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The Calico Rock Sandstone Member of the Everton Formation (Ordovician), Northern Arkansas

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ABSTRACT

Surface and subsurface stratigraphic studies in northeastern Arkansas show the Calico Rock Sandstone (Middle Ordovician) to be a lobate sand body up to 200 ft thick. The environment of deposition is considered from a study of grain characteristics, ripple marks, subjacent and superjacent units and unpublished isopachous maps. The data indicate the Calico Rock Sandstone formed in a transgressing Everton sea as a barrier island and nearshore sand complex. The quartz sand was derived from a northern source and was distributed by southwestward flowing longshore currents.

INTRODUCTION

The Calico Rock Sandstone is a St. Peter-like sandstone member of the Everton Formation (Fig. 1) which is up to 200 ft thick. It is exposed extensively in Izard and adjacent counties in northeastern Arkansas, and is present in several wells in the subsurface on the south. Westernmost exposures of the Calico Rock Sandstone are on the Buffalo River in southeast Marion County. Eastward from Marion County the sandstone is present along the tributaries of the White River and from there it extends northward to Viola, Fulton County, Arkansas. Inasmuch as the Calico Rock Sandstone is of high porosity and permeability, petroleum geologists may find this sandstone to be a potential reservoir for oil and gas in the subsurface of Arkansas.

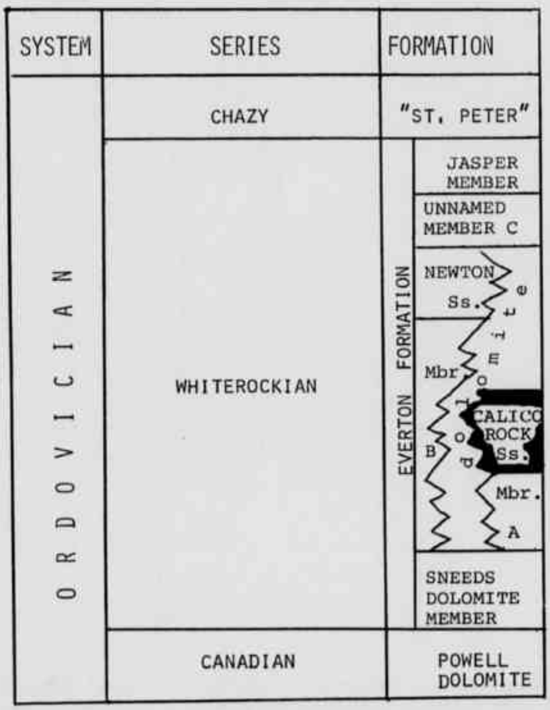

Figure 1. Age and stratigraphic position of Calico Rock Sandstone in Everton Formation of northern Arkansas.

The detrital fraction of the Calico Rock contains more than 95% quartz. Where the sandstone is silica cemented, it is composed of frosted to transparent, angular to subrounded quartz grains which commonly have secondary crystal overgrowths. The quartz grains are of fine to medium size and are well sorted (Fig. 2). Because of the overall paucity of cement, however, the beds of sandstone are friable and characterized by porosity in the range of 30-40% (Giles, 1930). Where beds of the Calico Rock Sandstone are calcareous, the well-sorted, medium-size grains of quartz are frosted and rounded to well rounded. Very calcareous beds may contain admixtures of oolites and calcilutite intraclasts.

The sand grains show extraordinary roundness which possibly was acquired by eolian action. That such sand passed through a desert eolian stage at one time before incorporation in the marine environment has been suggested by Dake (1921) and more recently by Kuenen (1959, p. 23). Additional corroborating evidence for an eolian transition comes from the bimodal texture of some of the Calico Rock sand (Fig. 2, nos. 1, 2; histograms of Giles, 1930, p. 122-125). According to Folk (1968), bimodality is attributed to the action of wind in desert areas. Undoubtedly the sand is marine, but the preserved size distribution was created in an eolian environment. Further, the absence of shale and significant clay fraction in the sandstone of the Calico Rock may be related to eolian winnowing as suggested by Pettijohn et al. (1972, p. 225).

The Calico Rock Sandstone is laminated, cross bedded, and ripple marked. Numerous ripple mark fields in the outcrop belt on the Salem Plateau allow paleogeographic reconstruction.

