Stevensite, Oolite, and Microbialites in the Eocene Green River Formation, Sanpete Valley, Uinta Basin, Utah*

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Abstract

Stevensite has been reported as a clay mineral in lacustrine carbonate successions commonly associated with hydrocarbon reservoirs of the pre-salt Aptian South Atlantic conjugate basins of Brazil, and is problematic in that it compromises reservoir porosity. Stevensite is an authigenic clay mineral, a Mg smectite, indicative of lacustrine saline-alkaline depositional environments. It has been reported from the Eocene Green River Formation in both the Uinta (Utah) and Green River (Wyoming) Basins. In the Uinta Basin (Sanpete Valley), it occurs in the same section with calcareous claystone, shale, tuff, oolite, and microbialites. Stevensite is variously described as forming or composing "pellets" or ooids and has been referred to as "coffee-ground beds". Grains are 1-2 mm in size, irregularly shaped, and commonly concentrically laminated. However, they are absent from the carbonate oolite facies in the upper half of the section.

Although various studies have noted and described the presence of stevensite, none has provided details of its depositional environment. Our preliminary study of successions in the Sanpete Valley, Utah, provides insights that contribute to a better understanding of stevensite deposition as well as the oolites and associated microbialites in the succession. The succession represents an overall shallowing upward sequence, with profundal claystones and shales dominating the lower half of the section and littoral oolite and microbialites the upper half of the section. The microbialites are nearly always associated with oolite and best developed in meter-thick, oolite beds that are ripple-cross laminated. Stevensite occurs in the lower half, in beds 1-25 cm thick, associated with shales and claystones. The exact origin of the stevensite grains is still the subject of further study. However, the facies association of the stevensite with shales and claystones suggests quiet water, profundal depositional conditions. This is contrary to the high-energy conditions suggested by the "oolite" interpretation for stevensite grains.

References Cited


Possible applications to the South Atlantic conjugate basins pre-salt lacustrine systems

1. Lacustrine or marine?
2. High or low energy?
3. Fresh or saline?
4. Shallow or deep?
5. Stevensite: “ooids”, authigenic pellets, or what?
Sanpete Valley

Ephraim

3 km
Basinal Scale

Lithostratigraphy

From Smith, et. al., 2008, Synoptic reconstruction of a major ancient lake system: Eocene Green River Formation, western United StatesGSA Bulletin; January/February 2008; v. 120; no. 1/2; p. 54–84
Location of Measured Sections

- Upper Member
- Lower Member
Outcrop study
Oolite
Oolite Petrology
Oolites and microbialites in upper member
Microbialite

Travertine or tufa -like
Microbialites
Microbialite Petrology
Stevensite—“Coffee Grounds”
Stevensite- “Coffee Grounds”

\[(\text{Mg}_{2.44}\text{Al}_{0.07}\text{Fe}^{+0.03})\text{Si}_{4.13}\text{O}_{10}(\text{OH})_2\]

1. Stevensite: a clay mineral in lacustrine successions commonly associated with hydrocarbon reservoirs of the pre-salt Aptian South Atlantic conjugate basins of Brazil
2. Of probable authigenic origin
3. Occurs in the Eocene Green River Formation in both the Uinta (Utah) and Green River (Wyoming) Basins
4. Described by Faulk (1948) as “coffee ground beds”
5. Occurs as “ooids” in Sanpete Valley Green River Formation; 1-2 mm dia, up to 5 mm; matrix of sparry calcite, micrite.
6. Indicative of lacustrine saline-alkaline, high silica & magnesium chemistry (occurs in evaporate facies Wilkins Peak Member)
7. It occurs in the same section with micritic mudstone, laminated dolomicrite, tuff, oolite, and microbialites.
Stevensite “Coffee”
Stevensite “Coffee Grounds”
Stevensite Petrology
Stevensite Petrology
Conclusions

1. This preliminary study provides insights that contribute to both a better understanding of stevensite deposition as well as the oolites and associated microbialites in the succession.

2. The succession represents an overall shallowing upward sequence, with profundal claystones and laminated micrite dominating the lower half of the section and littoral oolite and microbialites the upper half of the section.
Conclusions, continued

1. The exact origin of the stevensite grains is still the subject of further study.

2. However, several lines of evidence suggest that the stevensite ooids are authigenic: high silica, high Mg, high pH (high alkalinity). Carbonate ooids precipitate when calcium is abundant.

3. It is not clear that high energy conditions are involved, however many stevensite ooids are eroded.