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The Hunton Anticline Quarry

Thomas M. Stanley, OGS Senior Geologist

Image of the Arbuckle Mountains just north of Ardmore, Oklahoma. This image is provided by Granger Meador from www.flicker.com.

One of my favorite outcrops is the Hunton Anticline Quarry because it incorporates the two aspects of geology I find most interesting: carbonate rocks and structural geology.

The Hunton Quarry is located in the northern part of the Arbuckle Mountains, located just south of the Lake of the Arbuckles (Figure 1). In fact, the quarry was originally opened by the Bureau of Reclamation in the mid-1960s to provide rip-rap and building material for the Lake of the Arbuckles dam (Al-Shaieb and others, 1993). Access to the quarry is along a dilapidated asphalt road located in the NE 1/4, SE 1/4, NW 1/4, Sec. 31, T. 1 S., R. 3 E., Dougherty 7.5' quadrangle that runs due south of Goddard Youth Camp road. Although the quarry road is gated, I've never had any conflicts with property owners; consequently, you can easily walk around the gate with no trouble. The quarry is just a short hike further south.

As you near the quarry area, the first thing you should notice are excellent exposures of the Woodford Shale on both sides of the access road (Figure 2). Here, rocks of the Woodford are primarily composed of well-laminated to fissile, very dark gray to black, phosphatic shale, interbedded with light gray siltstone and bedded chert. Note from Figure 2 that the chert beds appear as more resistant layers within the overall Woodford section and are generally more common toward the base (closer toward the main quarry) of the Formation. The Woodford, although dark colored when fresh, commonly turns medium to light gray when exposed due to weathering of the abundant phosphate. This trait is well exemplified by the outcrops at the Hunton quarry (Figure 2). Long famous as a major source rock for Oklahoma oil and gas, lately, the Woodford has become a very important and economic oil and gas reservoir due to improved horizontal drilling practices and hydraulic fracturing.

Walking further south through the exposed Woodford, one must make a short climb across limestone exposures of the Bois d'Arc Formation (pronounced 'bow dark') before entering the main Hunton quarry. Rocks exposed in the quarry belong to the upper part of the Late Ordovician through Early Devonian limestone package of the Hunton Group, and include the before mentioned Bois d'Arc Formation and the uppermost eight feet of the Haragan Formation, which is exposed low on

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the south wall of the quarry (Figures 3 and 4). The Bois d'Arc can be further subdivided into the basal Cravatt Member, which constitutes the bulk of exposed carbonates in the main quarry walls, and the upper Fittstown Member, which is exposed to the north, just outside the quarry (you probably walked passed it on your way inside the main quarry) (Figure 2). Differentiation between these three units is primarily based on the presence or absence of chert within the Cravatt Member, and as such, their contacts are gradational (Figures 5 and 6).

One last aspect about the general geology around the quarry, the contact between the Bois d'Arc and the Woodford Shale is covered at this location. However, a more regional examination of the geology indicates that

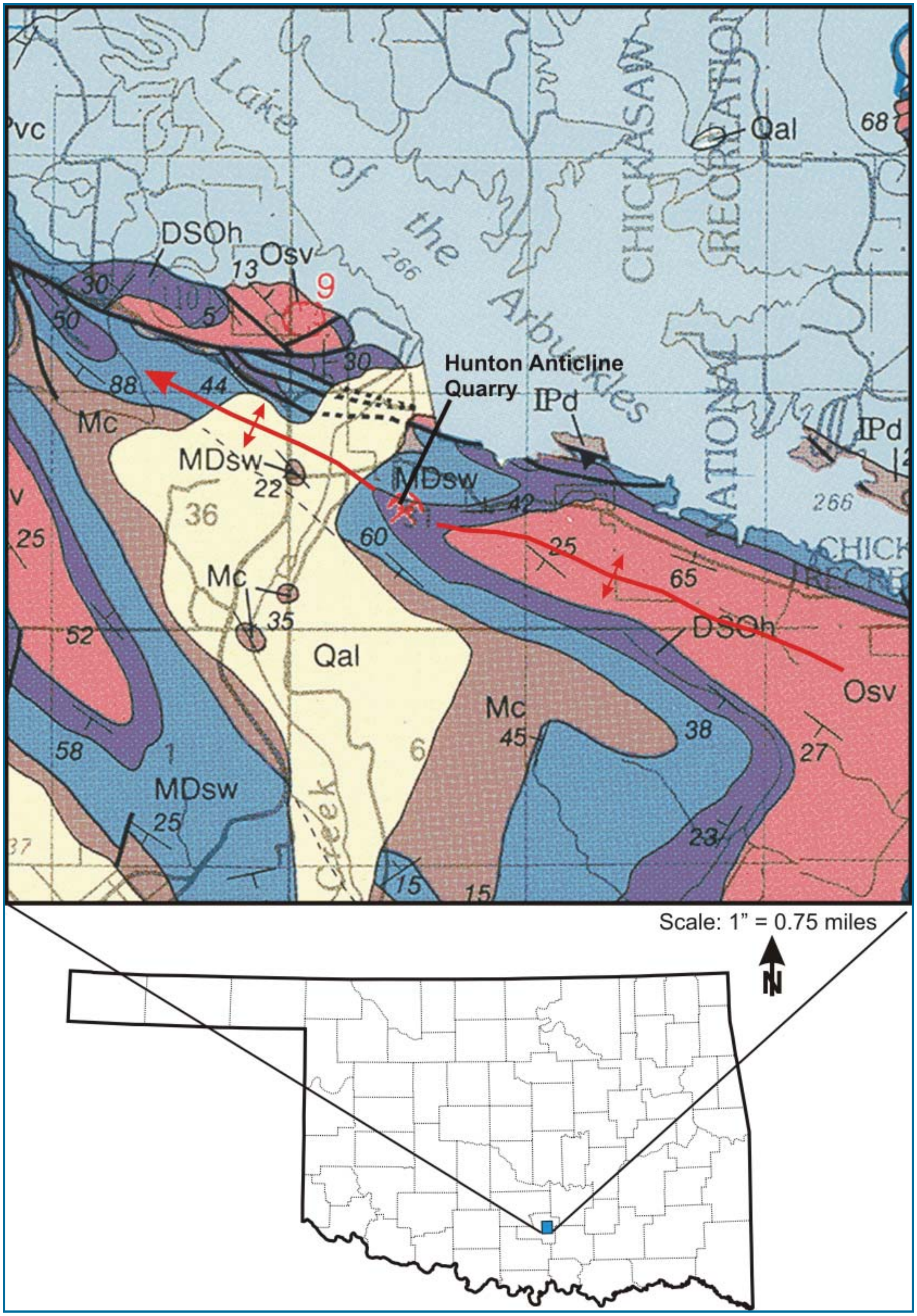

Figure 1. General areal geology and location of the Hunton Anticline Quarry (red, crossed picks) relative to the Lake of the Arbuckles. Trace of fold axis (red line) exposed in the quarry walls also shown. General map units: Mc = Caney Formation; MDsw = Woodford Shale; DSOh = Hunton Group; Osv = Sylvan Shale and Viola Limestone. Map taken from Ham and McKinley (1954).

In This Issue. . .

