Journal of the Arkansas Academy of Science

Volume 19 Article 17

1965

Shale-Limestone Alteration in the Upper Portion of the Fayetteville Formation Near Marshall, Arkansas

W. Bruce Saunders

SHALE-LIMESTONE ALTERNATION IN THE UPPER PORTION OF THE FAYETTEVILLE FORMATION NEAR MARSHALL, ARKANSAS

W. Bruce Saunders[1]
University of Arkansas

INTRODUCTION

The Fayetteville Formation is extensively exposed near Marshall, Arkansas, where it includes two distinct portions; a lower black shale unit, and an upper unit of alternating shale and limestone. A study of the upper portion of the outcrop was made in the Fall of 1964, which involved field work and laboratory investigations.[2] Field work included measuring, collecting, and describing the rocks of the exposure. Laboratory investigation involved more detailed examination of the rock units by means of the binocular microscope, and, in the case of selected rock samples, the use of the petrographic microscope. The detailed examination of the Marshall exposure was undertaken for the purpose of providing information concerning the environment of deposition of the upper portion of the Fayetteville Formation.

STRATIGRAPHY

The Fayetteville Formation, of late Mississippian age, was named and described for exposures near Fayetteville by Simonds (1891, p. 42-48). In this area, the formation contains three mappable units:

1. a lower black shale,
2. a middle tan, quartz sandstone known as the Wedington Sandstone Member,
3. an upper black shale unit.

In the Marshall area, the Fayetteville Formation is made up of two distinct portions; a lower portion, composed of concretionary, calcareous, black shale, and an upper portion, composed of alternating beds of concretionary, calcareous, dark-grey shale and limestone.

Sections of the Fayetteville Formation similar in appearance to the Marshall outcrop also occur at Alco, Stone County, 15 miles east of Marshall; at Mountain View, Stone County, 28 miles east of Marshall; and at Bragg's Mountain, Muskogee County, Oklahoma, 120 miles west of Marshall. Similar sections are also known to occur elsewhere

[1]Department of Geology.

[2]Professor R. H. Konig, University of Arkansas, assisted greatly in laboratory investigations and in the editing of this manuscript. Professor James H. Quinn, University of Arkansas, also provided helpful suggestions for the final preparation of this paper.

in northeastern Arkansas. This report is restricted to the examination of the exposure at Marshall, however, the similarity of alternation in the other exposures indicates similar environments of deposition.

The exposure examined extends more or less continuously for 1400 feet along the northeast side of State Highway 65. Bedding in the outcrop dips one-half to two degrees to the northwest. Due to dip, and to the orientation of the roadcut, a total thickness of 115 feet of upper Fayetteville strata is exposed.

LITHOLOGY

The most striking feature of the Marshall exposure is the uniform alternation of shale and limestone layers. (Plate 1).

Shale is similar in appearance from the bottom to the top of the exposure, but differs markedly in carbonate content (21% carbonate by weight in the lower-most shale unit increasing gradually to 46% in the upper shale units). The shale is silty throughout the section. Shale composes 69 per cent of the measured portion of the outcrop, and is more abundant in the lower half of the section than in the upper half.

Four additional kinds of rock occur in the measured section. These include lithographic limestone; sparsely fossiliferous, fine-grained limestone; oolitic, phosphatic, bioclastic calcarenite; and pellet phosphorite.

Lithographic limestone is present in the exposure as a continuous unit approximately 13.5 feet thick. On a fresh surface, the rock is dark brown, somewhat waxy in appearance, and displays sub-conchoidal fracture. Microscopic examination discloses unoriented, irregularly shaped calcite grains making up the majority of the rock. Most of the calcite grains are less than .0089mm in diameter, although some larger grains (averaging 0.045mm in diameter) are also present. Impurities, including iron oxide, pyrite, and quartz occur as accessory constituents. The quartz grains are strongly angular in outline.

