STATE OF ARKANSAS

ARKANSAS GEOLOGICAL SURVEY
BEKKI WHITE, STATE GEOLOGIST AND DIRECTOR

GUIDEBOOK 2016-1

Fayetteville Shale Field Trip, North-Central Arkansas

by

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Edited by

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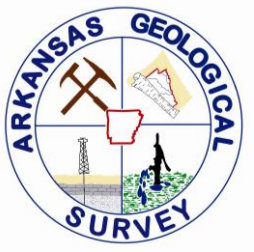

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Preface

This guidebook is adapted from the guidebook for the Fayetteville Shale field trip in north and central Arkansas on March 30, 2008 during the Geological Society of America (GSA) south-central section meeting in Hot Springs, Arkansas. The Fayetteville Shale Play has been the focus of a regional shale-gas exploration and development program within the central and eastern Arkoma Basin of Arkansas since 2004 (Figure 1). As of year-end 2015, cumulative production of gas from the Fayetteville Shale has totaled approximately 6.6 Tcf from 5,875 wells. Most Fayetteville Shale wells are drilled horizontally and fracture stimulated using slickwater or cross-linked gel fluids. Fayetteville Shale gas production generally ranges between depths of 1,500 to 6,500 feet. The thickness of the Fayetteville Shale varies from 50 feet in the western portion of the Arkoma Basin of Arkansas (fairway area) to 550 feet in the central and eastern regions (primary producing area). Due to a regional southern dip, the Fayetteville Shale crops out north of the producing area. In light of the privacy of personal properties, stops at Granny Mountain shale pit and Panther Mountain are not examined in the guidebook. Three field stops are included herein to characterize the stratigraphic section of the Fayetteville Shale (Figure 2). Studying these outcrops provides a better understanding of the geologic characteristics of their subsurface counterparts. The results of previous studies have been used to make the geologic interpretations of the exposures described in this guidebook.

