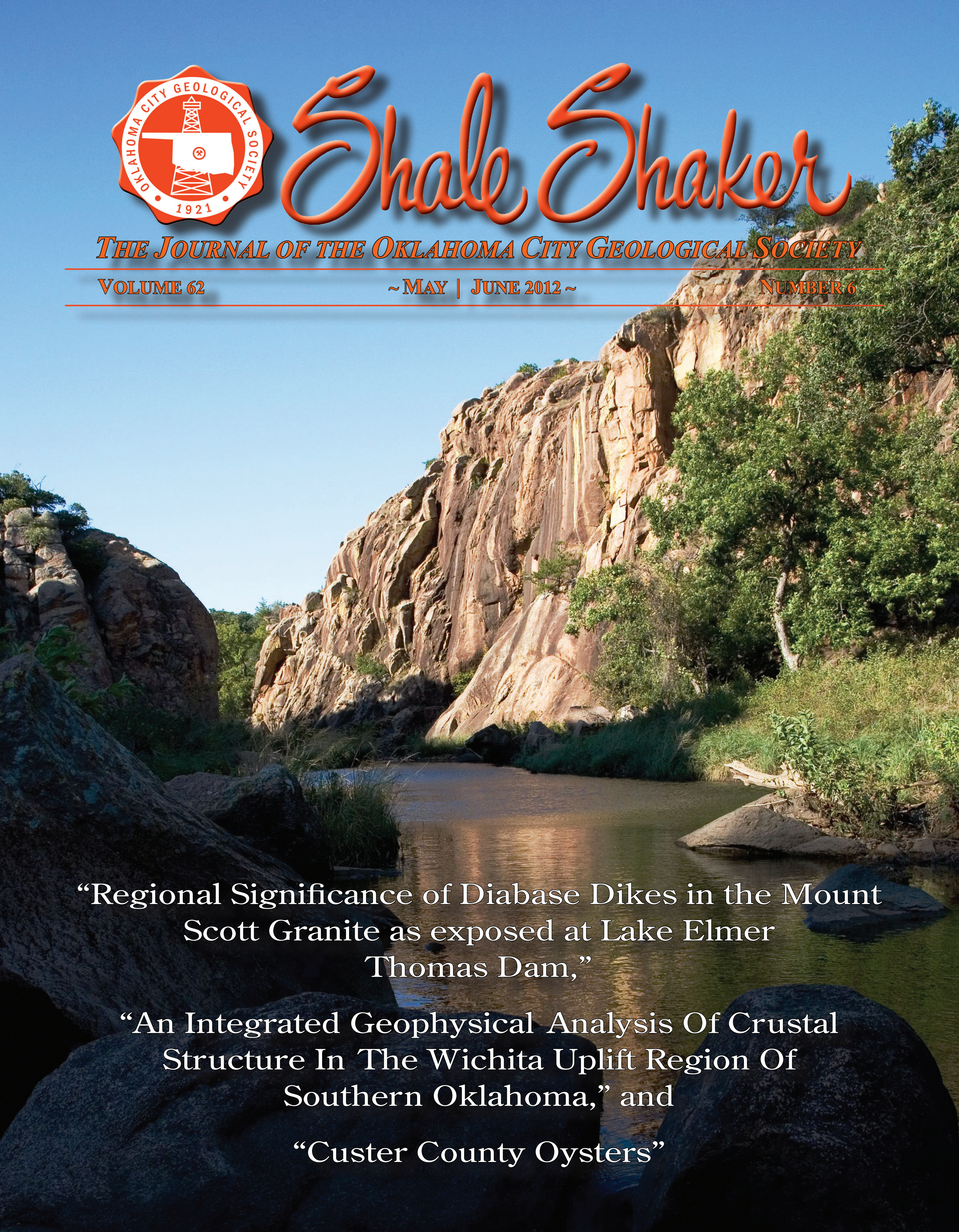

Shale Shaker

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"Regional Significance of Diabase Dikes in the Mount Scott Granite as exposed at Lake Elmer Thomas Dam,"

"An Integrated Geophysical Analysis Of Crustal Structure In The Wichita Uplift Region Of Southern Oklahoma," and

"Custer County Oysters"

The Journal of the Oklahoma City Geological Society

Shale Shaker Features

Oil and Gas Exploration

My Favorite Outcrop

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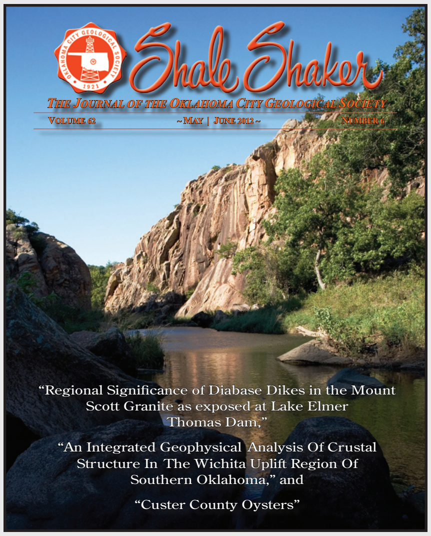
Announcements



About the Cover

Michael Root creates the covers of the Shale Shaker. His cover for this Issue utilizes several images supplied by the Wichita Mountains Wildlife Refuge, as well as photomicrographs from articles within this Issue.