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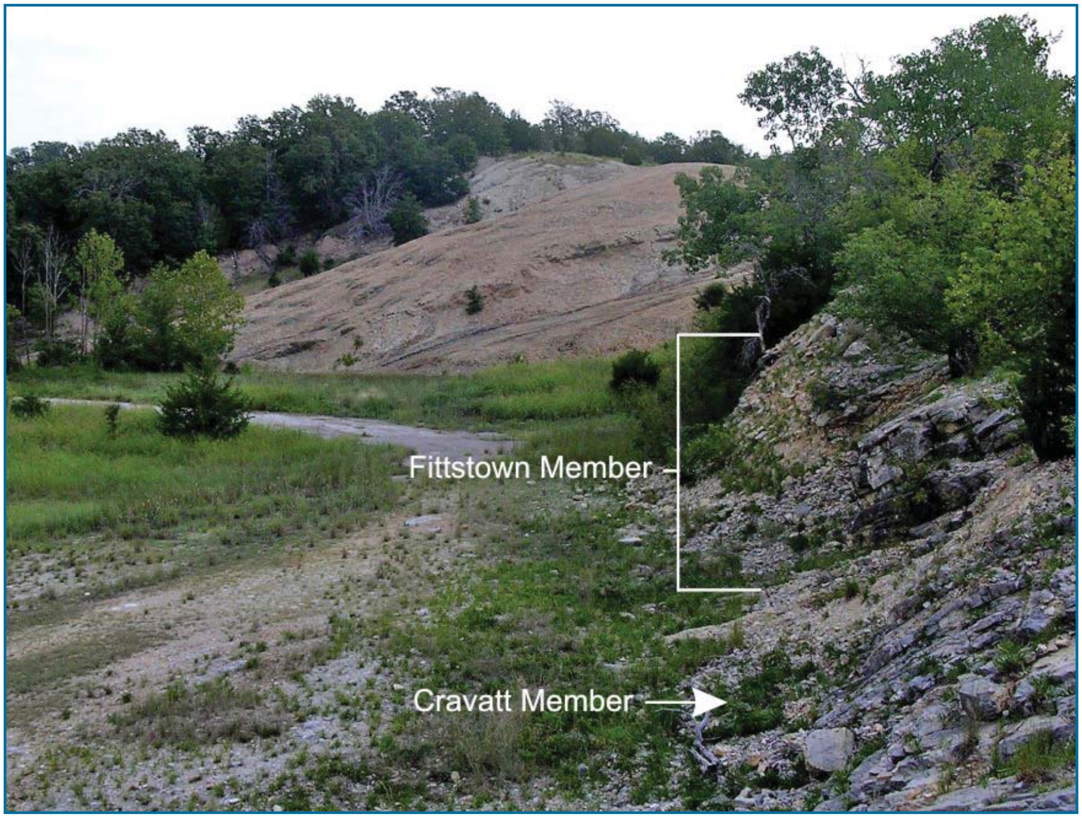


Figure 2. Standing just outside of the Hunton Anticline Quarry and looking northeast. Foreground shows outcrops of the Fittstown and Cravatt Members of the Bois d'Arc Formation. The large, light gray outcrop in the background is the Woodford Shale. Main quarry is immediately to the right of the photo.

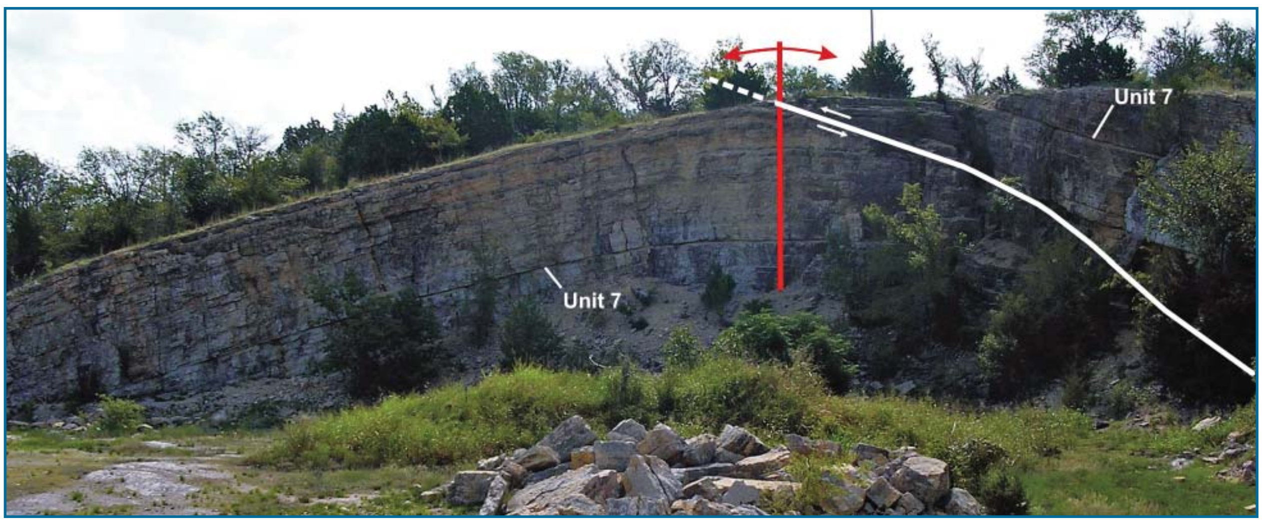


Figure 3. Looking just about due east within the main Hunton Quarry and right down the axis of the anticline (shown in red). Rocks exposed in the east quarry wall all belong to the Cravatt Member of the Bois d'Arc Formation. The top of the quarry wall just about corresponds to the top of the Cravatt. The Fittstown Member is exposed to the left of the photo and just outside the main quarry, and the Haragan Formation is exposed at the base of the quarry south wall to the right of the photo. Note that the south limb of the anticline is cut by low-angle reverse fault (shown in white). Unit 7 from columnar section (see Figure 5) is labeled on either side of the fault, and illustrates the amount of displacement that has occurred.

the Frisco Formation (the top of the Hunton Group in the Arbuckle Mountains) is absent in this area (Figure 4). Due to this, a disconformity exists between the top of the Bois d'Arc and the Woodford.

Getting back to the main quarry, both the Bois d'Arc and Haragan are Early Devonian (Lochkovian) in age based on conodont biostratigraphy (Figure 4), and both have a rich and diverse invertebrate macrofauna. Brachiopods dominate the macrofossil assemblage along with various types of crinoid debris (plates, stems and ossicles), and are the most common fossils found (Figure 7). However, horn corals, mollusks (mostly gastropods) and even trilobites have been collected in all the units in the quarry. The lack of