DEPOSITIONAL ENVIRONMENT

The environment of deposition for the Calico Rock Sandstone was deduced from an examination of (1) internal characteristics such as grain size and sedimentary structures, (2) the rock types and depositional environments of the overlying and underlying rock units and (3) the overall geometry and thickness relations of the Calico Rock sand body (from unpublished maps).

The aforementioned data suggest that most of the Calico Rock Sandstone probably accumulated in a barrier island-strandplain system. Minor amounts of sand were deposited on the shallow marine shelf. Sand from the Calico Rock barrier was washed and blown seaward into the shelf environment or even into the lagoonal environment depending on wind direction. The dune sand of the Calico Rock barrier complex, however, is not preserved. Characteristic high-angle dune cross bedding has not been observed in outcrops of the Calico Rock Sandstone. Evidently, the slow but inevitable sea level rise accompanying the Everton transgression reworked and modified some barrier island characteristics.

Internal Characteristics. Statistical data for the grain size of the Calico Rock Sandstone from several localities in the outcrop belt were taken from Giles (1930) and used to make a contour plot of zones of coarseness (Fig. 3). Two linear zones of coarse sand are illustrated and probaby correspond to the high-energy shoreface environment of the barrier. Areas where the finer fraction is indicated may signify an inter-barrier environment. The trends suggest longshore transport of sand from the north and northeast.

Ripple marks are abundant on the upper surface of most layers of the Calico Rock Sandstone (Fig. 4). Ripple mark fields, some in excess of 90,000 sq yd, are extensive in Izard County, Arkansas. Symmetrical ripple marks are the most common type, hence the orientation of their crests should be parallel with the shore and consequently useful in paleogeographic reconstruction. Six ripple mark fields were studied in the outcrop belt (Table I). Rose diagram plots for stations 1, 2 and 3 (Fig. 5) show trends similar to those of zones of coarse-grained sand illustrated in Figure 3. Stations 4, 5 and 6, however, deviate from this pattern. This is understandable as Kukal (1971, p. 221) found that 10% of ripples form at a right angle to the shoreline and about 27% are diagonal to it; 63% of ripples form parallel with the shoreline. The paleogeographic significance of ripples, therefore, is important but deviations can be expected.

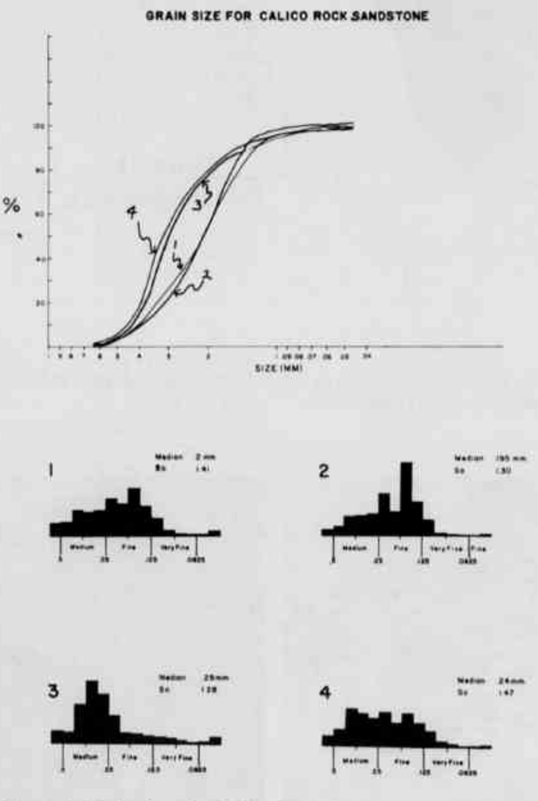

Figure 2. Grain sizes for Calico Rock Sandstone illustrated by cummulative curves and histograms. Trask's sorting coefficient indicated by So. Sample 1 from Sugarloaf Mt., Stone County; Sample 2 from Calico Rock, Izard County; Samples 3 and 4 from ripple mark fields 1 and 6, respectively (see Fig. 5).

