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

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MacGinitie, H.D., 1969, The Eocene Green River flora of northwestern Colorado and northeastern Utah: University of California Press, Berkeley, 202 p.

Smith, M.E., A.R. Carroll, and B.S. Singer, 2008, Synoptic reconstruction of a major ancient lake system: Eocene Green River Formation, western United States: GSA Bulletin, v. 120/1/2, p. 54-84.

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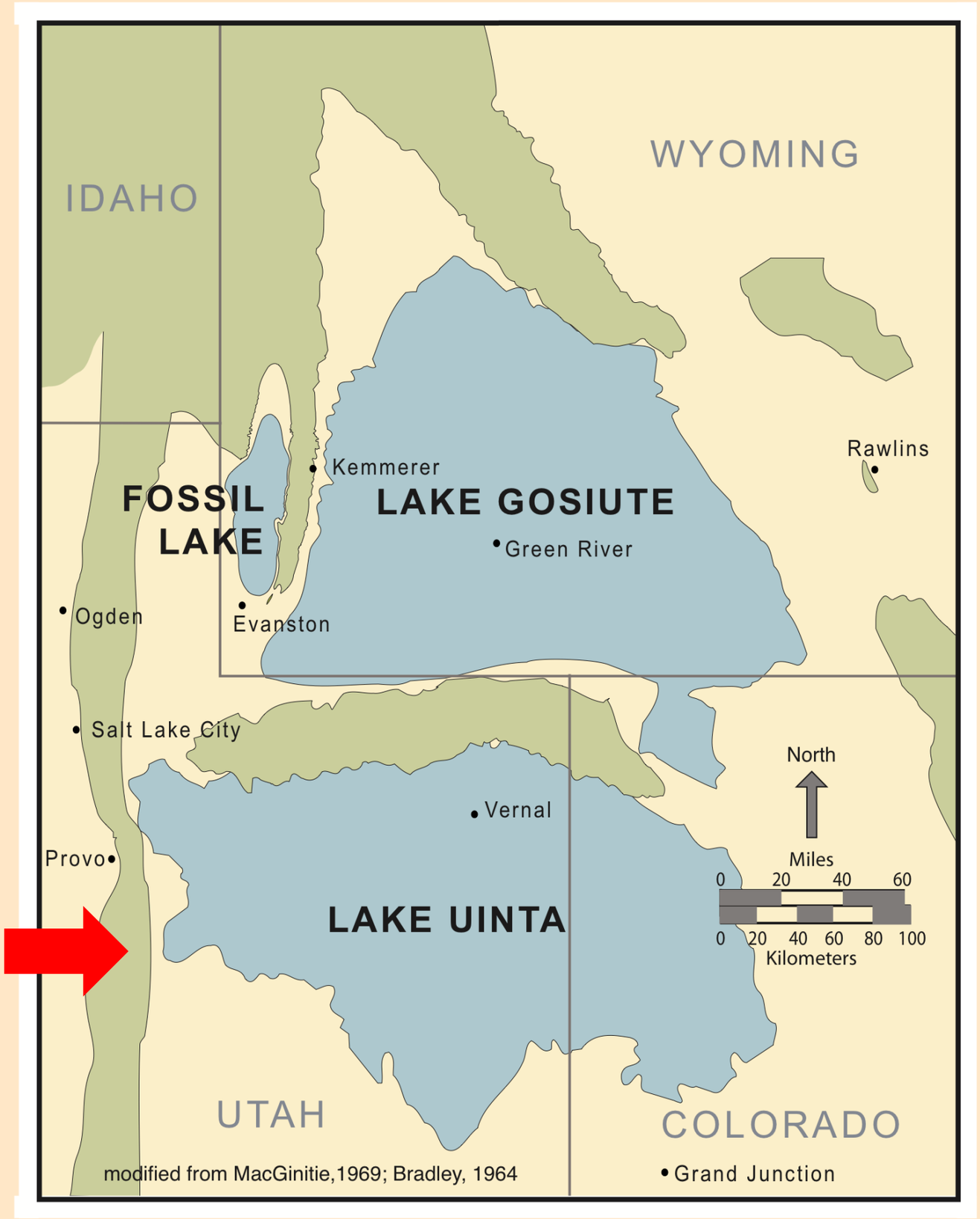
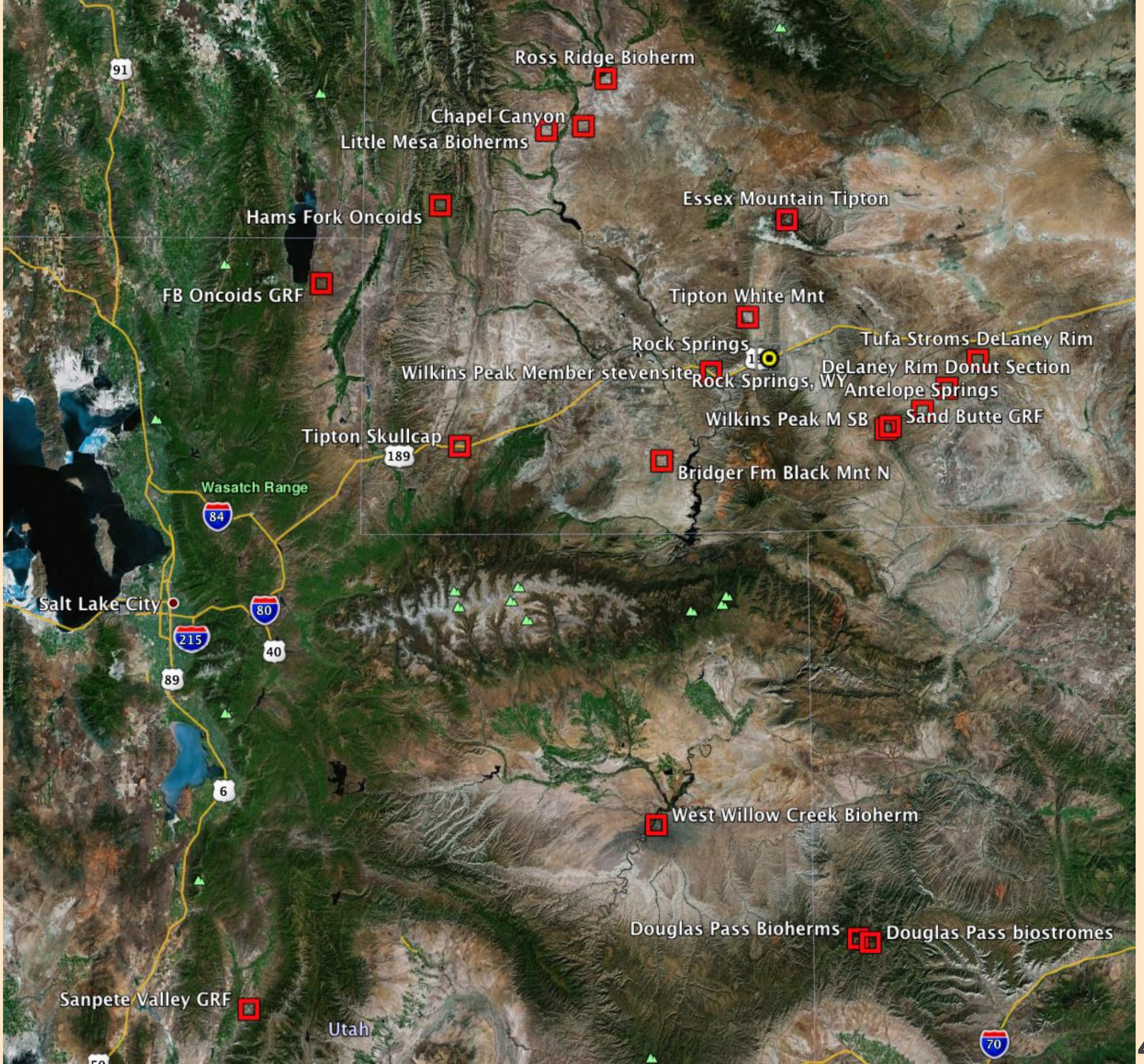
Possible applications to the South Atlantic conjugate basins pre-salt lacustrine systems