The cover ties nicely with this Issue's technical subject matter: "Regional significance of diabase dikes in the Mount Scott Granite as exposed at Lake Elmer Thomas Dam," by Jonathan D. Price, M. Charles Gilbert, and John P. Hogan; and "An integrated geophysical analysis of crustal structure in the Wichita Uplift Region of Southern Oklahoma," by Amanda (Rondot) Buckey.

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Custer County Oysters

Introduction

Custer County, Oklahoma is not known for its oysters. Most geologists probably picture gently rolling plains of red soil – Permian red – interrupted by the rare gypsum bed or mesa-capping dolomite. There are, however, a number of very small outcrops – one of which is described in this report – of Cretaceous strata in Custer County. Although they cover probably less than 0.1% of the area of the county, they provide a glimpse into part of the post-Permian geological history of the area. To date, only the Cretaceous Kiowa limestone and Dakota sandstone have been recognized. A thorough study of these rocks could lead to knowing more about the character of the Western Interior Seaway in Oklahoma and the mechanism of near-surface deformation and collapse structures.

The Dakota sandstone / Kiowa limestone outcrops (center of the S½ sec. 28, T. 12 N., R. 19 W.) described here are located about three miles northwest of the town of Foss in southwestern Custer County along road D2115 (labeled in some atlases) (Figure 1). They are about half way between Clinton and Elk City (Figure 2) and about four miles north of Interstate 40. Geologically, the exposures are near the axis of the Anadarko Basin. For the purposes of this report, these closely spaced outcrops will serve as an example of others in Custer, Washita, Rogers Mills, and Dewey Counties (Figure 2), all of which occur near the axis of or on the northeast flank of the basin.