Vertical Sequence. The Calico Rock Sandstone conformably to unconformably overlies interbedded limestone and sandstone referred to as Member A by Suhm (1974). The limestone of Member A is calcarenite with symmetrical and asymmetrical (quiet water) oolites, quartz grains and calcilutite intraclasts. Bedded calcilutite is locally stromatolitic with algal heads and oncolites. Thin to medium beds of calcareous to siliceous sandstone are interbedded with the limestone. Scour and fill structures and convolute bedding are seen in places. The sedimentary structures, lithologic character and stromatolites (see Ginsburg, 1960) of Member A represent deposition in an extensive shallow water environment such as a lagoon.

Conformably overlying the Calico Rock Sandstone, in contrast, is a thick sequence of medium and fine-medium crystalline dolomite interbedded in minor amounts with dolomitic sandstone. The crystalline dolomite is assumed to have originated by late secondary dolomitization of limestone. Some lithologic characteristics, as well as the lateral persistence of the strata in this interval, seem to indicate deposition in the shallow subtidal marine environment.

Therefore, because laterally migrating environments are reflected in lithologic transition (Walther, 1894), and because rock units underlying and overlying the Calico Rock Sandstone were found to be lagoonal and offshore, respectively, the Calico Rock Sandstone apparently accumulated in a barrier island environment (see Suhm, 1974, Fig. 15, p. 699).

SOURCE AREA

The source area for the sand of the Calico Rock Sandstone (from data contained herein and unpublished isopachous maps) must have been a delta-river system on the north, perhaps in Missouri. The river system could have traversed the Ozark Dome or the Canadian Shield or both. Dake (1921) suggested that the quartz sand was derived from the shield and that the sand was transported southward across a desert-like area (see introductory comments) and then incorporated into a transgressing sea such as the Everton sea. Also, Cambrian sandstone exposed and eroded at a position peripheral to the shield added sand to points southward (Dapples, 1955; Lamar, 1928; Potter and Pryor, 1961; Theil, 1935). The fact that the sand of the Calico Rock, as well as that of younger sandstone units, coarsens on the north in Missouri and Illinois also seems to indicate a source in that direction (Giles, 1930, p. 42-43).

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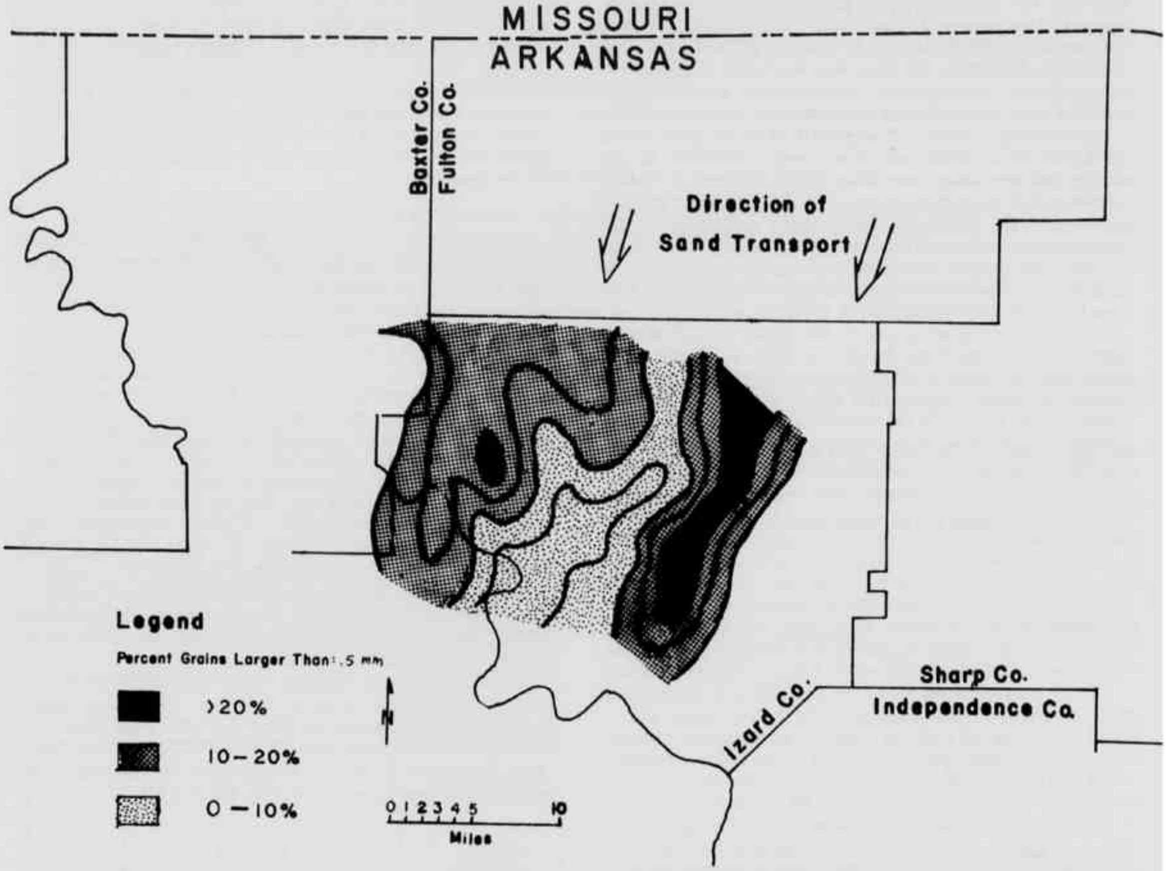