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


IDAHO
WYOMING
Kemmerer
Rawlins
FOSSIL LAKE
LAKE GOSIUTE
Green River
Ogden
Evanston
Salt Lake City
Vernal
Provo
LAKE UINTA
North
Miles
0 20 40 60
0 20 40 60 80 100
Kilometers
UTAH
COLORADO
modified from MacGinitie,1969; Bradley, 1964
Grand Junction


Canada
United States
Mexico

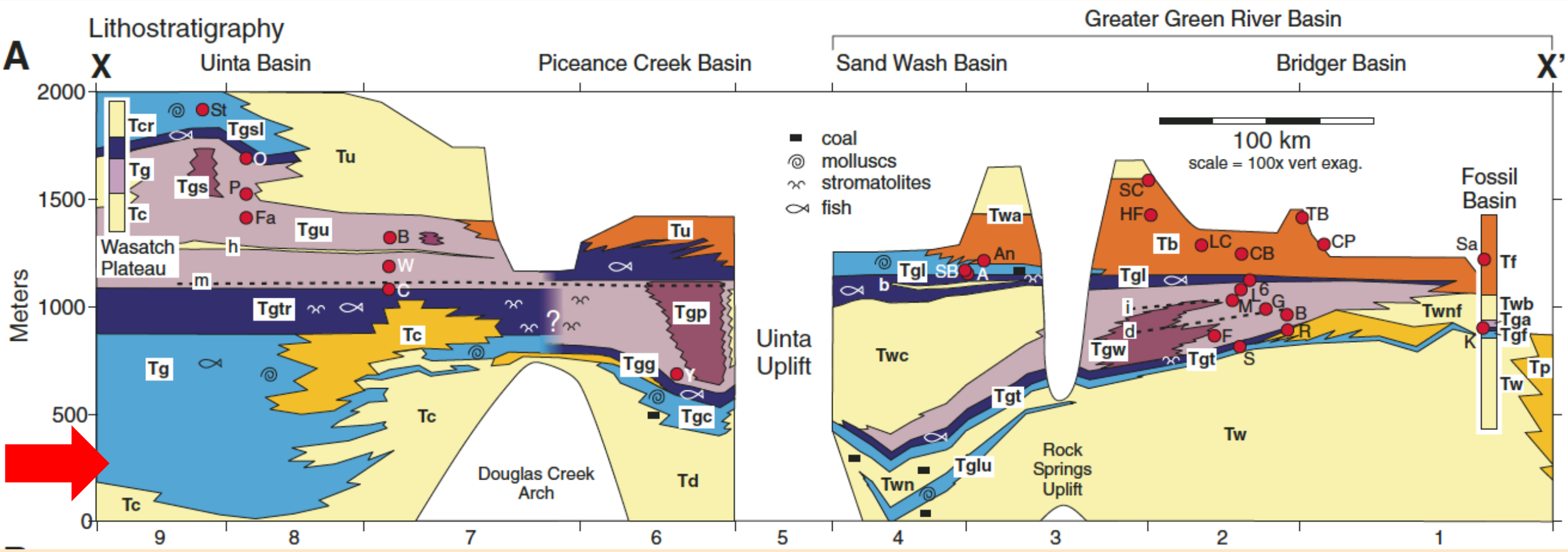

Ross Ridge Bioherm
Chapel Canyon
Little Mesa Bioherms
Essex Mountain Tipton
Hams Fork Oncoids
FB Oncoids GRF
Tipton White Mnt
Rock Springs
Tufa Stroms DeLaney Rim
DeLaney Rim Donut Section
Wilkins Peak Member stevensite
Rock Springs, WY
Antelope Springs
Sand Butte GRF
Wilkins Peak M SB
Tipton Skullcap
Bridger Fm Black Mnt N
Wasatch Range
Salt Lake City
West Willow Creek Bioherm
Douglas Pass Bioherms
Douglas Pass biostromes
Sanpete Valley GRF
Utah
91
189
84
80
215
40
89
6
70


Sanpete Valley
Ephraim
3 km
3000 m
Image USDA Farm Service Agency
Image State of Utah
Google earth
N

Locations


N
1000 m
1000 m
Image USDA Farm Service Agency
Image State of Utah
Google earth

Basinal Scale Lithostratigrapy



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

Sanpete Valley Geologic Map

Qsw	Slope-wash deposits
Qtu	Tufa deposits
Qe	Earthflow deposits
Ql(Tg)	Landslide block of Green River Formation
Ql	Landslide deposits
Qrs	Rockslide deposits
Qof	Older alluvial-fan deposits
Qmw	Mass-wasting deposits
Qt	Glacial till
Qao	Older alluvium