History

Small, isolated outcrops of Cretaceous strata (here termed “outliers”) have long

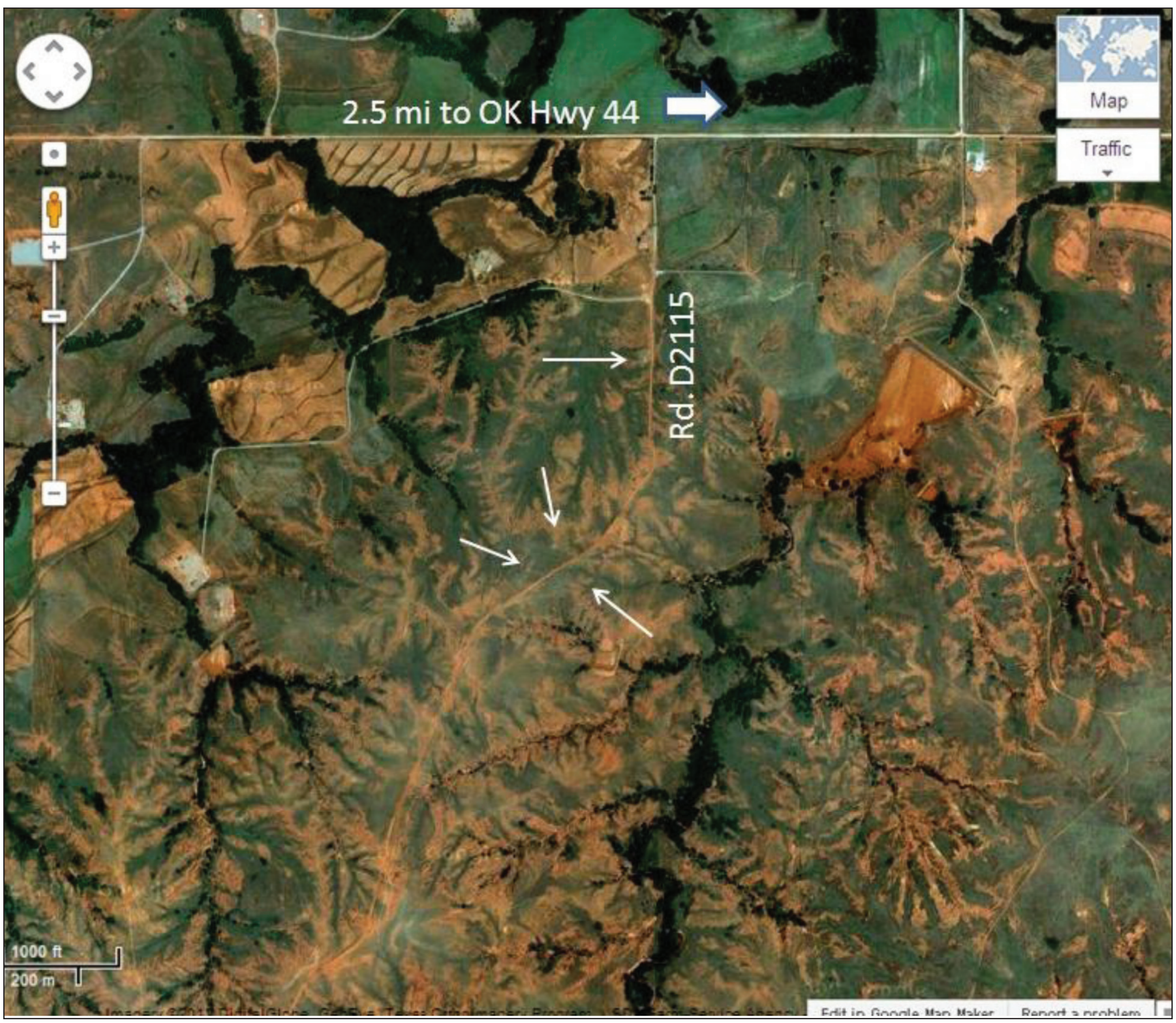

Figure 1. Google image of section 28 area (north to top) showing location of Cretaceous outliers discussed (three arrows in center of image). Also shown is a fourth outlier on the west side of the north-south segment of Rd. D2115. The town of Foss is 2.5 miles to the east and 2.8 miles to the south on OK Hwy. 4

been recognized in western Oklahoma. In fact, Fay and Hart (1978, p. 42) suggest that Jules Marcou – a French geologist working with the Pacific Railroad Expeditions of 1853, 1854, and 1855 – was the first person to recognize Lower Cretaceous strata in North America based on oyster fossils (*Texigryphaea navia*) he collected about 10 miles to the east-