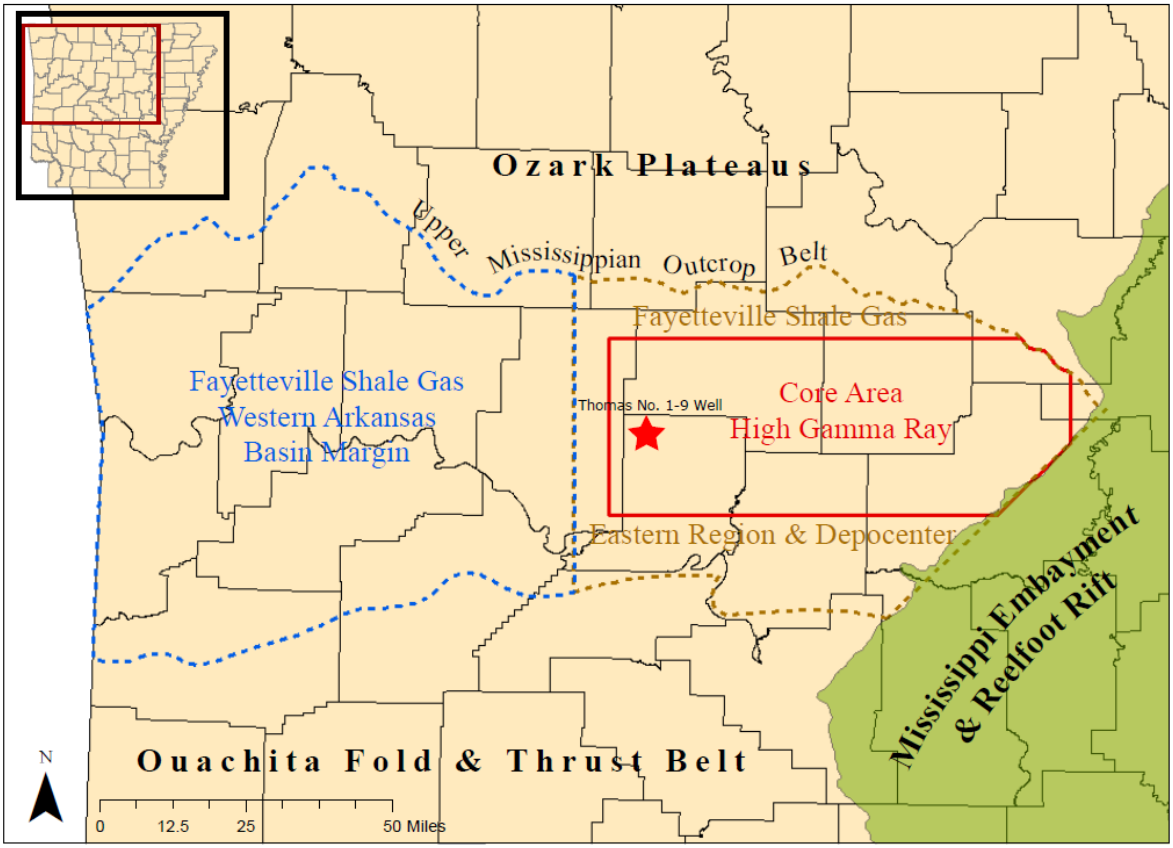

Figure 1. Primary area of the Fayetteville Shale exploration and development in Arkansas.

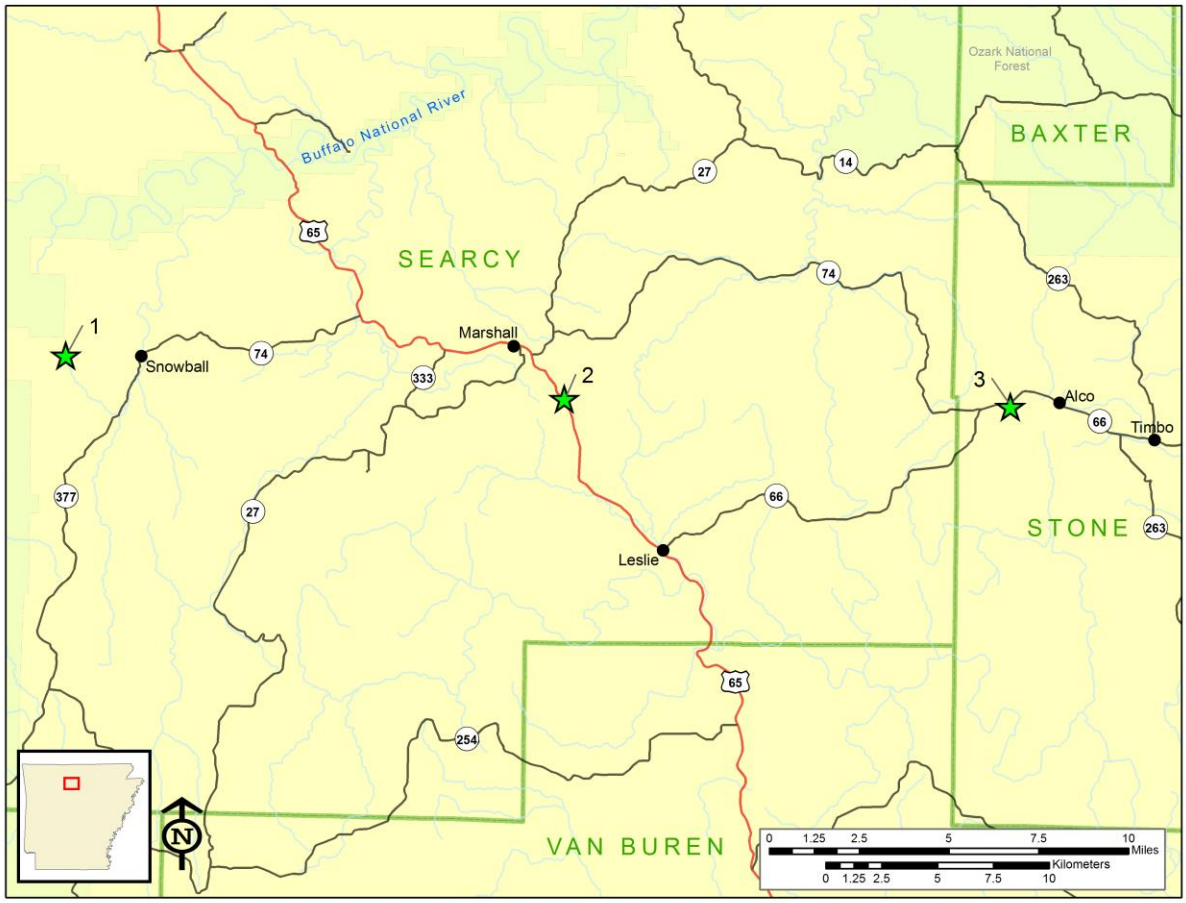

Figure 2. Index map of the field trip area. Green stars indicate stops.