Quaternary-Tertiary Deposits

QTcf	Coalesced alluvial-fan deposits
QTpm	Pediment mantle

Tertiary Detachment Blocks

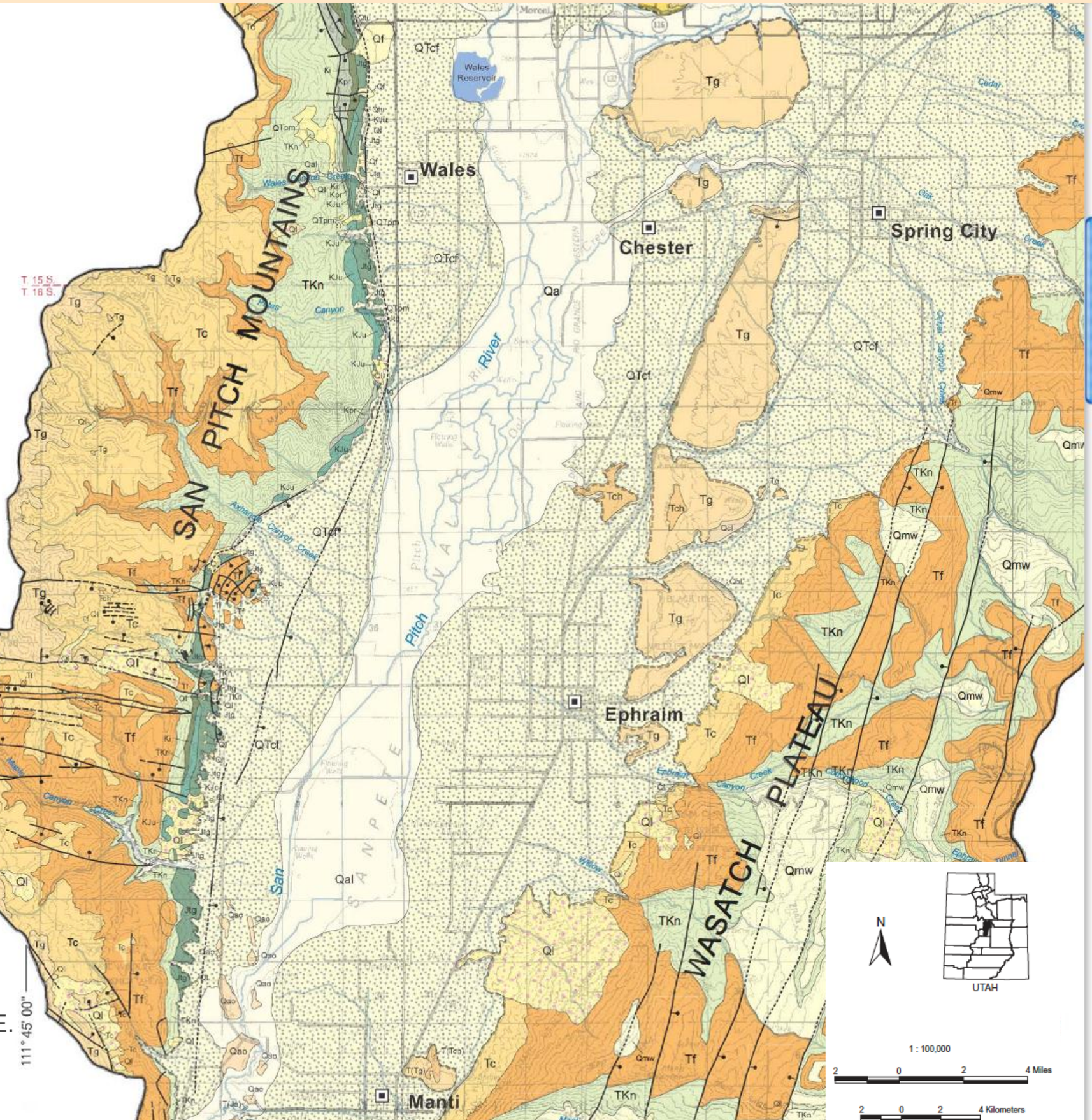
T(Tch)	Displaced Block of the Oligocene Crazy Hollow Formation
T(Tg)	Displaced Block of the Eocene Green River Formation

Tertiary Sedimentary Rocks

Tch	Crazy Hollow Formation
Tg	Green River Formation
Tc	Colton Formation
Tf	Flagstaff Limestone