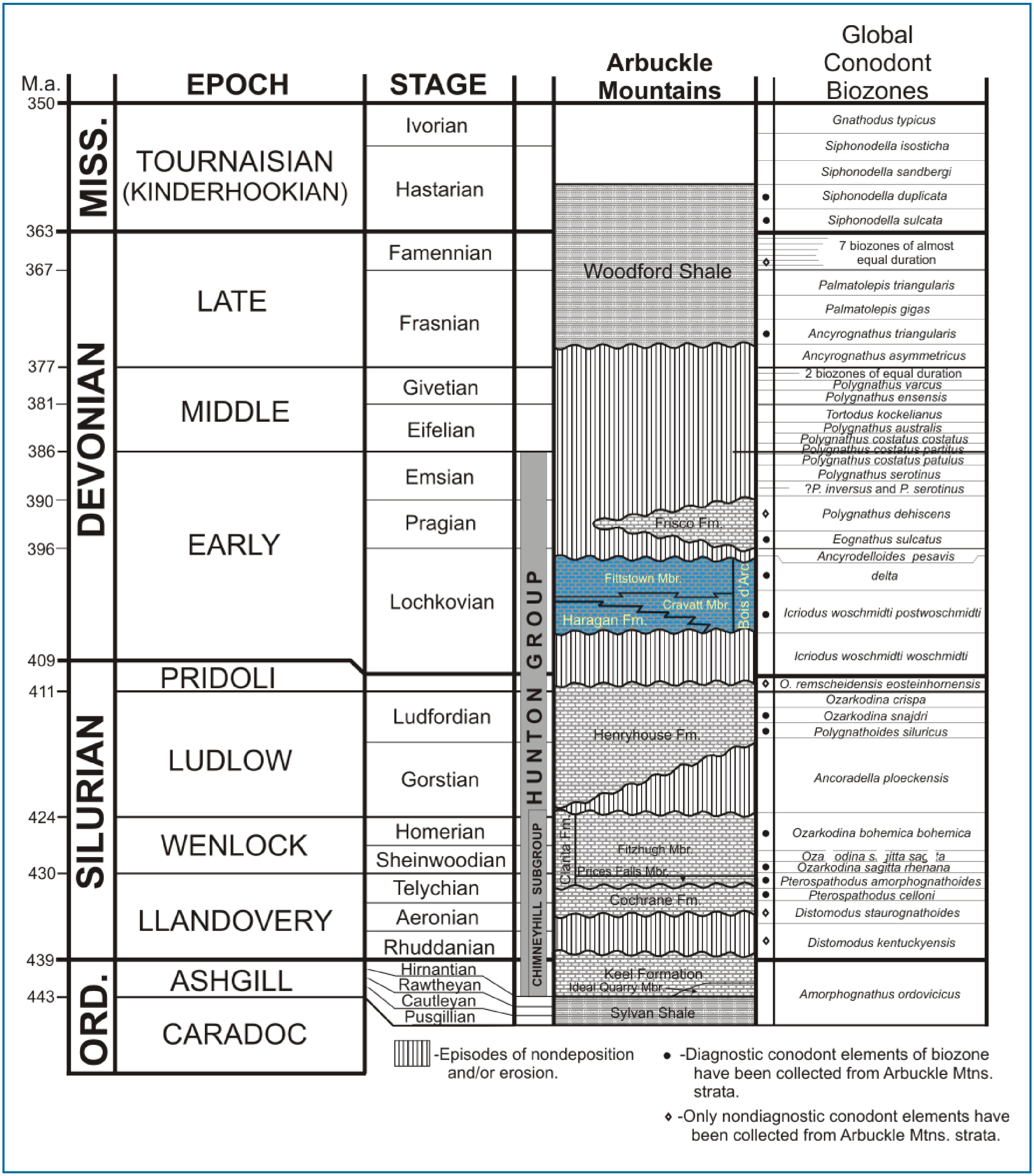


Figure 4. Chronostratigraphic chart illustrating units constituting the Hunton Group. That part of the section exposed in the Hunton Anticline Quarry is highlighted in blue and includes the upper Haragan through Bois d'Arc Formations. Vertical thickness of units based on presence or absence of world-wide conodont assemblages. Chart from Stanley (2001).

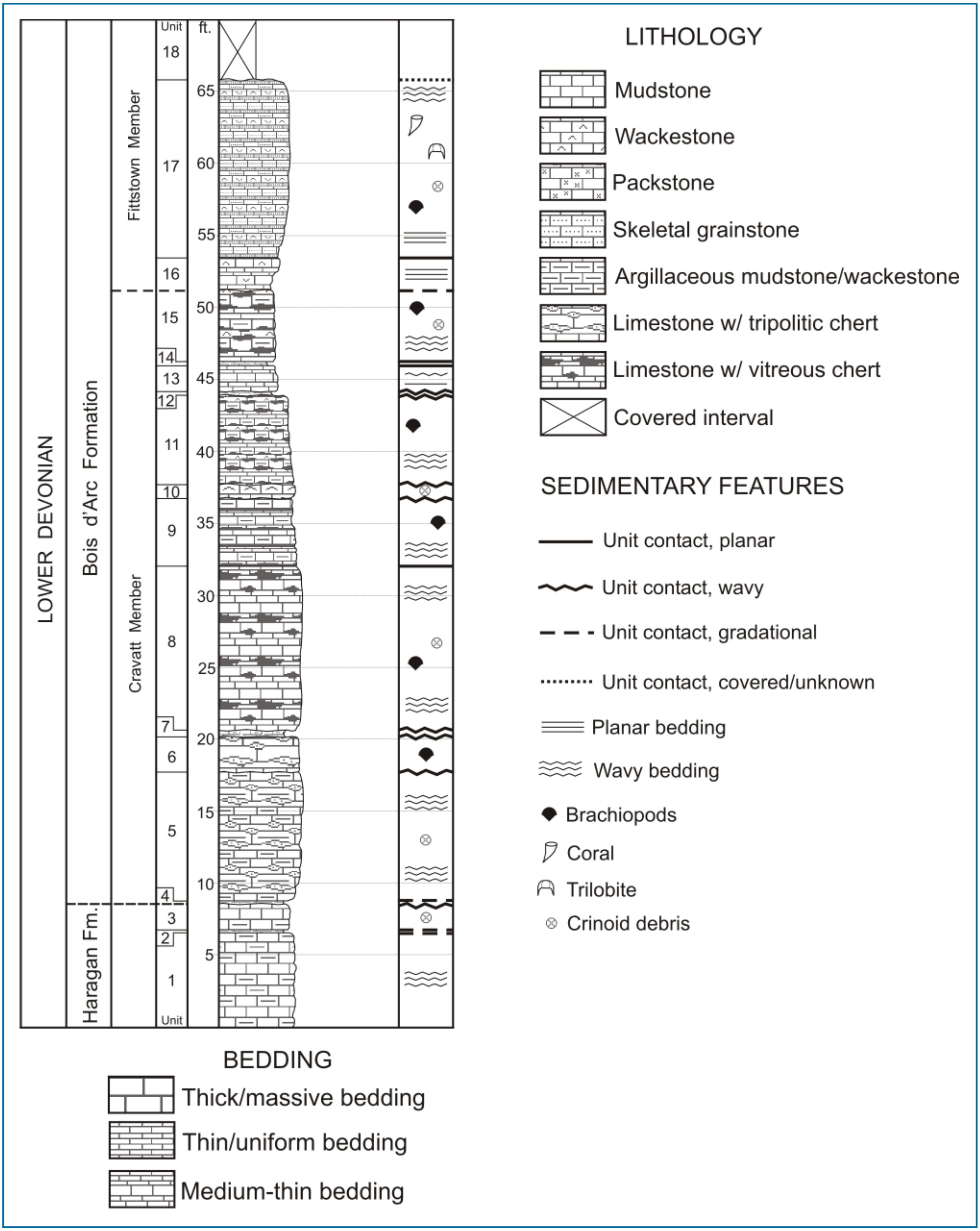


Figure 5. Measured section of the main Hunton Quarry. For a more detailed description of the rocks exposed in the Hunton Quarry see Stanley (2001).