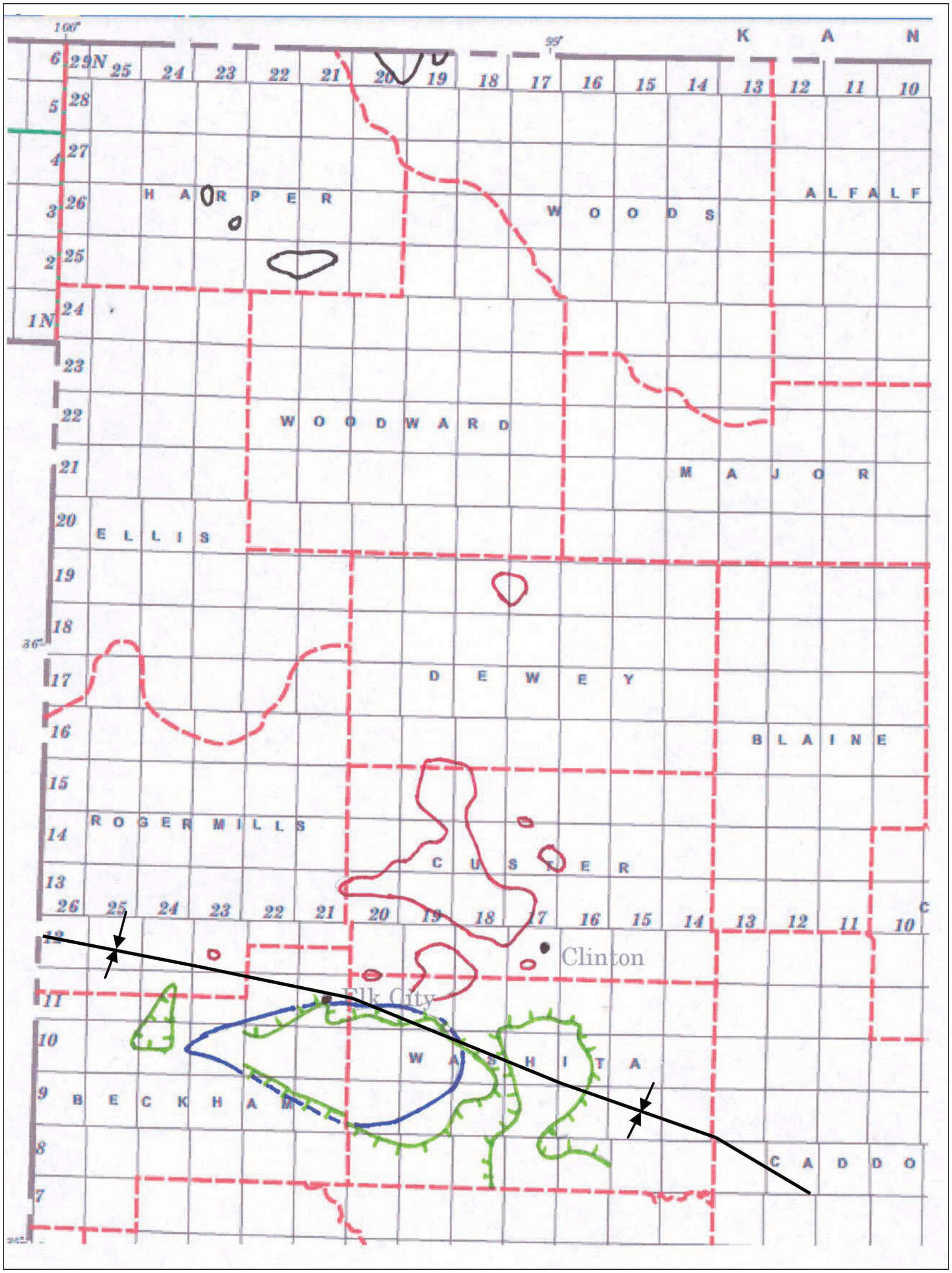

Figure 2. Map of northwestern and west-central Oklahoma showing location of in situ Cretaceous outcrops (black) in Woods and Harper Counties (Fay, 1965; Myers, 1959), areas of scattered Cretaceous outliers (collapsed blocks) (red) in Dewey, Custer, Washita, and Roger Mills Counties (Birchum, 1963; Stanley, 2002; Fay and Hart, 1978; Carr and Bergman, 1976; Pete Thurmond, 2003, pers. commun.), areas of disrupted bedding (green, hachures point toward areas of disrupted bedding) in Washita, Beckham, and Roger Mills Counties (Moussavi-Harami, 1977; Richardson, 1970; Smith, 1964; Meinert, 1961), and subsurface location of Yelton Salt (blue) in Washita and Beckham Counties (Johnson, 1963; Jordan and Vosburg, 1963).

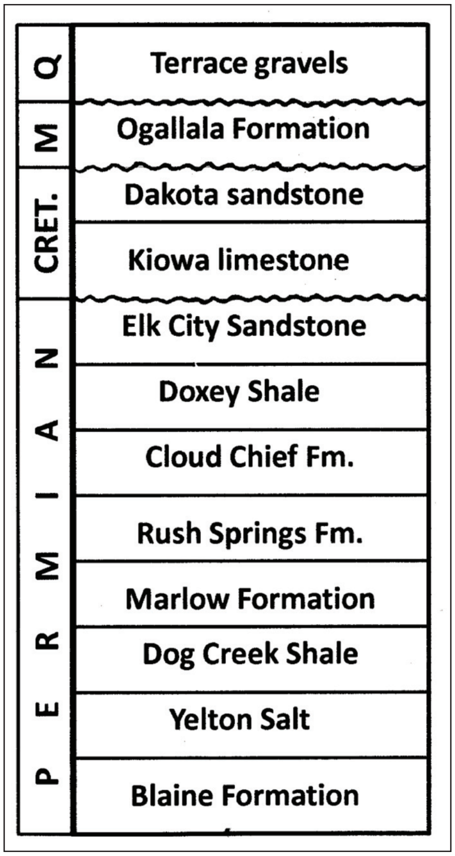

Figure 3. Stratigraphic column of upper part of Permian in western Oklahoma, Cretaceous units preserved in collapse structures, and Upper Cenozoic units that may be preserved in collapse structures. Kiowa limestone and Dakota sandstone are used informally and refer simply to the lithology of the collapsed blocks.

northeast of section 28. Bullard (1928, pl. I) identified three areas of Cretaceous outliers in western Oklahoma – the Supply area (near present-day Fort Supply), the Seiling – Cestos area, and the Butler – Foss area. Bullard (1928) noted that most of the Cretaceous rocks are "slumped" but that two outcrops – one in the Supply area and one along the Kansas border about eight miles east of the Cimarron River – were *in situ* and could be measured and studied (which he did). In addition, he noted that the "slumped" Cretaceous rocks included what he called a "*Gryphea* (sic) agglomerate" as well as sandstone and conglomerate. Bullard (1928) noted that one Cretaceous outcrop is a collapse feature, but suggested that most of the outliers were preserved in a north- to northwest-trending syncline oblique to the trend of the Anadarko Basin, an idea that has since been disproved.

Fay and Hart (1978, pl. 1) first referred to the outliers as collapse structures, although in the text they were less definitive. They suggested, "… perhaps the Cretaceous beds collapsed into sinkholes beneath Pleistocene rivers in the area" (p. 39). Johnson and others (1988) identified the outliers as "chaotic blocks and masses" that collapsed 160 feet to 320 feet into the surrounding Permian strata (Figure 3). Recent maps by the Oklahoma Geological Survey of the area to the north (Stanley and others, 2002; Stanley, 2002) clearly state that the Cretaceous outliers have collapsed into older formations.