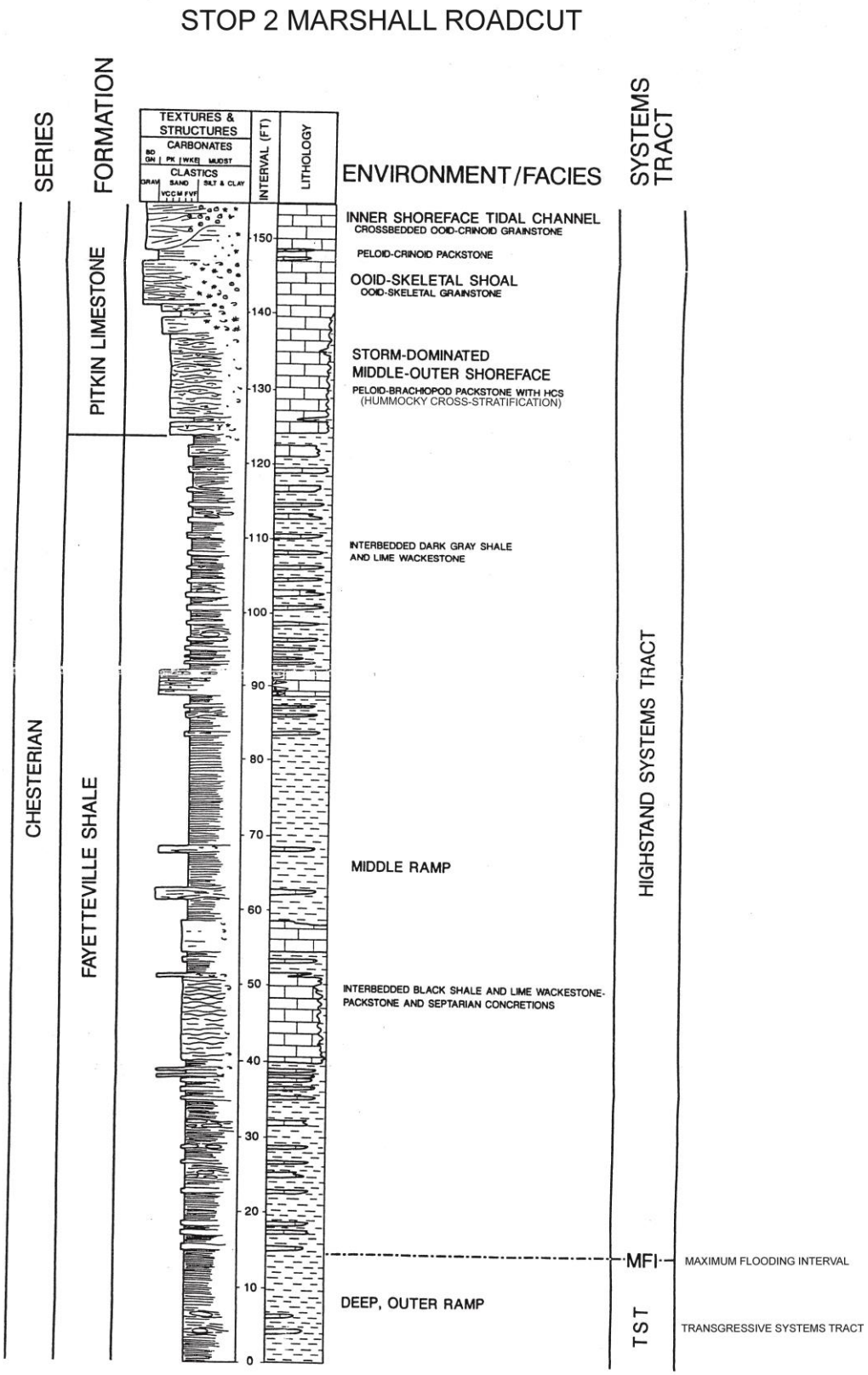

Figure 3. Stratigraphic column for Stop 2. Modified from Handford and Manger (1993).