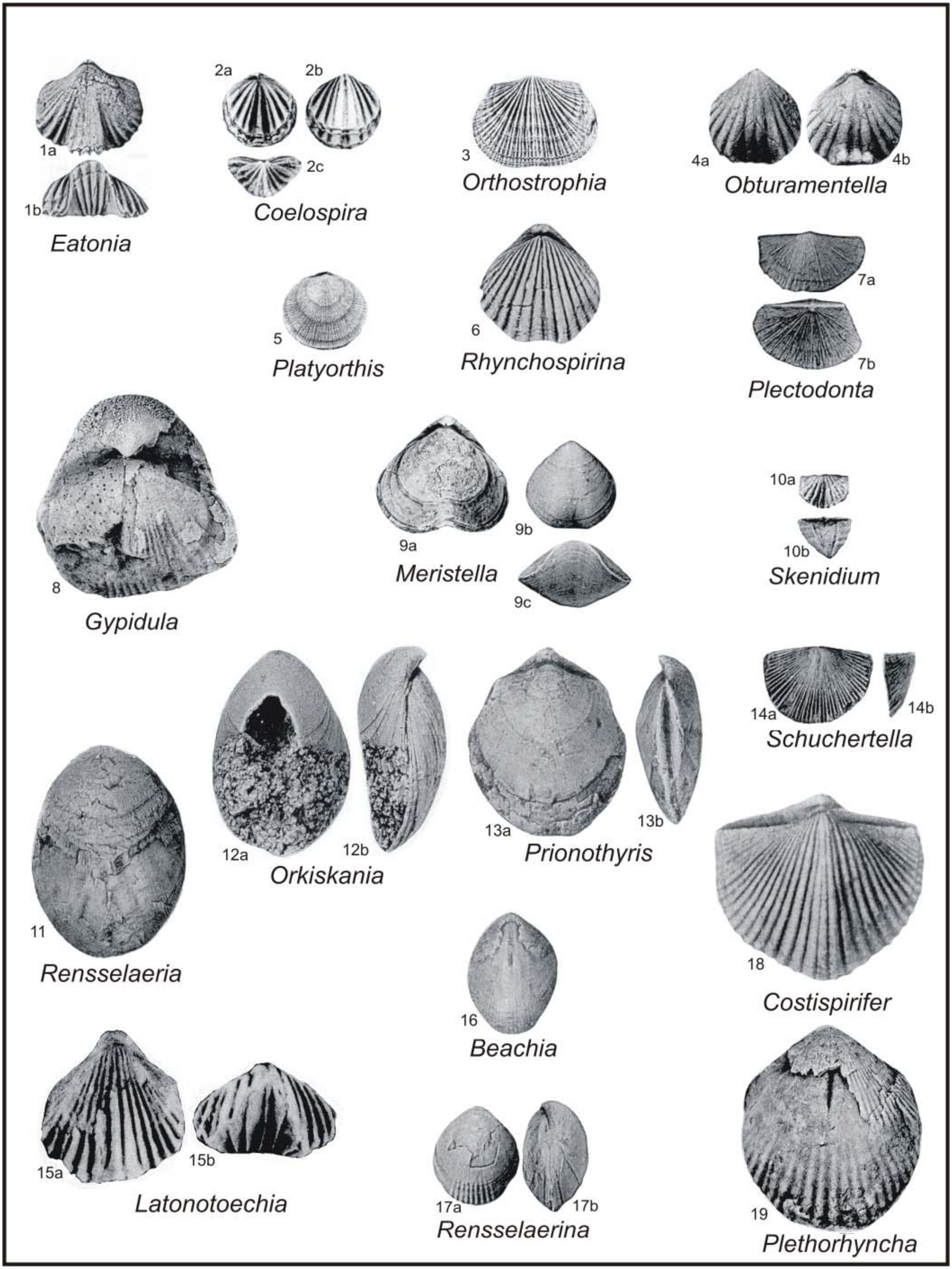
Figure 6. Large nodule of what is termed, 'tripolitic chert.' This type of chert is commonly found in the lower parts of the Cravatt Member, and forms as irregular, light brown nodules having a more or less 'sandy' internal texture and dull luster. The more common variety of dark gray chert nodule, one having a glassy and vitreous texture and luster, is found higher in the section. Note all the fossil debris surrounding the chert nodule, making the depositional texture of the limestone matrix a skeletal argillaceous wackestone.

faunal changes, both micofaunally and macrofaunally, throughout this part of the Hunton Group, also exemplifies the gradational transition that occurs between the Haragan and members of the Bois d'Arc.

Part of the reason I like carbonate rocks is that with only a brief examination of their textures, one can get a pretty good understanding of their overall, environment of deposition. All carbonates that exhibit good depositional textures, and the Hunton Quarry limestones are no exception, are invariably marine in origin. Sediment comprising all Hunton Group carbonates was originally deposited across a shallow, cratonic shelf that exhibited slow rates of deposition (Al-Shaieb, et al., 1993; Al-Shaieb and Puckette, 2000). As such, the regional development of the Hunton Group in general, and the Haragan through Bois d'Arc sequence specifically, is associated with a ramp-style carbonate model (Figure 8) (Fritz and Medlock, 1993; Stanley, 2001). The environment of deposition of the quarry limestones can be further refined with a closer examination of their depositional textures (i.e., how much lime mud versus fossil fragments is found in the rock), the condition of their fossils (i.e., how much abrasion and breakage has occurred), as well as the relative amount of terrigenous clastics each unit contain (higher amounts of argillaceous material indicate deeper water along carbonate ramps).

The Haragan Formation contains a fairly high percentage [average 16% (Amsden, 1960)] of terrigenous silt and clay, and along with its contained fossils, which exhibit very little abrasion and breakage, suggests that the formation was deposited along the outer (i.e., deeper) parts of the carbonate ramp, well below storm wave base (Figures 5 and 8) (Stanley, 2001). As one continues stratigraphically higher into the Cravatt Member, argil-

Figure 7. The most common fossils found in the Hunton Quarry, other than crinoid debris (disarticulated plates, stems and ossicles), are brachiopods. Some of the more common types that can be collected at the quarry include: 1, Eatonia, a,b, brachial and anterior views, x1; 2, Coelospira, a—c, brachial, pedicle, and posterior views, x1; 3, Orthostrophia, pedicle view, x1; 4, Obturamentella, a,b, pedicle and brachial views, x2; 5, Platyorthis, brachial view, x1; 6, Rhynchospirina, brachial view, x2; 7, Plectodonta, a,b, pedicle and brachial views, x3; 8, Gypidula, brachial view, x1; 9, Meristella, a—c, brachial, pedicle, and anterior views, x1; 10, Skenidium, a,b, brachial and posterior views, x3; 11, Rensselaeria, pedicle view, x1; 12, Orkiskania, a,b, pedicle and left lateral views, x2; 13, Prionothyris, a,b, brachial and right lateral views, x2; 14, Schuchertella, a,b, pedicle and right lateral views, x2; 15, Latonotoechia, a,b, brachial and anterior views, x 1; 16, Beachia, pedicle view, x1; 17, Rensselaerina, a,b, pedicle and right lateral views, x1; 18, Costispirifer, brachial view, x1; 19, Plethorhyncha, pedicle view, x1. For detailed references on original source material for the brachiopod photographs see figure captions for figs. 11 and 13 in Stanley (2001).


1a
1b
Eatonia
2a
2b
2c
Coelospira
3
Orthostrophia
4a
4b
Obturamentella
5
Platyorthis
6
Rhynchospirina
7a
7b
Plectodonta
8
Gypidula
9a
9b
9c
Meristella
10a
10b
Skenidium
11
Rensselaeria
12a
12b
Orkiskania
13a
13b
Prionothyris
14a
14b
Schuchertella
15a
15b
Latonotoechia
16
Beachia
17a
17b
Rensselaerina
18
Costispirifer
19
Plethorhyncha

