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Early Cementation of the Short Creek Oolite Member, Boone Formation (Osagean, Lower Mississippian), Northern Arkansas

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Running Title: Early Cementation of Short Creek Oolite

Abstract

The Short Creek Oolite is the only formally named member of the Boone Formation in northern Arkansas. It lacks bedding features, and oolith concentrations that would suggest a shoal environment, and it occurs at variable stratigraphic horizons within the upper Boone Formation consistent with episodic deposition as grain-flow slurries. As with modern oolite examples, such as Joulters Cays, Bahamas, the Short Creek preserves numerous intraclasts, and at least one large olistolith indicating an early cementation history.

Introduction

The Short Creek oolite was proposed as a member of the Boone Formation (Osagean, Lower Mississippian) for exposures along the stream of that name heading in Newton County, Kansas, and flowing westward into the Spring River in Cherokee County, Kansas (Smith and Siebenthal 1907). Those authors described the interval as a persistent, massive, homogeneous bed of concentric ooliths that was 20.3-45.7 cm (8-18 in) thick. The unit was identified in a number of sections in southwestern Missouri, particularly quarries in the vicinity of Springfield, Greene County, and Joplin, Newton County, where it thickens to 0.61-2.4 m (2-8 ft) (Spreng 1961). It is the only formally named member of the Boone Formation recognized in Arkansas with only sporadic occurrences, but reaching a maximum thickness of 7.6 m (25 ft) at War Eagle Quarry (Lisle 1983) (Fig. 1).

Deposition of the Short Creek in northern Arkansas is somewhat problematic. The concentration of ooliths is lower than would be expected for a shoal, typically less than 50% of the grain volume (Lisle

Fig. 1. Short Creek Oolite exposed in the abandoned War Eagle Quarry, on the south side of U.S. Highway 412, accessible on a road just east of the bridge over War Eagle Creek between Old Alabam and Harmony, Madison County, Arkansas. Upper Boone exhibits sharp, planar contacts above and below a 7.6 m (25 ft) interval of Short Creek Oolite (white arrows). This locality was studied by Lisle (1983).

1983), while non-oolith grains, mostly crinozoan ossicles and columnals, comprise as much as 25% (Fig. 2). Lime mud matrix and calcite cement may contribute as much as 75% in some intervals (Lisle 1983). Bedding is planar, and there is no obvious evidence of a high energy regime, particularly a lack of exposures with tabular cross-bedding (Fig. 1). Contacts of the oolitic interval with the adjacent upper Boone strata are sharp and the interbedded limestone-chert succession above and below those contacts is identical (Fig. 1). It seems more probable that these ooliths were transported down-ramp as periodic grain-flow slurries derived from shoal areas that probably developed sporadically as Upper Mississippian sea level fell during the Kaskaskia II regression (Witzke and Bunker 1996). There are far more exposures of the upper Boone Formation in Arkansas that have no oolite development compared with those that do contain the member.

Early Cementation History

Rip-up Clasts and Intraclasts

Although apparently unattributed, the term *rip-up clast* is applied to flat, mud clasts that have been stripped by currents from semiconsolidated mud deposits and transported to a new location (Neuendorf et al. 2011). *Intraclasts* were defined by Folk (1959) as a component of limestones, representing torn-up and reworked fragments of poorly cemented, penecontemporaneous sediments deposited within the same basin as their origin. Oolite deposits commonly produce intraclasts because: 1) they are deposited in shallow water and can be exposed either by tidal change, or brief drops in sea level; 2) the original aragonitic composition is easily dissolved and redeposited as cement by rain and interstitial water. Major et al. (1996) reported that some cored intervals taken through the modern oolite shoal developed at Joulters Cays, north end of Andros Island, Bahamas, comprised as much as 30% intraclasts (Fig. 3).

Figure 10. Intraclasts in a cemented layer recovered from core B3 at a depth of 2.4 m (7.9 ft) (scale bar = 2 cm). This intraclast zone occurs at the base of the well sorted ooid sand facies just above the poorly sorted ooid sand facies.