Dense, sparsely fossiliferous, fine-grained limestone is the most abundant of the carbonate rocks, and it represents approximately 18 percent of the measured section. This type of rock makes up all of the more uniformly alternating limestone units. These limestones are essentially identical from the top to the bottom of the exposure. They differ only in that some beds contain more pyrite, fossils, or color banding than others. The color banding consists of occasional dark brown bands in otherwise dark grey rock, and is probably caused by concentrations of iron oxide, and/or organic material. Fossils, mostly brachiopods and pelecypods, contained in the rock provide little evidence of having been abraded or fragmented. The fossils are filled with rock material essentially identical to the enclosing matrix. Many of the shells have been partially replaced by pyrite. Most of the fossils are oriented with their long axes parallel to bedding planes.

Plate 1. Shale-limestone alternation in the upper portion of the Fayetteville Formation along State Highway 65 near Marshall, Arkansas. Photograph by courtesy of H. F. Garner, University of Arkansas.

Limestone lentils and lenticular calcareous concretions, which appear to be completely enclosed within the shale, are composed of fine grained limestone. Some of the calcareous concretions are fossiliferous. The uncrushed living chamber of an orthoconic nautiloid, **Rayonnoceras,** approximately five inches in diameter was found oriented horizontally in a calcareous concretion. The preservation of the **Rayonnoceras** indicates that the concretions formed soon after deposition, and before compaction, of the enclosing sediment.

Oolitic, bioclastic, phosphatic limestone is scarce in the section; an aggregate thickness of only a few feet of this type of rock was observed. The thickest phosphatic limestone unit is only six inches thick, whereas most units are less than four inches thick. On a weathered surface, most of these units display well developed fissility.

The lower portion of several of the phosphatic limestone beds contains rounded pebbles averaging 10mm in diameter. These pebbles were apparently derived from an indurated, fossiliferous, silty limestone.

Many of the fossils in the phosphatic limestone units have been broken into fragments, but complete shells of gastropods and pelecypods are abundant. The shells are filled with a reddish-brown, fine-grained, fossiliferous sediment similar in texture and color to the rounded pebbles contained in the lower portions of these units. In some places, fragments of shells retain fine-grained sediment on the concave surface, apparently indicating transportation of the fossils after their initial deposition. Thus, fossils filled with a sparsely fossiliferous, non-oolitic sediment are enclosed in oolitic, highly fossiliferous limestone which is different in texture and color.

One orthoconic nautiloid 25mm long was observed, oriented with its long axis and apical end pointing downward, perpendicular to bedding. The long axis of some ooliths and fossil fragments are arranged around the shell so as to indicate "drag" apparently caused by downward penetration of the shell into what was evidently an unconsolidated lime mud or ooze (Fig. 1).

Minerals identified in the phosphatic limestone, besides calcite, include quartz, pyrite, hematite, and phosphatic material (collophane). The phosphatic material is contained in ooliths, in fossil fragments, and as disseminated grains scattered throughout the rock. Phosphate averages approximately 20 percent of these rocks by volume. Individually, ooliths average approximately 2mm in diameter, and vary in shape from spherical to ellipsoidal. Many ooliths are concentrically banded about distinct nuclei of undetermined composition.

The only other type of rock identified is a unit two feet thick which may be called a pellet phosphorite. It is extremely fissile, black, and not calcareous. In thin section, angular fragments of detrital material, including scattered quartz grains and fossil fragments are identifiable. Ooliths compose approximately 10 percent of the rock. Approximately 50 percent of the rock consists of rounded pellet-like masses. These pellets may be of organic origin; they are of various shapes and sizes, and display indistinct boundaries. The ooliths and pellets are richly phosphatic.

SUMMARY

Initial examination of the Fayetteville age rocks at Marshall indicated that the limestone-shale units in the upper portion of the Fayetteville Formation are the product of cyclic changes in the depositional environment. Closer examination, however, indicates the complexity of the alternation involved. This is demonstrated by the presence in the exposure of lithographic limestone; fine-grained limestone; oolitic, phosphatic, bioclastic, limestone; and pellet phosphorite (Figure 1).

A marine environment suitable for the formation of oolitic and pellet phosphorites is considered to be one of shallow water with gentle agitation. The source of the phosphate is not entirely clear. It may be of organic origin, since it is definitely associated with fossil shells and pellets, or some of the phosphate may have been derived by precipitation from sea water. The precipitated phosphate could then replace shells, ooliths, and pellets.