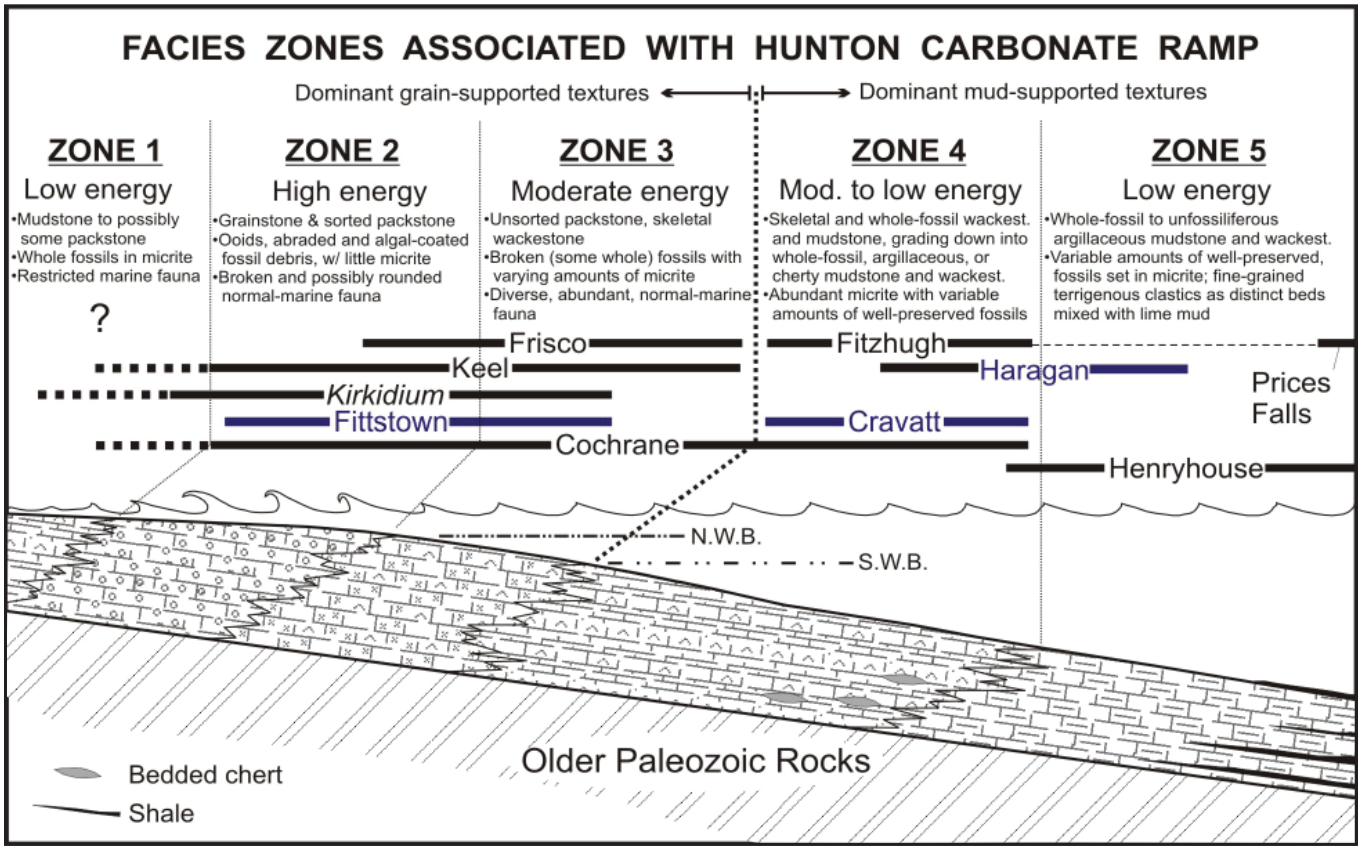


Figure 8. Idealized standard facies model of the Hunton Group, based on a carbonate-ramp model of deposition. Illustrated are the main facies zones, their diagnostic depositional textures, and the relative bathymetric positions the major Hunton units would have theoretically formed under. Those units and their associated facies that are found in the Hunton Quarry are highlighted in blue. N.W.B. and S.W.B. represent normal wave base and storm wave base, respectively. Facies zone 1 and the Kirkidium biofacies are only found in the subsurface. No vertical or horizontal scale is implied. For detailed descriptions of each standard facies zone see Stanley (2001).

laceous material begins to drop off (averaging from 0% to 11%) while abrasion of whole fossils and the presence of skeletal wackestone textures, increases. These observations, coupled with the occurrence of abundant chert, suggest the Cravatt was forming in slightly shallower marine waters at the base of the member as compared to the Haragan facies (Wilson, 1975), while wackestone textures toward the top of the member indicate that water conditions continued to shallow throughout deposition (Figures 5 and 8). Just how shallow the waters were along the carbonate ramp cannot be determined precisely, but based on the limestone textures, the benthos was probably close to storm wave base toward the top of the Cravatt. Shallowing conditions continue further up section into the Fittstown Member, culminating with shoaling conditions represented by well-sorted, skeletal grainstones that formed well within the intertidal zone of the carbonate ramp (Figures 5 and 8).

Structural elements represented in the Hunton Quarry include a nicely developed, symmetrical anticline with an accompanying low-angle reverse fault that cuts through its south limb (Figure 3). Both structural elements are in keeping with the overall structural style of the Arbuckle Mountains as a whole, which was formed from, more or less, compressional, north-south directed forces during the Late Pennsylvanian (Desmoinesian through Virgilian) Ouachita-Wichita orogeny. Although the displacement along the fault is only a few tens of feet, it is enough to expose the top of the Haragan along the south wall of the quarry.

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2014 STATEMAP Update

Julie M. Chang, Thomas M. Stanley, and G. Russell Standridge
OGS Staff

Background

STATEMAP is a program funded jointly by the U.S. Geological Survey and state geological surveys. The purpose of the STATEMAP program is to provide a solid geological framework in areas that are important to each state, primarily through geologic mapping. In Oklahoma, the STATEMAP program has focused on (1) mapping the geology of urban areas at the 1:24,000-scale (7.5' quadrangles) and (2) producing new 1:100,000-scale geologic maps (30'x60' quadrangles) by field checking older maps. When all of the 1:100,000-scale maps have been updated, they will be combined to produce a new 1:500,000-scale map of the state of Oklahoma. All STATEMAP products are drafted in digital form and are available as ArcGIS and PDF files.

7.5' Quadrangles

The first urban area to be mapped in Oklahoma through the STATEMAP program was the Oklahoma City Metro Area. This area was mapped between 1998 and 2003 and produced twenty-five 7.5' quadrangles (Fig. 1). These quadrangles have been combined to produce a 1:100,000 scale geologic map of the Oklahoma City Metro Area.

The second urban area to be mapped was the Tulsa Metro Area. This area was mapped between 2004 and 2013 and produced nineteen 7.5' quadrangles (Fig. 1). The final 7.5' quadrangle to be mapped was the Tulsa 7.5' quadrangle, which was completed last year. These quadrangles will be combined to produce a 1:100,000 scale geologic map of the Tulsa Metro Area.

The third urban area in Oklahoma that will be mapped through the STATEMAP program is the Ada area. This area will contain six 7.5' quadrangles (Fig. 1). Mapping of the first of these six, the Vanoss 7.5' quadrangle, will be done this year. The Roff N

93-4, p. 183-212. [Link: www.ogs.ou.edu/pubsscanned/SPs/SP93_4.pdf]

------; and Puckette, J., 2000, Sequence stratigraphy of the Hunton Group ramp facies, Arbuckle Mountains and Anadarko Basin, Oklahoma, in Johnson, K.S. (ed.), Platform carbonates in the southern Midcontinent, 1996 symposium: Oklahoma Geological Survey Circular, 101, p. 131-137. [Link: www.ogs.ou.edu/pubsscanned/Circulars/circular101.pdf]

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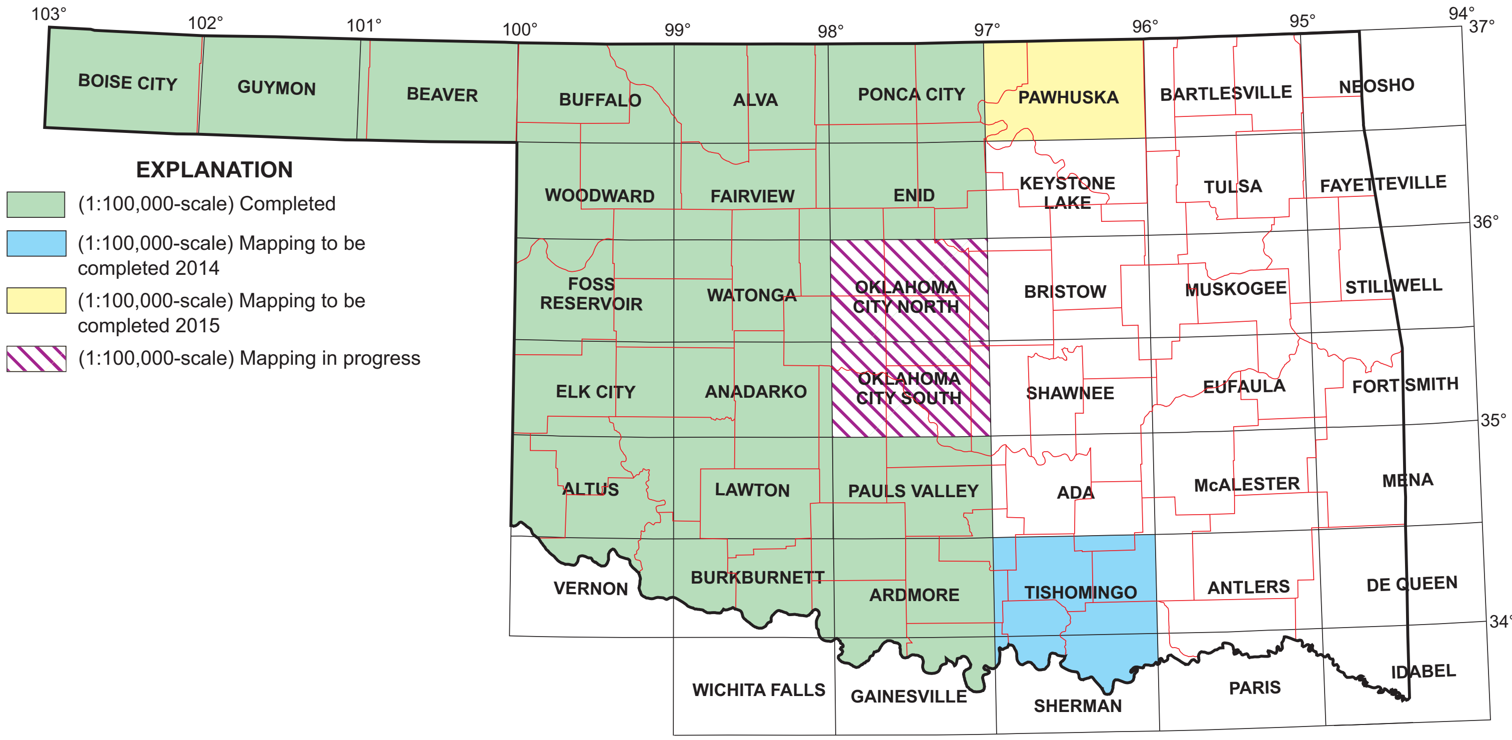