Throughout much of central and western Washita County and eastern and central Beckham County, bedding in the Guadalupian-Ochoan Cloud Chief Formation, Doxey Shale, and Elk City Sandstone (Figure 3), which "should be" horizontal or subhorizontal, dips 5° – 10° or more. This "disrupted bedding" was first noted by Gould (1905, p. 72) who suggested it was "caused by the undermining of deep-seated rocks, probably some of the various gypsum members of the Greer" (now Cloud Chief Formation). Lovett (1960) suggested several mechanisms caused the disrupted bedding, including subsurface slumping, soil creep, anhydrite to gypsum expansion, and dissolution. Meinhert (1961, p. 43) suggested that gypsum dissolution played "a large role". Johnson (1963) noted that the area of non-disrupted bedding approximately followed the axis of the Anadarko Basin, but more importantly that it also occurred where the Yelton Salt was still present in the subsurface (Figure 2). (The Yelton Salt was named by Jordan and Vosburg (1963) who showed it to overlie the Blaine Formation, underlie the Dog Creek Shale (Figure 3), and to

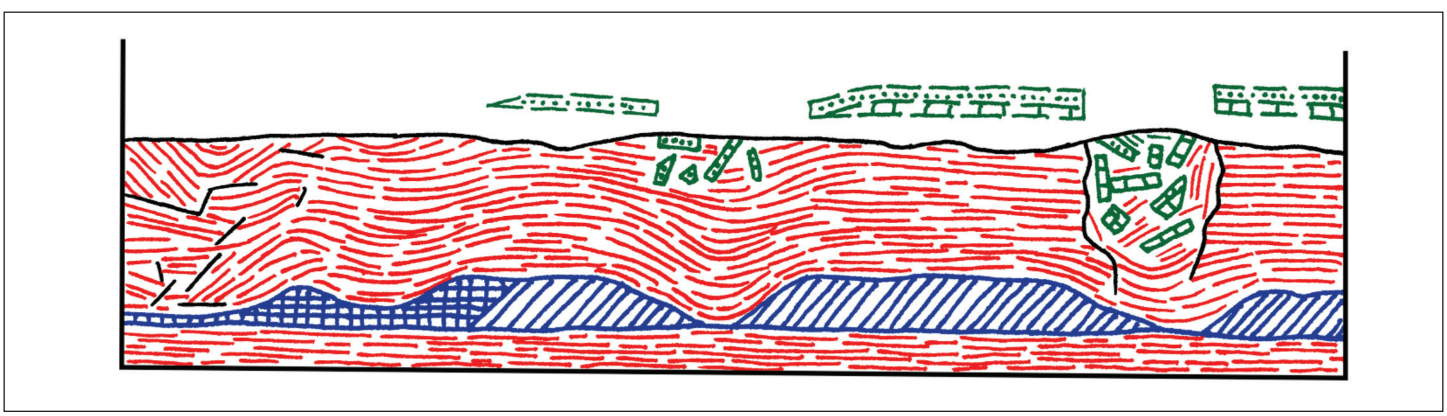

Figure 4. Sketch of probable mechanisms of collapse. Green – Dakota sandstone (dotted), Kiowa limestone (brick pattern). Eroded where shown above ground level. Red – Permian strata, undivided. Blue – salt (cross pattern, on left), gypsum (diagonal pattern, on right). On left – disrupted bedding (including minor faults and folds) above dissolved salt. In middle – blocks of Cretaceous strata in downwarped Permian strata. On right – blocks of Cretaceous strata in collapse "pipe" with either minor or no downwarping. Kiowa is shown as pinching out, but this is entirely conjectural. Overlying Ogallala Formation possibly preserved in collapse structures is not shown. Note: gypsum beds may be at any depth within the Permian.

be about 290 feet thick in the Elk City area.) Johnson (1963) concluded that the disrupted bedding observed at the surface was due to collapse in areas where the Yelton Salt had dissolved and that strata showed normal (zero or near zero) dips where the salt was still present (Figure 4). One subsequent study (Moussavi-Harami, 1977) showed an area of normal bedding six to 15 miles east of the easternmost extent of the Yelton Salt; disrupted / non-disrupted bedding in this area may be related to gypsum dissolution in the Cloud Chief Formation.

Section 28 Outcrops

(Note: The following description is based only on a brief visit I made to these outcrops in January, 2012, with Jack Smith (see Acknowledgements). They were impressive enough, and the origin and significance of them is interesting enough, that I decided they should be described in the Shale Shaker.)