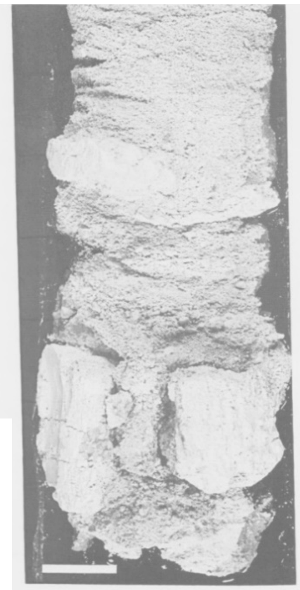

Figure 11. Mud layers recovered from near top of a buried interval of poorly sorted ooid sand facies in core D3 at a depth of 1.5m (4.9 ft)(scale bar = 2 cm).

Fig. 3. Intraclasts and cemented mud layers in poorly sorted oolitic sands, Joulters Cays, Bahamas (Figs 10 & 11 reprinted with permission from Major et al. 1996)

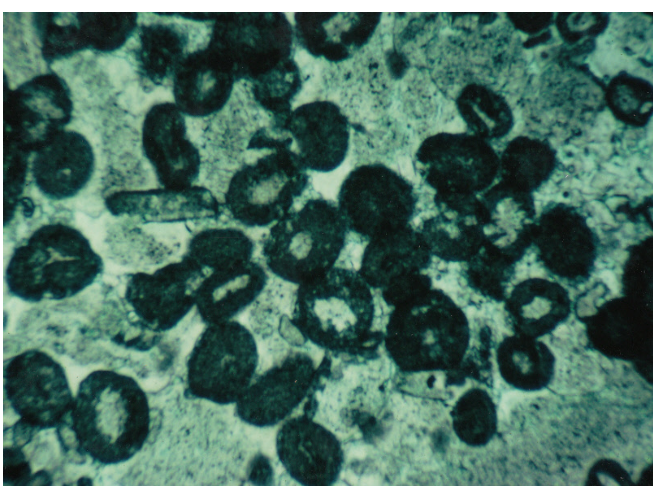

Fig. 2. Photomicrograph of Short Creek Oolite from War Eagle Locality. Clouded grains are crinozoan ossicles and columnals; light areas are calcite spar.

Many exposures of the Short Creek Oolite encountered across the northern Arkansas outcrop belt contain intraclasts similar to those reported by Major et al. (1996) (Fig. 4).

Olistoliths

Flores (1955) proposed the term *olistolith* for large exotic blocks transported by submarine gravity sliding or slumping within the host deposit. Braden and Ausbrooks (2003) described a massive oolite block at least 23 m. (76 ft) long and nearly 4.6 m. (15 ft) high encased within the Short Creek Oolite (Fig. 5). The juxta-position of a large block of well-cemented oolite preserved as an olistolith within a similar oolitic interval is further confirmation of the susceptibility of this lithology to early cementation**.**

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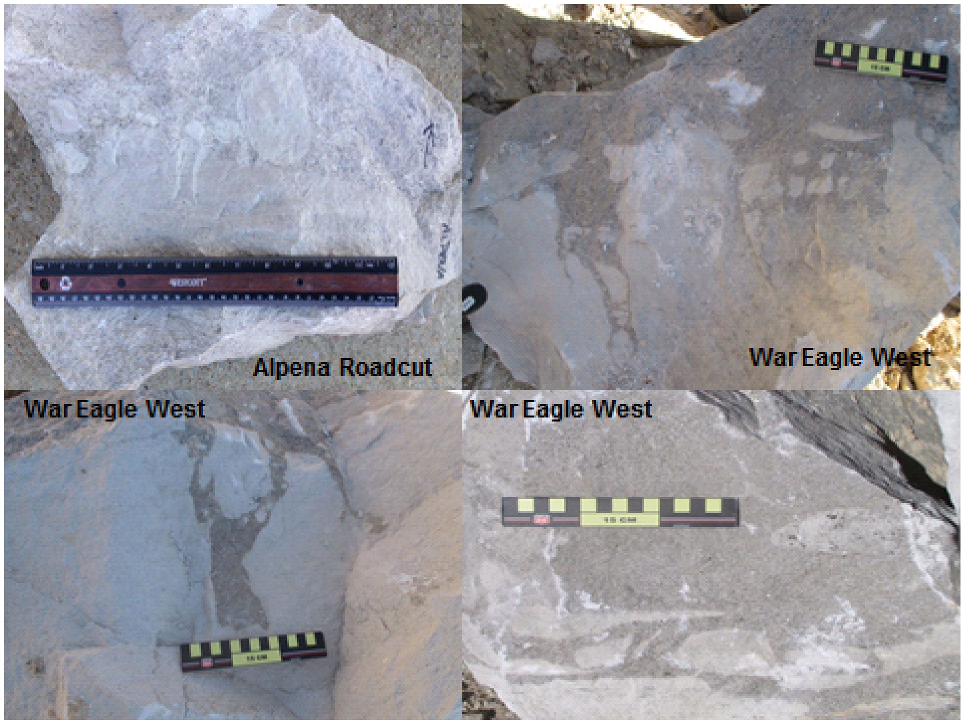