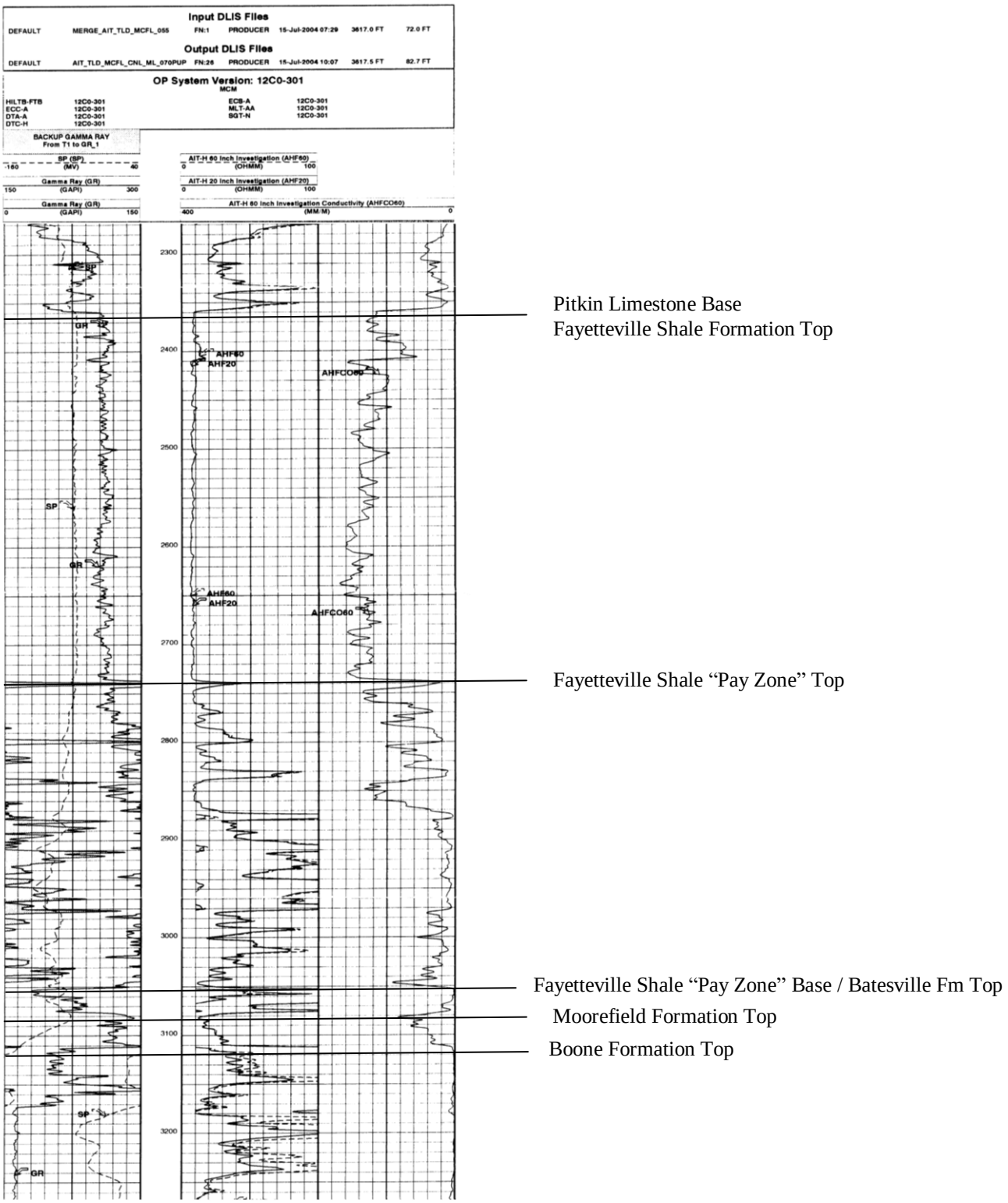

Figure 4. Typical well log response in the Fayetteville Shale, Thomas No. 1-9 discovery well located in Conway County (shown in Figure 1). Modified from Ratchford et al. (2006).

Road Log -- Fayetteville Shale Field Trip

Begin in Snowball, AR.

Turn Right (north) at the intersection of Hwy 74 and Hwy 377 and then take an immediate left (west) onto an unimproved dirt road called Point Peter Road.

Continue traveling west on this dirt road to the Point Peter shale pit as shown on the map.

Stop 1 – The shale pit contains a partially exposed section of the lower Fayetteville Shale.

This part of the stratigraphic succession is interpreted as corresponding to the "pay zone" associated with Fayetteville Shale gas wells located to the south (Figure 4). The outcrop exposure consists of black, fissile shale and siliceous, organic-rich shale. Total organic carbon (TOC) values of 3.14% and 3.70% with vitrinite reflectance (R_o) of 1.23% and 1.16%, respectively, are measured (Jordan et al., 2010). Note that several exposures display two to three joint sets demonstrating the siliceous character of the lower Fayetteville sequence. The joint sets illustrate that this part of the sequence would likely respond favorably to hydraulic stimulation in the subsurface.

