The Critters are Innocent! Organic Matter Preservation in the Bakken Formation, North Dakota - A Function of Primary Production and Proximality to the Shoreline, not Bioturbation

Sven Egenhoff [1] and Neil Fishman [2]
[1]Geosciences, Colorado State University, Fort Collins, CO.
[2]US Geological Survey, Denver, CO.

Bioturbation is considered one of the key elements to enhance degradation/consumption of organic matter in sediments, including black shales. The Bakken Formation, a prolific reservoir in the Williston Basin, North Dakota, contrasts with current models insofar as high total organic carbon (TOC) contents remain even in black shales where bioturbation is ubiquitous.

The Bakken Formation represents an epeiric ramp system with a siltstone-dominated shoreface and shelf facies (middle sandstone member) that grades distally into black shales, represented by the lower and upper shale members. Bioturbation increases down-ramp from non-bioturbated shallow shelf deposits over completely homogenized wacke- and siltstones at the interface between light-colored well-oxygenated shelf sediments to organic-rich black shales. Within the black shales, the most proximal facies consists of highly bioturbated mudstones (TOC of 8.25-9.83%), grading distally into laminated, slightly bioturbated mudstones (TOC of 7.85-8.52%) with non-bioturbated radiolarites (3.41-5.87%) occurring in the deepest part of the basin.

Using established models for black shale deposition, the transition of light-colored shelf sediments into black shales should mark the boundary between the oxygenated shallow (low TOC) and "anoxic" deep (high TOC) parts of the basin. However, from this study, the transition of low- to high-TOC sediment in the Bakken occurs in the absence of a significant difference in the intensity of bioturbation. More astonishing, the highest TOC values occur in the proximal black shale facies in which bioturbation is most intense, while both bioturbation and TOC contents drop distally. It is therefore likely that the present TOC values in the shales still reflect original organic production in the water column with its maximum closer to the basin margin and its minimum at the center. The amount of preservation of organic material is controlled by the degree of consumption by organisms living at the sea bottom and within the sediment. While bioturbating, organic-consuming organisms must have flourished in shelf sediments, the black shale facies may have hosted a smaller, less diverse community of bioturbating organisms resulting in more organic preservation. The sharp contact between high- and low-TOC sediments may therefore not reflect an anoxic-oxic boundary but rather the influence of different communities of organisms on the sediment, destroying or preserving organic matter.