Figure 3. Map showing percentage of grains larger than 0.5 mm from 35 sampling stations in upper half of Calico Rock Sandstone. Trends may represent reworked barrier or beach ridge sand. Size analyses from Giles (1930).

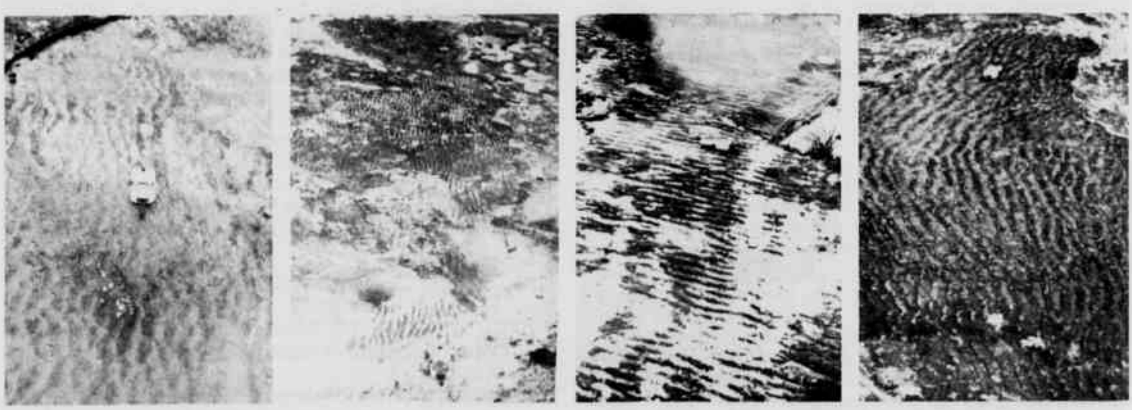

Figure 4. Portions of four different ripple-marked fields in Calico Rock Sandstone Member, Izark County, Arkansas.

Table I. Ripple mark fields in Calico Rock Sandstone.

Locality	Position in Calico Rock Sandstone	No. Measurements	Remarks
1. Approximately ½ mi N of Naked Joe Knob on E side of Ark. State Hwy 5, N½, Sec. 35, T18N, R12W.	Upper half	17	Wave length from 1" to 3", average about 2". Symmetrical. Cross-bedding common.
2. Approximately 5 mi NW of Calico Rock, Ark., on NE side of Ark. State Hwy 5, W½, SE¼, Sec. 4, T17N, R11W.	Upper half	83	Wave length from ½" to 4¼", average about 2¼". Wave height from 3/8" to ½". Most ripples symmetrical. Interference ripples seen. Cross-bedding common.
3. Approximately 1 mi N of Calico Rock, Ark., on N side of Ark. State Hwy 5, NW¼, Sec. 15, T17N, R11W.	Upper half	81	Wave length from ¾" to 5", average about 2". Wave height about ½". Most symmetrical but asymmetrical dip to north. Cross-bedding common.
4. One half mile S of Pineville, Ark., on E side of highway, N½, SE¼, Sec. 1, T17N, R11W.	Upper half	82	Wave length from ¾" to 2", average about 1¼". Most symmetrical but interference and asymmetrical dipping to N or E also seen.
5. One mile W of Forty Four, Ark., on N side of Ark. State Hwy 56, NW¼, Sec. 8, T17N, R10W.	Upper half	65	Wave length from 1" to 5", average about 1¾". Wave height about ½". Symmetrical.
6. Approximately 1 mi W of Band Mill, Ark., on N side of Ark. State Hwy 56, SW¼, Sec. 7, T17N, R9W.	Upper half	59	Wave length average about 1½". Symmetrical. Cross-bedding seen in middle of Calico Rock Sand stone as well as upper part.