Tertiary Extrusive Igneous Rocks

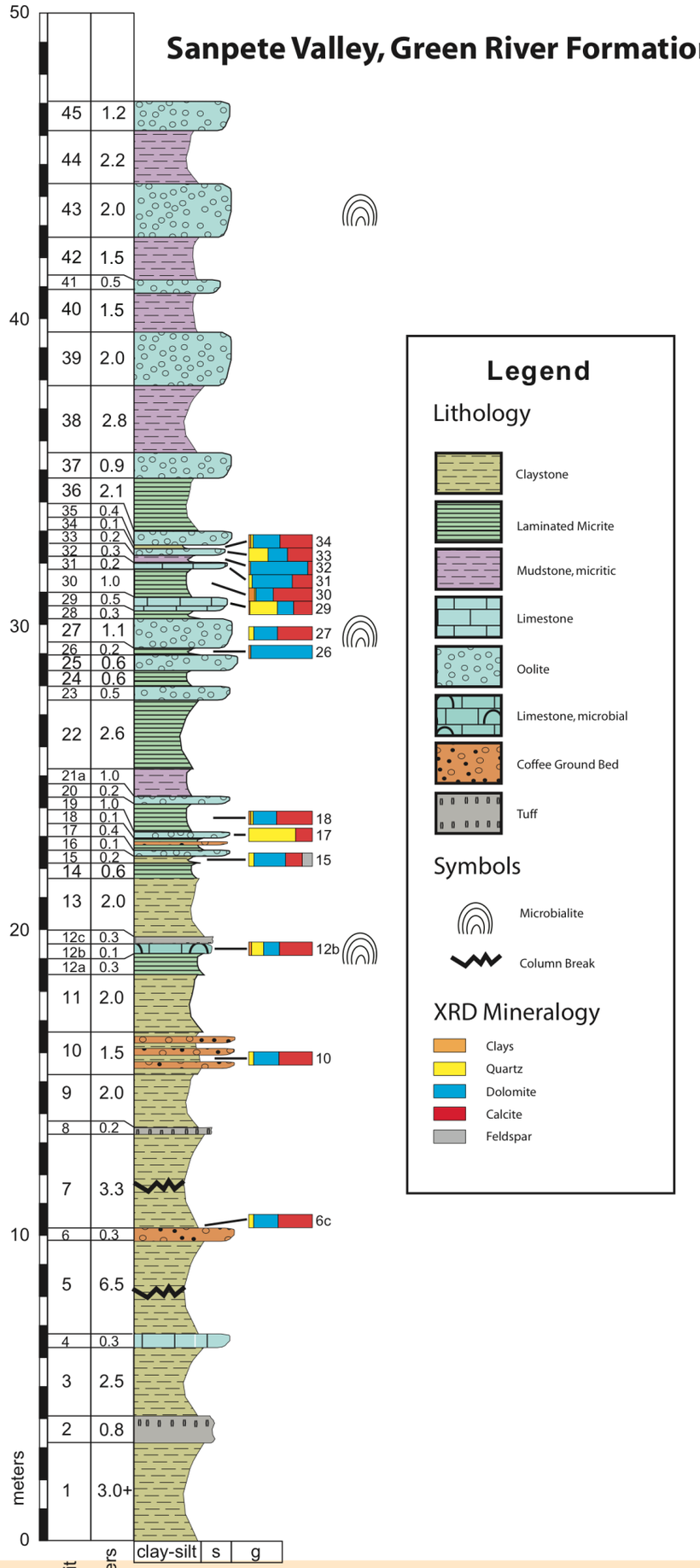
Tm	Moroni Formation



Special Study 102
Plate 3A
By Mike Lowe, Janae Wallace, and Charles E. Bishop
Compiled Geologic Map of
Sanpete Valley,

Location of Measured

Sanpete Valley, Green River Formation



Legend

Lithology

- Claystone
- Laminated Micrite
- Mudstone, micritic
- Limestone
- Oolite
- Limestone, microbial
- Coffee Ground Bed
- Tuff