Fay and Hart (1978, pl. 1) mapped the section 28 outcrops as outliers of Dakota Group (unnamed lower sandstone) (herein called Dakota sandstone, as described above) surrounded by Doxey Shale. There are three separate outcrops in the south half of section 28 within easy walking distance of each other (Figure 1); there is a fourth outcrop immediately west of the road in the north half of the section that will not be discussed here.

The largest Cretaceous outcrop forms a low, but distinct hill on the southeast side of the road (Figure 5). (Many of the outliers in western Oklahoma occur on topographic highs because they are more resistant to erosion than the surrounding Permian strata.) Several large blocks of well-stratified and locally cross-stratified coarse-grained sandstone crop out on the hill (Figure 6). All the blocks are highly tilted and show dips greater than 50^{o}, although dips are not in the same direction. Significantly, petrified wood and dinosaur(?) bones are present in the float on the hill. The high tilts are not the result of surface slumping, rather, they likely reflect the positions of the sandstone blocks in the collapse feature (Figure 4).

A second outcrop that also caps a low hill

Figure 5. Dakota(?) sandstone outcrop forming small hill on southeast side of Road D2115. Note large blocks of steeply dipping sandstone.

is present on the northwest side of the road. Although mapped as Dakota, this outcrop consists mostly of large blocks of the "*Gryphaea* agglomerate" of Bullard (1928) (Figure 7). However, small pieces of sandstone (Dakota?) are present, as are rare pieces of petrified wood.

The third outcrop (westernmost of three) is very poorly preserved.

Significance and Future Studies

Cretaceous outliers such as those described here, in addition to others in Washita, Custer, Roger Mills, and Dewey Counties afford the opportunity to more fully understand several aspects of the post-Permian geology of western Oklahoma.

1. Collapse structures as evidenced by disrupted bedding are clearly related to dissolution of the Yelton Salt and possibly younger gypsum beds in Washita and Beckham Counties (Johnson, 1963; Moussavi-Harami, 1977), but the origin of the Cretaceous outliers as collapse structures is unknown. Outliers identified as collapse structures only occur within the Rush Springs or younger formations, therefore, it is possible, but unproved, that dissolution of gypsum beds in the lower part of the Cloud Chief or underlying Rush Springs Sandstone has caused collapse of overlying beds.

2. Was collapse abrupt or did it occur over years or even centuries, and what kind of field evidence would contribute to answering this question?

3. In a recent paper in the Shale Shaker, Mulvany (2011) described a collapse structure in the Mesozoic of the Dry

Figure 6. Highly tilted Dakota(?) sandstone. This block is not tilted in the same direction as other blocks in the outcrop.

Cimarron Valley of northeastern New Mexico and described a zonation of the structure – outer ring dike, inner breccia, central plug. Do the Cretaceous outliers of western Oklahoma show any structural zonation and, if so, what is the origin of the zonation? Are the outliers accompanied by disrupted bedding, or are they "pipes" with abrupt margins (Figure 4)?

4. Fay and Hart (1978) show some outliers as Kiowa limestone and others as Dakota sandstone. Some of these are misidentified (e.g., section 28 outcrop, described above) and others contain both units. Are units other than the Kiowa and Dakota present and is there any systematic areal distribution of the units present in the outliers?

5. The Western Interior Seaway extended across most of western Oklahoma, and much of the evidence for it resides in the Cretaceous outliers discussed in this report. However, few attempts have been made to document the facies changes in the Kiowa limestone from where it occurs *in situ* (140 feet thick on Avila Hill, Comanche County, Kansas, near the Oklahoma – Kansas border (Fay, 1965); 52 feet thick northeast of Ft. Supply (Myers, 1959)) through the area of collapse structures. Most of the Kiowa at Avila Hill consists of shale, but very little shale has been identified in the outliers. Is the shale present but poorly exposed? Has the shale disappeared through facies changes? Or has the shale been removed via some mechanism during collapse?

6. Facies changes within the Dakota sandstone from *in situ* outcrop to the outliers have not been studied. Such studies could lend support (or disprove) Johnson and others' (1988) assertion

Figure 7. "Gryphaea agglomerate" of Bullard (1928). Typical example of most of the limestone blocks in the southern part of Custer County. Blocks such as this inspired the title of this report.

that post-Cretaceous pre-Miocene uplift occurred across the area, removing some of the Cretaceous. An alternative hypothesis is that the area remained high and that the Cretaceous strata were never as thick as to the north and south.

7. Lovett (1960) and Smith (1964) identified collapse structures filled with Pleistocene or younger deposits. To date, the Ogallala Formation has not been identified as fill material although, admittedly, it would be difficult to distinguish the Ogallala from more recent terrace gravels. Identification of the Ogallala to the east of its present outcrop would help clarify how far it originally extended.