Figure 1. Index map showing the mapping status of 7.5' quadrangles in Oklahoma.

7.5' quadrangle will be mapped in 2015.

The only 7.5' quadrangle outside of an urban area to be mapped through the STATEMAP program was the Picher 7.5' quadrangle in 2006 (Fig. 1). This map provides detailed geology of the area in and around the Tar Creek Superfund site.

Another STATEMAP effort the Oklahoma Geological Survey has undertaken has been to digitize previously mapped 7.5' quadrangles from the northern Ouachita Mountains. Twenty-two 7.5' quadrangles, as well as two partial 7.5' quadrangles, were mapped between 1989 and 1997 as part of the COGEOMAP program, a precursor to the STATEMAP program (Fig. 1). These maps were originally hand-drafted, black and white products but are now being digitized into color ArcGIS and PDF files. To date, the westernmost twelve of these maps have been digitized (Fig. 1). These include the Panola, Baker Mountain, Wilburton, and Damon 7.5' quadrangles, which were digitized in 2011 and published in 2012; the Adamson, Gowen, Higgins, and Hartshorne 7.5' quadrangles, which were digitized in 2012 and published in 2013; and the McAlester, Krebs, Savanna, and Hartshorne SW 7.5' quadrangles, which were digitized in 2013 and will be published in 2014. This year, the Red Oak, Talihina, LeFlore, and Blackjack Ridge 7.5' quadrangles will be digitized. They will be published in 2015.

30'x60' Quadrangles

Since 2002, seventeen 30'x60' quadrangles and three partial 30'x60' quadrangles from the western half of Oklahoma have been mapped (Fig. 2). Work on the Oklahoma City North and Oklahoma City South 30'x60' quadrangles is in progress. This year, the Tishomingo and Oklahoma part of Sherman 30'x60' quadrangles will be completed. Next year, the Pawhuska 30'x60' quadrangle will be mapped. As stated previously, when all 30'x60' quadrangles are completed, they will be combined to create a new 1:500,000-scale geologic map of the state of Oklahoma.

All digital STATEMAP products are available free of purchase on the Oklahoma Geological Survey website.

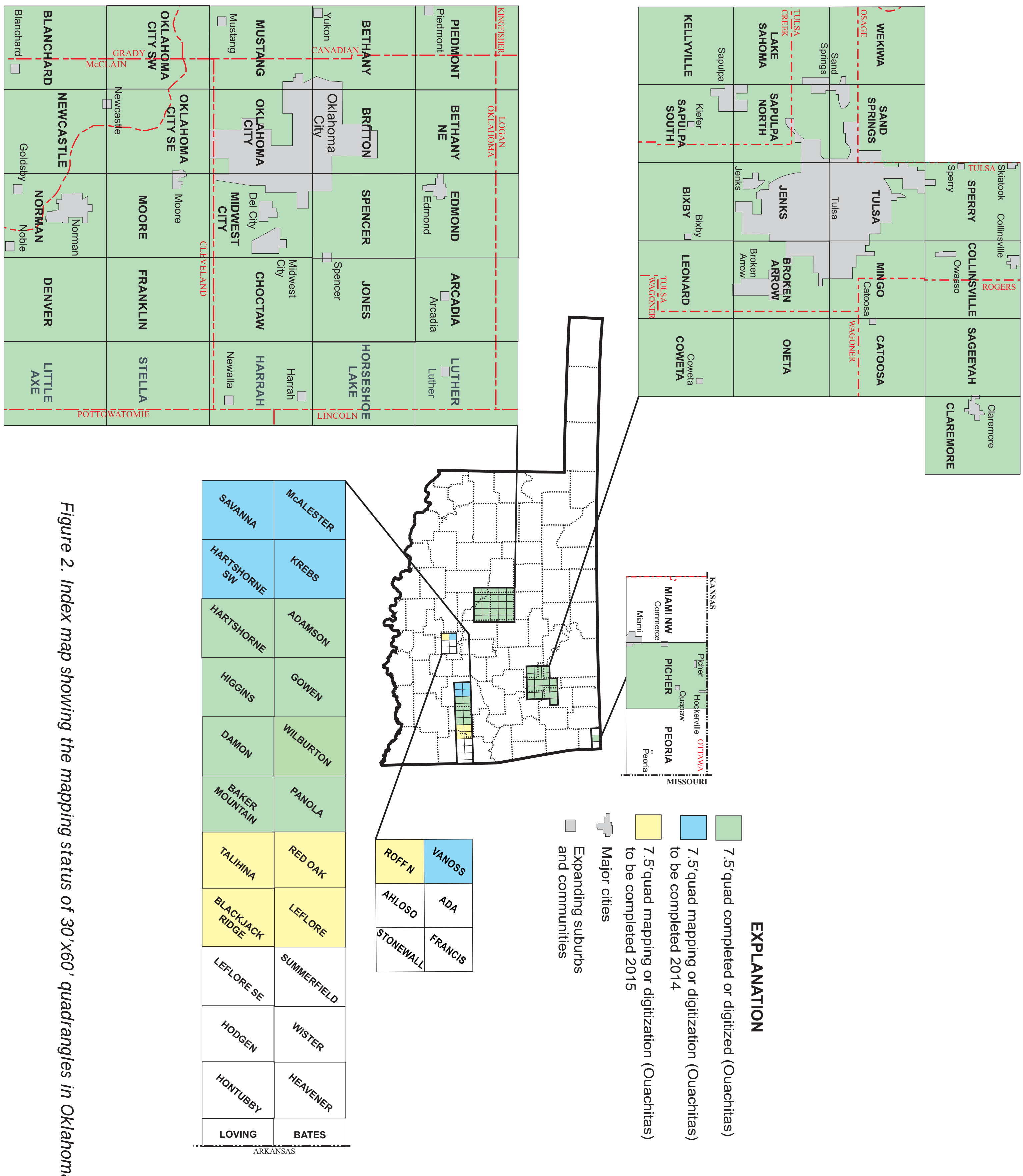


Figure 2. Index map showing the mapping status of 30'x60' quadrangles in Oklahoma.

