.; information: Oklahoma Geological Survey; phone (405)325-3031 or (800)330-3996. E-mail: mjsummers@ou.edu; website: http://www.ogs.ou.edu.

OCTOBER

21 and 23 Oklahoma Gas Shales Field Trip

22 Oklahoma Gas Shales Conference, Oklahoma City, Okla.; information: Oklahoma Geological Survey; phone (405)325-3031 or (800)330-3996. E-mail: mjsummers@ou.edu; website: http://www.ogs.ou.edu.