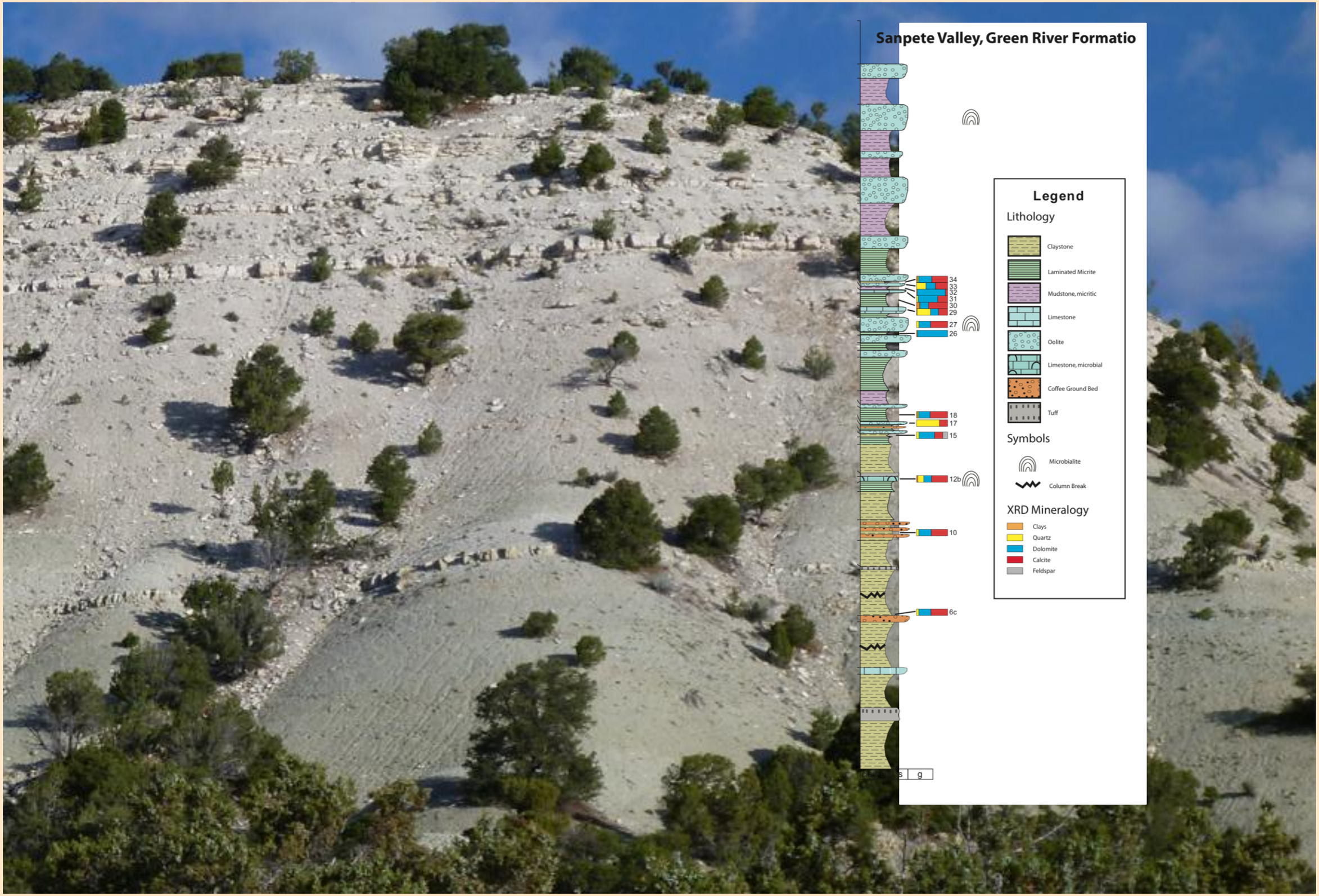
Symbols

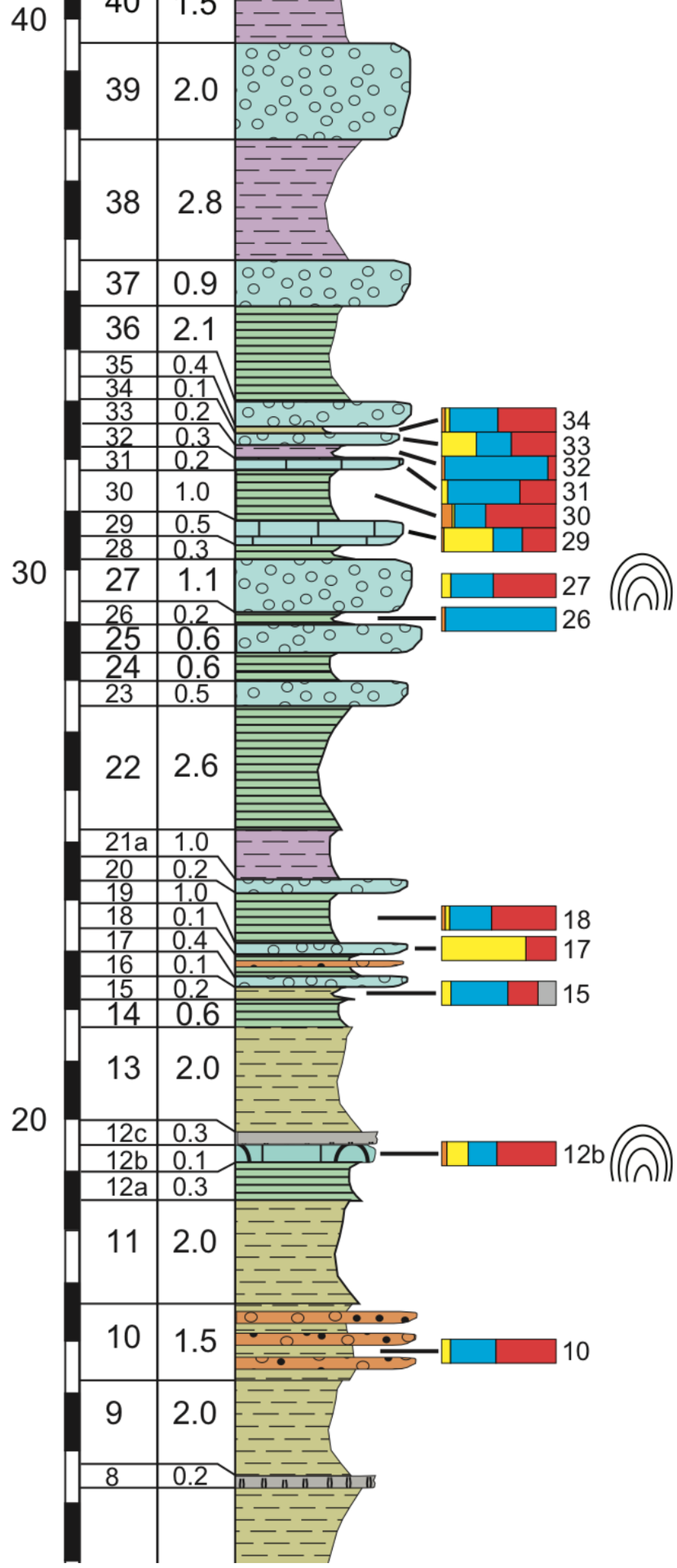
- Microbialite
- Column Break

XRD Mineralogy

- Clays
- Quartz
- Dolomite
- Calcite
- Feldspar

Outcrop study

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39 2.0
38 2.8
37 0.9
36 2.1
35 0.4
34 0.1
33 0.2
32 0.3