Earthquake Report 2nd and 3rd Quarter 2013

Austin Holland, Amie Youngblood, Amberlee Darold, OGS Staff

2nd Quarter Summary

The Oklahoma Geological Survey (OGS) located more than 864 earthquakes within Oklahoma from April 1 to June 30, 2013. There were 68 felt earthquakes in the second quarter of 2013. Most notably there was a significant swarm of earthquakes that occurred near Wellston in April with earthquakes occurring both in Lincoln and Oklahoma counties from this swarm. In response to the Wellston swarm one OGS temporary seismic station, LC30, was installed. In addition, the

Table 1 - Felt earthquakes for April 1 to June 30, 2013, MMI IV-VI

(MMI is the maximum reported Modified Mercalli Intensity)

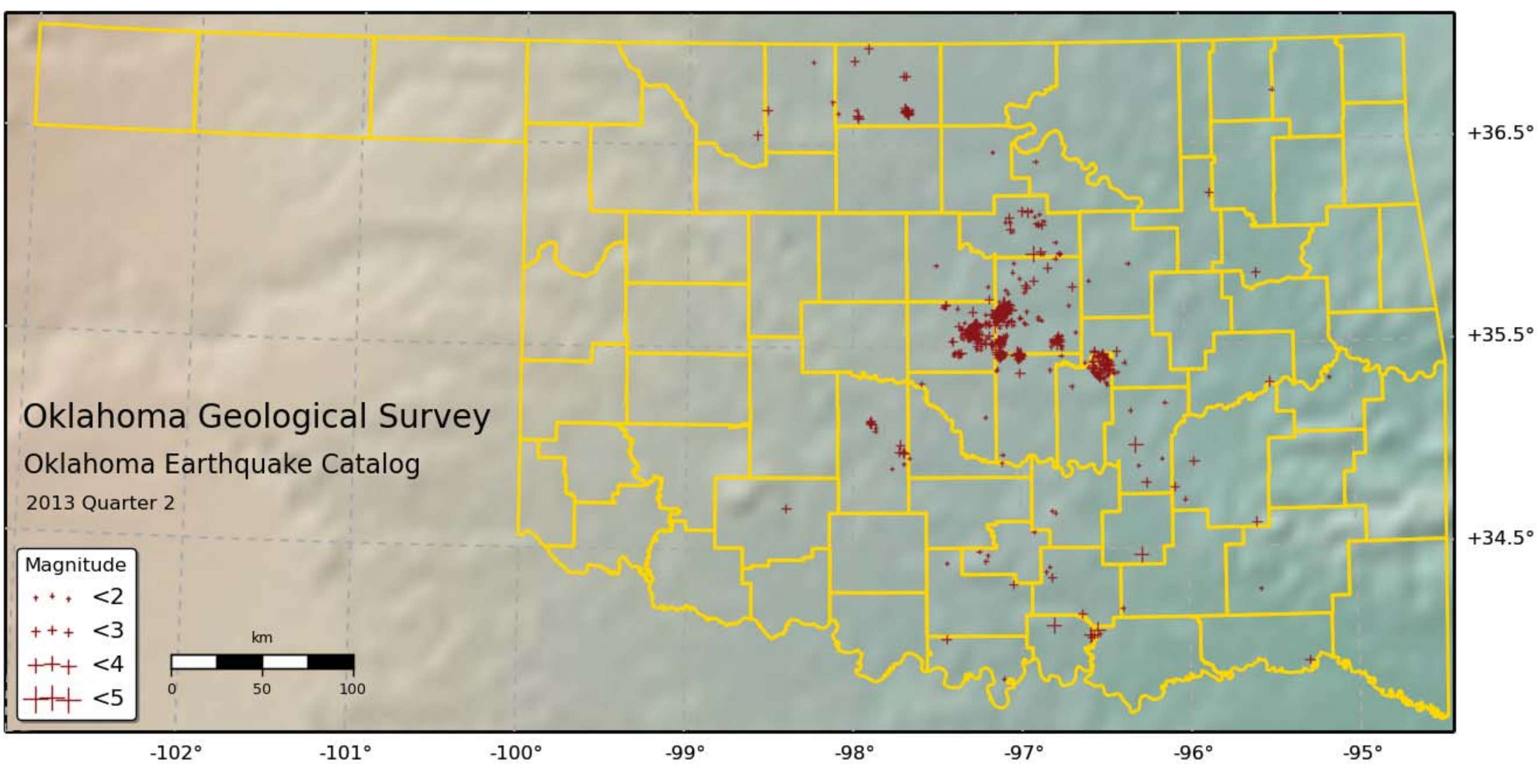
Origin Time (UTC)		Longitude	Latitude	Depth (km)	Magnitude		MMI	County
					Mag	Type		
4/4/13	0:32	-95.959	34.925	5.0	2.8	ML	IV	PITTSBURG
4/16/13	10:16	-97.098	35.681	7.0	4.2	MW	VI	LINCOLN
4/16/13	6:56	-97.089	35.686	6.2	4.4	MW	V	LINCOLN
4/16/13	7:16	-97.106	35.675	6.9	3.3	MW	V	LINCOLN
4/16/13	16:47	-97.115	35.668	6.9	3.3	ML	V	LINCOLN
4/16/13	17:07	-97.119	35.668	7.0	3.7	ML	V	LINCOLN
4/16/13	6:45	-97.094	35.677	7.3	2.9	ML	IV	LINCOLN
4/16/13	21:03	-96.770	35.525	6.7	3.2	ML	IV	LINCOLN
4/16/13	21:51	-97.124	35.660	7.3	3.6	ML	IV	LINCOLN
4/17/13	1:14	-97.125	35.659	7.7	3.2	MW	V	LINCOLN
4/17/13	11:37	-97.077	35.682	7.8	2.8	ML	IV	LINCOLN
4/17/13	14:56	-97.123	35.659	7.7	3.4	MW	IV	LINCOLN
4/17/13	16:25	-97.082	35.685	7.0	3.2	ML	IV	LINCOLN
4/19/13	18:40	-97.136	35.658	5.0	2.8	ML	V	LINCOLN
4/23/13	19:33	-97.098	35.677	5.0	3.1	ML	IV	LINCOLN
4/24/13	18:04	-97.093	35.686	4.8	3.3	ML	V	LINCOLN
4/28/13	3:06	-96.810	34.123	5.0	3.3	MW	IV	MARSHALL
5/9/13	14:47	-97.250	35.541	6.3	2.6	ML	IV	OKLAHOMA
5/15/13	10:54	-97.117	35.530	10.6	2.8	ML	IV	LINCOLN
5/27/13	7:58	-96.590	34.075	6.7	3.2	ML	IV	MARSHALL
6/5/13	20:51	-96.862	35.970	2.9	2.8	ML	IV	PAYNE
6/9/13	7:12	-97.262	35.608	7.2	3.7	ML	IV	OKLAHOMA
6/10/13	22:24	-97.011	35.463	6.6	3.3	ML	IV	POTTAWATOMIE
6/12/13	16:05	-97.292	35.575	6.1	3.1	ML	V	OKLAHOMA
6/16/13	22:35	-97.293	35.564	6.1	3.2	ML	V	OKLAHOMA
6/16/13	8:08	-97.308	35.566	7.2	3.1	ML	IV	OKLAHOMA
6/16/13	18:06	-97.306	35.565	7.3	3.6	ML	IV	OKLAHOMA
6/18/13	12:42	-97.118	35.473	13.5	3.2	ML	IV	LINCOLN
6/27/13	8:31	-97.902	35.130	13.3	2.8	ML	IV	GRADY
6/29/13	0:46	-97.006	35.458	6.6	3.3	ML	IV	POTTAWATOMIE

U.S. Geological Survey provided two temporary seismic stations, which were also installed in the area. Earthquakes continued within Oklahoma County with more than 199 earthquakes consistent with the ongoing Jones earthquake swarm. There were 419 earthquakes located within Lincoln County primarily in the aftershock zone of the 2011 M5.7 earthquake from the Wellston swarm. The Paden swarm continued its activity with 46 earthquakes in Pottawatomie county and 26 earthquakes in Okfuskee. Other counties that had significant numbers of earthquakes include Seminole (59), Grant (25), Payne (22), and Grady (13) counties. Overall 35 counties had earthquakes located within their boundaries. The largest earthquakes to occur during this quarter were associated with the Wellston Swarm with a magnitude 4.2 and 4.4. All earthquakes located in Oklahoma for the second quarter of 2013 can be seen in Figure 1 and events with a Modified Mercalli Intensity (MMI) of IV and above are listed in Table 1. Seismic activity continues to be concentrated within central Oklahoma.