The presence of lithographic limestone is also considered to indicate a shallow, protected, marine environment at the time of deposition (Carozzi, 1960 p. 211). The lithographic limestone at Marshall is very uniform in texture, color, and composition, and is probably the result of chemical precipitation. The remarkably low content of clastic material, such as quartz, in the lithographic limestone as well as in some of the other types of rock indicates an area of deposition not subject to contamination with such material. This would generally require isolation from products of continental erosion, including wind blown silts and stream transported sands and silts.

In retrospect, both the phosphorite and the lithographic limestone probably required a sheltered, shallow, depositional environment for their formation. The environmental situation which could have provided such a setting cannot be definitely inferred from the examination of one rock exposure. However, Quinn (1959, p. 33) states that the upper portion of the Fayetteville Formation becomes greatly thickened and calcareous along a line extending from Fort Douglas to Batesville, Arkansas, and suggests that the thickened part represents a large east-west trending reef which was as much as 200 feet high at the end of Fayetteville time. Such a reef could have produced shallow, sheltered, lagoonal environments within the reef proper, or landward to it. The lithologic nature of the rocks in the exposure at Marshall appear to conform to such a theory.

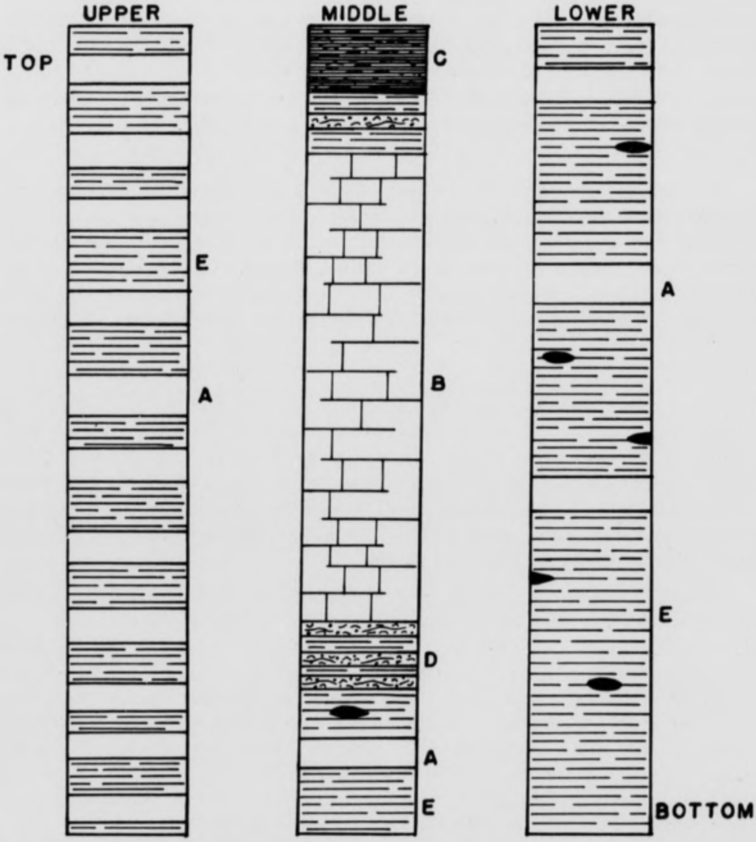

Figure 1. Schematic diagram of the upper portion of the Fayetteville Formation near Marshall, Arkansas, showing relative position of different lithologic units; A — fine-grained limestone; B — lithographic limestone; C — pellet phosphorite; D — oolitic, phosphatic, bioclastic limestone; E — calcareous grey-black shale, concretionary in places.

BIBLIOGRAPHY

Carozzi, A. V. (1960) Microscopic Sedimentary Petrography, 485 pp. J. Wily and Sons, New York.

Simonds, F. W. (1891) The Geology of Washington County, Arkansas. Arkansas Geological Survey Annual Report, Vol. 4.

Quinn, J. H. (1959) Buried Structures of the Boston Mountains. Regional Guide Book, First Regional Field Conference, Fort Smith Geological Society, pp. 29-46.