Acknowledgements

I would like to thank local historian/archaeologist Jack Smith of Oklahoma City for reintroducing me to some of the geology of Custer County. Jack is retracing the Beale Wagon Road which passed near many of the Cretaceous outliers discussed in this report. I would also like to thank reviewers Ken Johnson and Tom Stanley of the Oklahoma Geological Survey and Robert Scott of the University of Tulsa. Much of Ken's professional career has been dedicated towards understanding the stratigraphy of western Oklahoma and, in particular, karst-related features. Tom is principal author of several recent 1:100,000-scale geologic maps of western Oklahoma. And Robert has long worked on Cretaceous chronostratigraphic and sequence stratigraphic problems in southern Oklahoma and worldwide.

References Cited

Birchum, J.M., 1963, Areal geology of northwestern Dewey County, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, 33p.

Bullard, F.M., 1928, Lower Cretaceous of western Oklahoma: Oklahoma Geological Survey Bulletin 47, 116p.

Carr, J.E., and Bergman, D.L., 1976, Reconnaissance of the water resources of the Clinton Quadrangle, west-central Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 5, sheet 1, scale 1:250,000.

Fay, R.O., 1965, Geology and mineral resources of Woods County, Oklahoma: Oklahoma Geological Survey Bulletin 106, 189p.

Fay, R.O., and Hart, D.L., Jr., 1978, Geology and mineral resources (exclusive of petroleum) of Custer County, Oklahoma: Oklahoma Geological Survey Bulletin 114, 88p.

Gould, C.N., 1905, Geology and water resources of Oklahoma: U.S. Geological Survey Water-Supply and Irrigation Paper 148, 178p.

Johnson, K.S., 1963, Salt in the El Reno Group (Permian), Elk City area, Beckham and Washita Counties, Oklahoma, in Proceedings of the Eighth Biennial Geological Symposium, western Oklahoma and adjacent Texas, held at the University of Oklahoma, May 5 – 6, 1963: Norman, Oklahoma, p. 79 – 92.

Johnson, K.S., Amsden, T.W., Denison, R.E., Dutton, S.P., Goldstein, A.G., Rascoe, Bailey, Jr., Sutherland, P.K., and Thompson, D.M., 1988, Geology of the southern Midcontinent, in Sloss, L.L., ed., Sedimentary cover – North American craton, U.S.: Geological Society of America, The Geology of North America, v. D-2, p. 307-359.

Jordan, Louise, and Vosburg, D.L., 1963, Permian salt and associated evaporites in the Anadarko Basin of the western Oklahoma – Texas Panhandle region: Oklahoma Geological Survey Bulletin 102, 76p.

Lovett, F.D., 1960, Areal geology of the Quartermaster area, Roger Mills and Ellis Counties, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, 81p.

Meinert, J.G., 1961, Areal geology of the Starvation Creek area, Roger Mills and Beckham Counties, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, 66p.

Moussavi-Harami, Meza, 1977, Areal geology of Cordell area, central Washita County, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, Oklahoma, 76p.

Mulvany, P.S., 2011, Geology of a well-exposed clastic plug in the Dry Cimarron Valley, northeastern Union County, New Mexico: Shale Shaker, v. 61, p. 355-364.

Myers, A.J., 1959, Geology of Harper County, Oklahoma: Oklahoma Geological Survey Bulletin 80, 108p.

Richardson, J.L., 1970, Areal geology of western Washita County, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, Oklahoma, 67p.

Smith, A.H., 1964, Areal geology of Elk City area, Beckham and Roger Mills Counties, Oklahoma: unpub. M.S. thesis, University of Oklahoma, Norman, 64p.

Stanley, T.M., 2002, Geologic map of the Woodward 30' x 60' Quadrangle, Ellis, Dewey, Roger Mills, and Woodward Counties, Oklahoma: Oklahoma Geological Survey Quadrangle OGQ-40, 1 sheet, scale 1:100,000. http://www.ogs.ou.edu/StatemapOGQ/OGQ-40_Woodward_100K.pdf

Stanley, T.M., Miller, G.W., and Suneson, N.H., 2002, Geologic map of the Fairview 30' x 60' Quadrangle, Alfalfa, Blaine, Dewey, Garfield, Kingfisher, Major, Woods, and Woodward Counties, Oklahoma: Oklahoma Geological Survey Quadrangle OGQ-41, 1 sheet, scale 1:100,000. http://www.ogs.ou.edu/StatemapOGQ/OGQ-41_Fairview_100K.pdf