31 0.2
30 1.0
29 0.5
28 0.3
30
27 1.1
26 0.2
25 0.6
24 0.6
23 0.5
22 2.6
21a 1.0
20 0.2
19 1.0
18 0.1
17 0.4
16 0.1
15 0.2
14 0.6
13 2.0
20
12c 0.3
12b 0.1
12a 0.3
11 2.0
10 1.5
9 2.0
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12b
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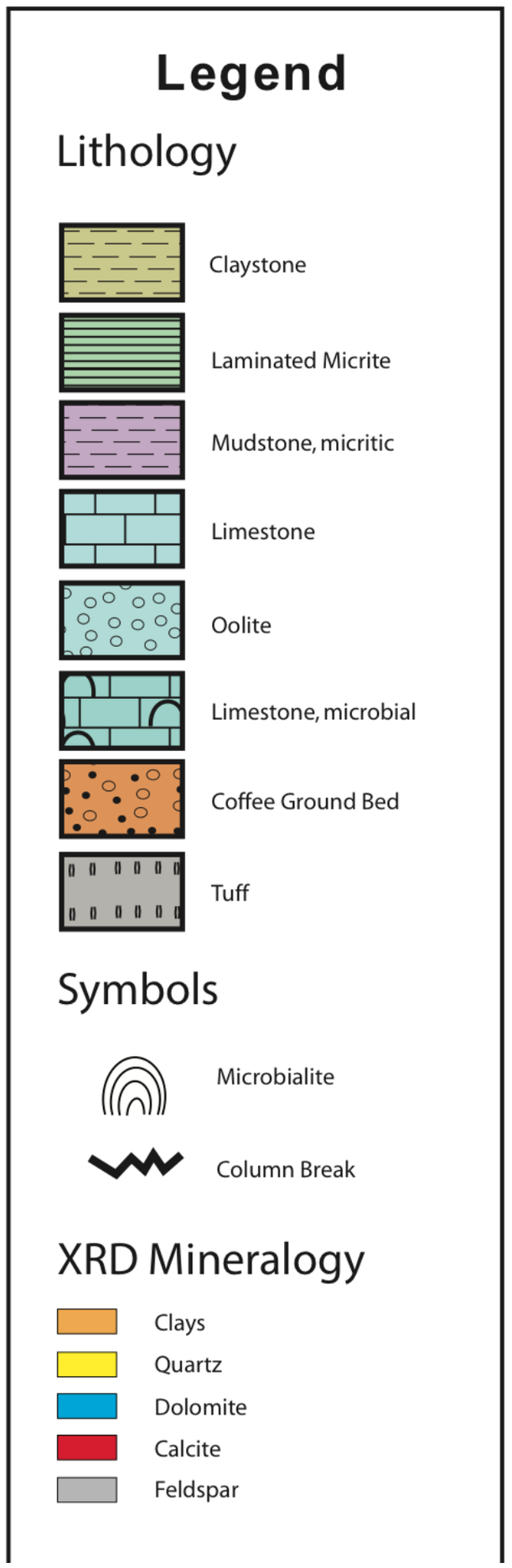