A poorly understood sequence of interbedded sandstone, siltstone, and claystone of the Batesville Formation are exposed approximately 150 feet to the south of the pit wall and on the other side of a grove of pine trees. The basal Fayetteville Shale overlies a ravinement surface (transgressive surface of erosion) present on top of the clean, quartzose Batesville Sandstone with accompanying fossils (e.g. brachiopods).

Stop 1. Lower Fayetteville sequence at the Point Peter shale pit. Note thin-bedded and fissile character of the organic-rich shale.

Stop 1. Two distinct joint sets are visible within the lower Fayetteville Shale sequence, Point Peter shale pit.

Return to vehicles and travel east on the unimproved dirt road back to the Snowball community.

Turn Left (east) onto Hwy 74 and continue to the Hwy 65 intersection (Note that the outcrop at this intersection is the Mississippian Boone Formation).

Turn Right (south) onto Hwy 65. We are now driving down section and fresh roadcuts in the Boone are visible along west of Marshall.

Continue south on Hwy 65 to the Marshall roadcut located 8 miles south of Marshall on the west side of Highway 65.

Stop 2 – This roadcut exposes a thick succession of upper Fayetteville Shale and lower Pitkin Limestone. More than 120 feet of Fayetteville Shale is exposed here. The limestone to shale ratio increases upward through the formation and into the overlying Pitkin Limestone.

The upper Fayetteville sequence in this roadcut consists of a cyclic repetition of black, organic-rich shale and light-gray, tan-weathered micrite. Septarian concretions are present along the lower part of the outcrop and are generally confined to the micrite beds. Most micrite beds are about 0.5 ft. thick. Note that a strong petroliferous odor is detectable on freshly broken micrite. Also note the light-gray, bioclastic and oolitic packstone debris from the overlying Pitkin Limestone.

Handford (1986) and Handford and Manger (1990, 1993) studied this particular roadcut and concluded that deposition of the organic-rich shale and muddy limestone (micrite) are consistent with a moderately deep, muddy, and anoxic shelf environment. They also concluded that deposition of the upper Fayetteville sequence is consistent with a highstand system tract as shown on the stratigraphic column (Figure 3).

Stop 2. Upper Fayetteville Shale sequence along the Hwy 65 roadcut south of Marshall. Note medium- to thick-bedded, tan-weathered micrite interbedded with black, fissile organic shale.

Stop 2. Note massive character of interbedded micritic units in comparison to the fissile shale units. (Upper Fayetteville Shale sequence, Marshall roadcut).

Jordan et al. (2010) analyzed the geochemistry of this roadcut. TOC values range from 0.89 to 3.41% in the upper Fayetteville Shale sequence and are generally higher in the organic-rich mudstones associated with high gammy

Stop 2. Upper Fayetteville Shale sequence along the Hwy 65 roadcut south of Marshall with truck for scale. Note Pitkin Limestone at top above orange markers.

ray values (over 200 API units). R_o values range from 0.96% to 1.00% which are less than those in the lower Fayetteville Shale at the Point Peter shale pit. The thermal maturity varies systematically with depth in the sequence.

Return to vehicles and continue south on Hwy 65 to Hwy 66 at Leslie.

Turn Left (east) onto Hwy 66 and travel through the town of Leslie.

Continue eastbound on Hwy 66 and turn off the right side (south) of the highway shoulder to examine the roadcut.

Stop 3 – The Alco roadcut exposes the uppermost portion of the Fayetteville Shale and the lowermost portion of the Pitkin Limestone. Note the conspicuous depositional slump blocks near the base of the outcrop that demonstrate angular discordance with respect to the overlying bedding. Spreng (1967) studied this exposure and suggested the slump blocks were transported from north to south. The limestone to shale ratio increases from the base of the outcrop to the top. The upper Fayetteville consists of an interbedded succession of shale, micrite, and chert, whereas the lower Pitkin consists of interbedded shale, micrite, and bioclastic and oolitic packstone. More chert is present at this location compared to the Marshall roadcut. Note the bioclastic Pitkin debris at the base of the outcrop. This roadcut has been described in detail by Handford (1986), Handford and Manger (1990, 1993) and Jordan et al. (2010).

Stop 3. This photo illustrates a submarine slide block in the Upper Fayetteville sequence at the base of the outcrop. Photo is taken at the Alco roadcut along Highway 66.

Return to vehicles and proceed west on Hwy 66 to Leslie.

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Notes