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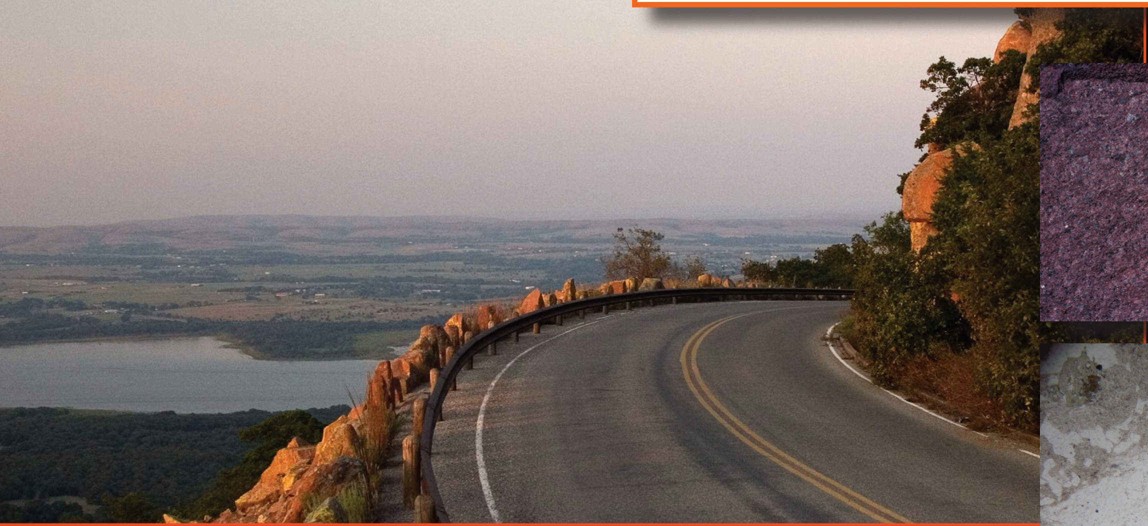
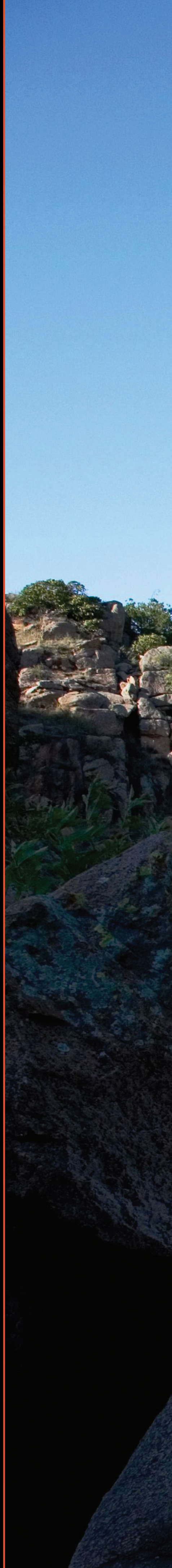
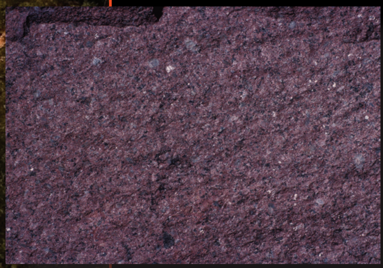
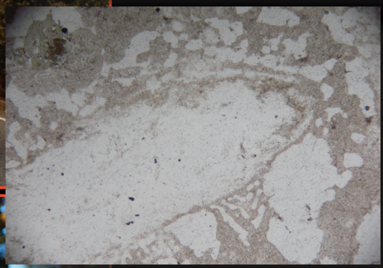
Biographical Sketch

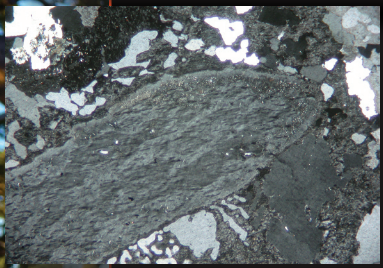
Neil Suneson has worked for the Oklahoma Geological Survey since 1986. His first major project with the Survey was mapping part of the frontal belt of the Ouachita Mountains and the very southern part of the Arkoma Basin, and many of his current interests focus on that part of Oklahoma. Prior to coming to Oklahoma he worked for Chevron USA as a development geologist in the San Joaquin Basin. He graduated from Amherst College in 1972, received his M.S. in geology from Arizona State University in 1976, and Ph.D. in geology from the University of California – Santa Barbara in 1980.

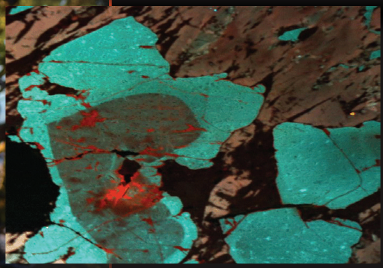


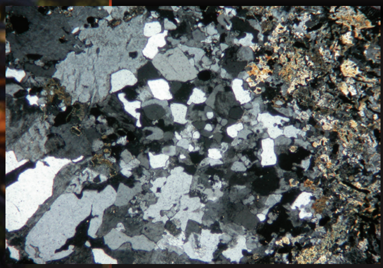












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