Fig. 4. Intraclasts of Short Creek Oolite incorporated into a matrix of Short Creek Oolite; Alpena Roadcut - Ark 412 just west of Alpena, Carroll County; War Eagle West - temporary quarry operation, now abandoned, on north side of Ark 412, west of junction with Ark 23 (principal scale divisions in centimeters).

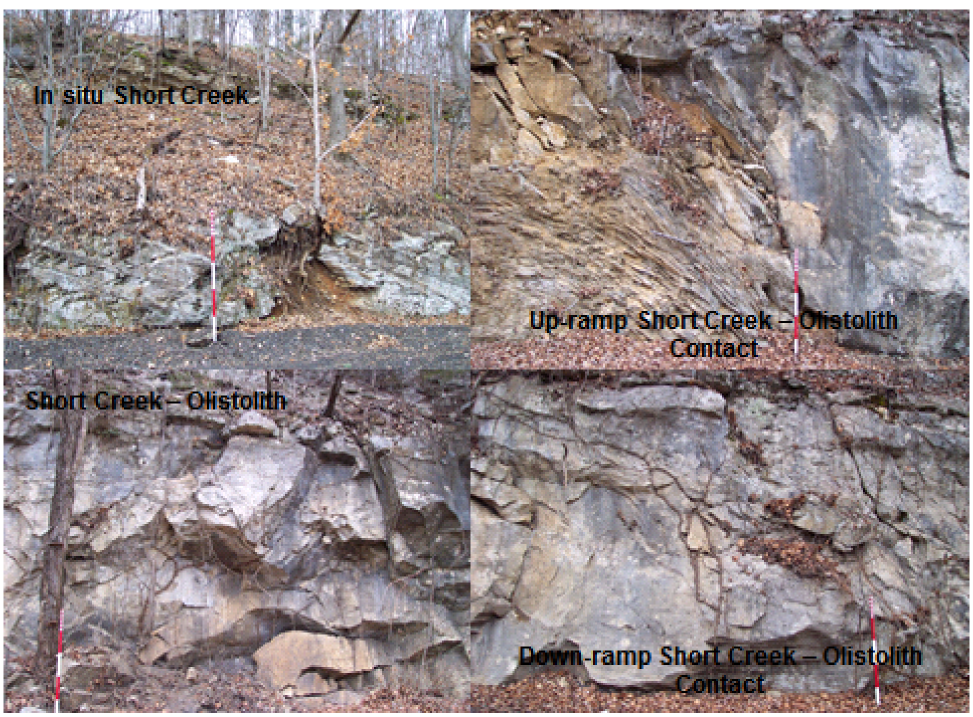

Fig. 5. Views of the Short Creek Olistolith in the Parthenon Quadrangle, Newton County, Arkansas (Braden and Ausbrooks, 2003) (scale divisions in feet).

Conclusions

Intraclasts are common in the modern oolite shoal environment on Joulters Cay, Bahamas. There, solution of carbonate by meteoric water is reprecipitated as cement lithifying surface crusts during periodic exposure of the oolite. These crusts are broken, transported and concentrated in low areas on the shoal by periodic storms, after which they become buried by continued formation of unconsolidated oolite. The Short Creek does not exhibit typical oolite shoal features, such as tabular cross-bedding, but the same process effecting Joulters Cay likely occurred during Short Creek deposition, producing intraclasts that could be transported and redeposited by grain-flow slurries. Cementation of large areas produced blocks - olistoliths - that were moved down-slope, perhaps by early shelf instability reflecting local fault movements, and became buried by unconsolidated oolite transported there also by grain-flow slurries.

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