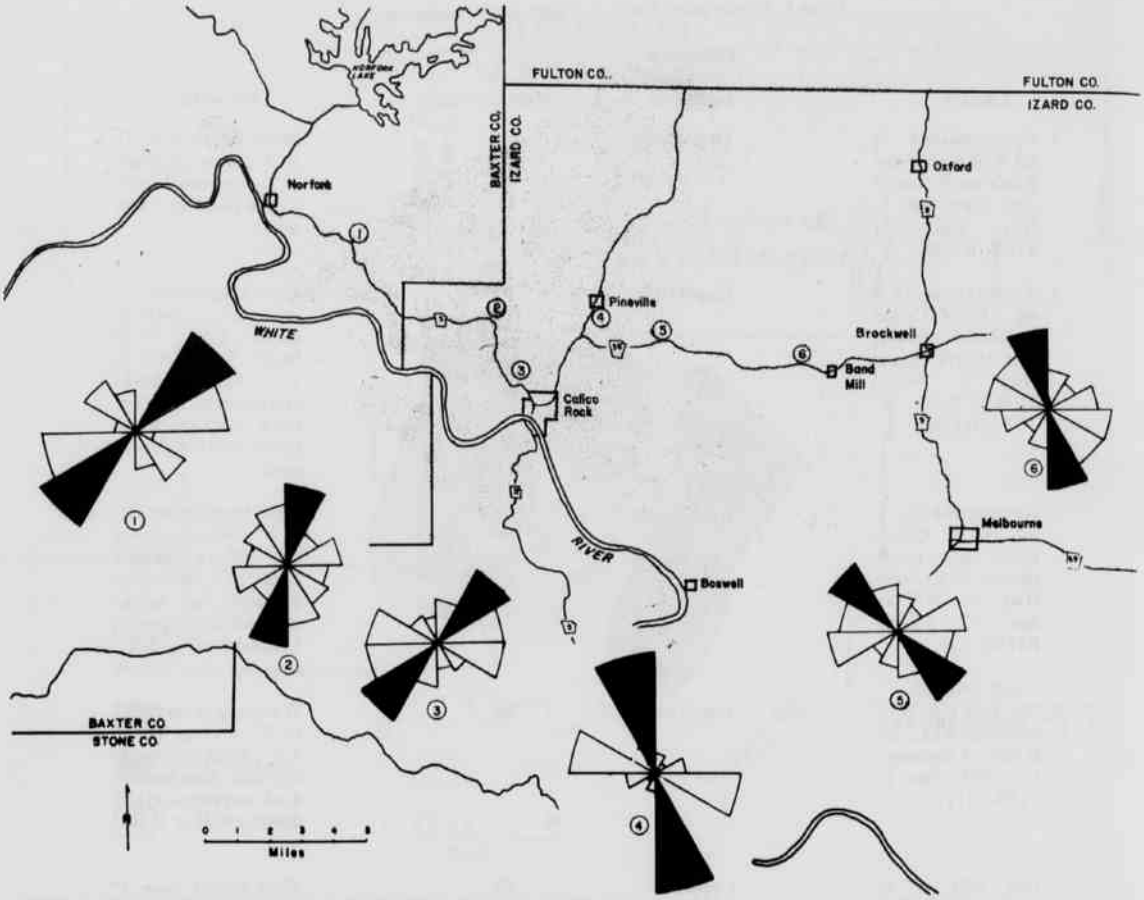

Figure 5. Rose diagrams of ripple mark directions from six ripple-marked fields in Calico Rock Sandstone outcrop belt (shaded). Specific localities of fields and number of measurements for ripple marks are indicated in Table I.

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