3rd Quarter Summary

From July 1 to September 30, 2013 the Oklahoma Geological Survey (OGS) located more than 720 earthquakes within Oklahoma. There were 39 felt earthquakes in the third quarter of 2013. Most notably there was a significant

Figure 1. 2013 2nd Quarter Earthquakes for April 1 to June 30, 2013 located with four or more seismic stations.



swarm of earthquakes that occurred in Grant County (144). In response to the increased activity an OGS temporary seismic station was installed in Grant County. Earthquakes have decreased but continued within Oklahoma County with more than 113 earthquakes consistent with the ongoing Jones earthquake swarm. Lincoln County associated with the Wellston swarm (in the aftershock zone of the 2011 M5.7 earthquake) seems to have quieted down with 99 events. Other counties that had significant numbers of earthquakes include Seminole (64), Love (46), Alfalfa (44), Payne (42), and Pawnee (27) counties. Overall 37 counties had earthquakes located within their boundaries. All earthquakes located in Oklahoma for the third quarter of 2013 can be seen in Figure 2 and events with a Modified Mercalli Intensity (MMI) of IV and above are listed in Table 2 Seismicity in the third quarter is primarily bimodal, focused north in Grant and Alfalfa counties and central in Oklahoma and Lincoln counties. There was a swarm of activity in Love County in September. This activity is documented in a preliminary OGS Open File Report "*Preliminary Analysis of the 2013 Love County Earthquake Swarm*". As part of this effort four temporary seismic stations were installed in Love County near the location of earthquake activity. Most notably the largest earthquake, magnitude 3.4, in Love county did minor damage to local residences immediately near the epicenter suggesting the earthquake was quite shallow. Preliminary work indicates the earthquakes are primarily occurring at about 2 kilometers depth.

Download 2013 2nd and 3rd quarter earthquake file and complete list of felt earthquakes (CSV):

http://www.okgeosurvey1.gov/media/quarterlies/2013_qt2.csv
http://www.okgeosurvey1.gov/media/quarterlies/2013_qt2_felt.csv

http://www.okgeosurvey1.gov/media/quarterlies/2013_qt3.csv

http://www.okgeosurvey1.gov/media/quarterlies/2013_qt3_felt.csv

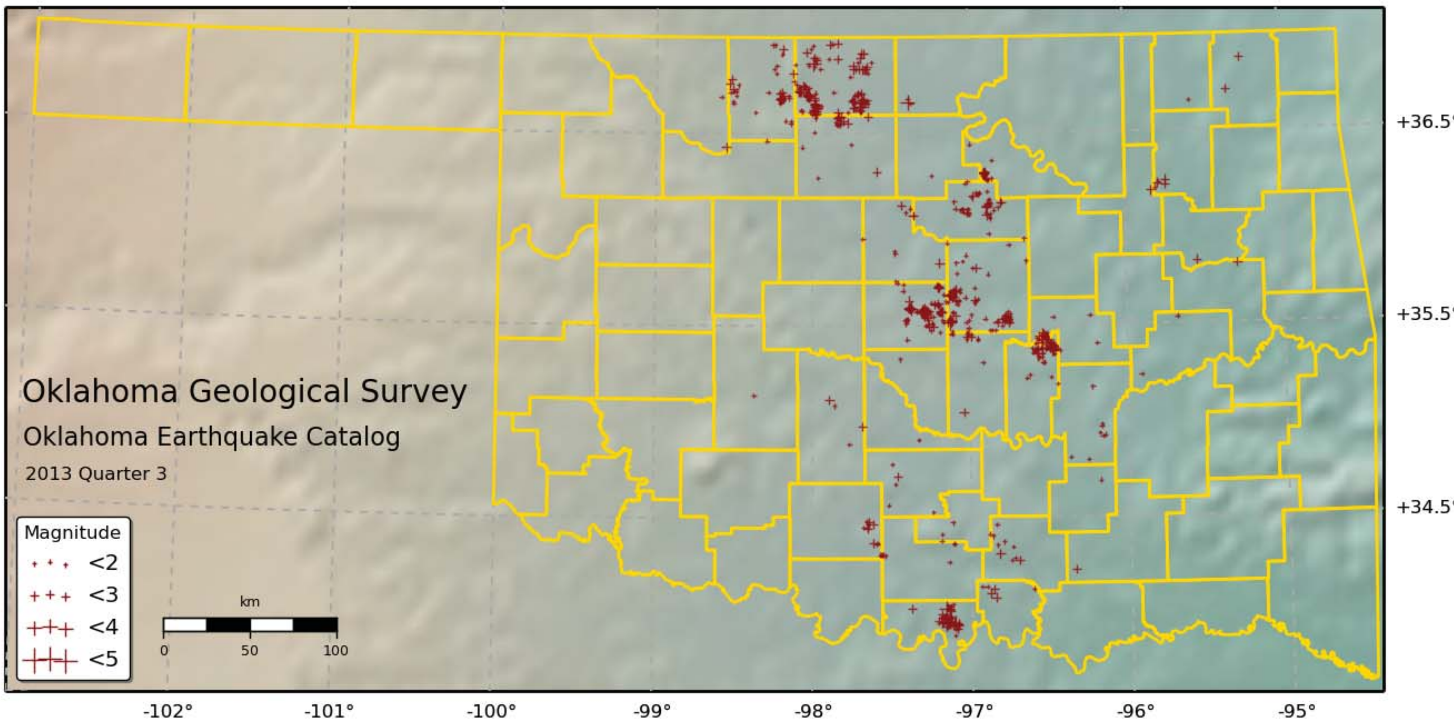
OGS OF1-2013 Preliminary Analysis of the 2013 Love County Earthquake Swarm (V2013.9.30 PDF)

Table 2 - Felt earthquakes for July 1 to September 30, 2013, MMI IV-VI

(MMI is the maximum reported Modified Mercalli Intensity)

Origin Time (UTC)		Longitude	Latitude	Depth (km)	Magnitude		MMI	County
					Mag	Type		
7/24/13	11:52	-96.481	35.373	8.6	3.5	ML	IV	SEMINOLE
8/1/13	2:39	-97.128	35.518	13.0	3.0	ML	IV	LINCOLN
9/15/13	5:58	-96.543	35.409	4.9	3.1	ML	IV	OKFUSKEE
9/23/13	13:56	-97.162	34.028	3.0	3.4	ML	V	LOVE
9/23/13	11:40	-97.111	33.954	3.0	3.2	ML	IV	LOVE
9/26/13	5:17	-97.375	35.590	5.0	3.2	ML	IV	OKLAHOMA

Figure 2. 2013 3rd Quarter Earthquakes from July 1 to September 30, 2013 located with four or more seismic stations.



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Oklahoma Geological Survey Mission Statement:

The Oklahoma Geological Survey is a state agency for research and public service located on the Norman Campus of the University of Oklahoma and affiliated with the University of Oklahoma Mewbourne College of Earth and Energy. The Survey is chartered in the Oklahoma Constitution and is charged with investigating the state's land, water, mineral, and energy resources and disseminating the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices.

Oklahoma Geological Survey
THE UNIVERSITY OF OKLAHOMA
MEWBOURNE COLLEGE OF EARTH & ENERGY
100 E. Boyd, Room N-131
Norman, Oklahoma 73019-1001

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