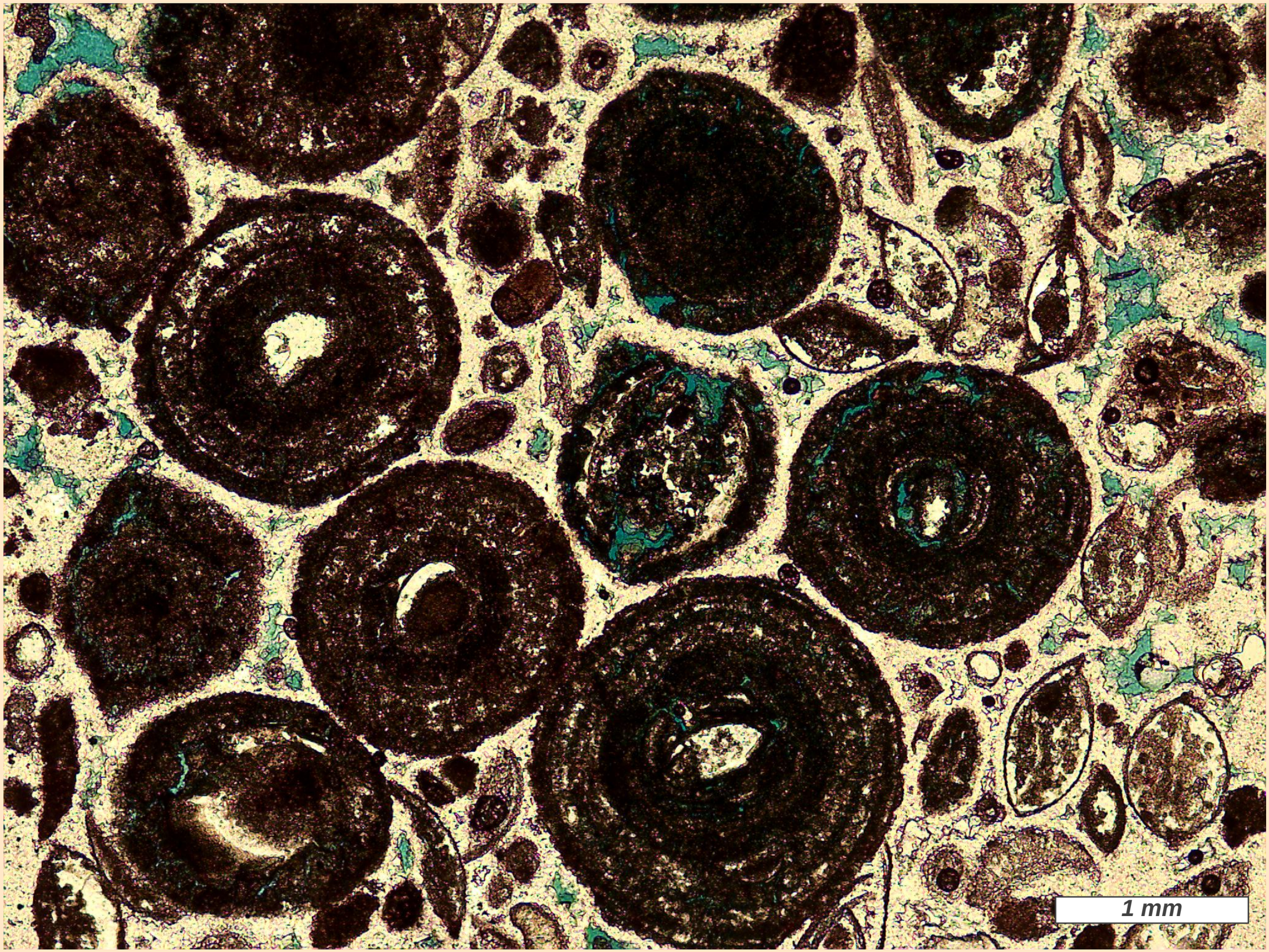

Legend
Lithology
Claystone
Laminated Micrite
Mudstone, micritic
Limestone
Oolite
Limestone, microbial
Coffee Ground Bed
Tuff
Symbols
Microbialite
Column Break
XRD Mineralogy
Clays
Quartz
Dolomite
Calcite
Feldspar

Oolite

Oolite

Oolite

Oolite Petrology

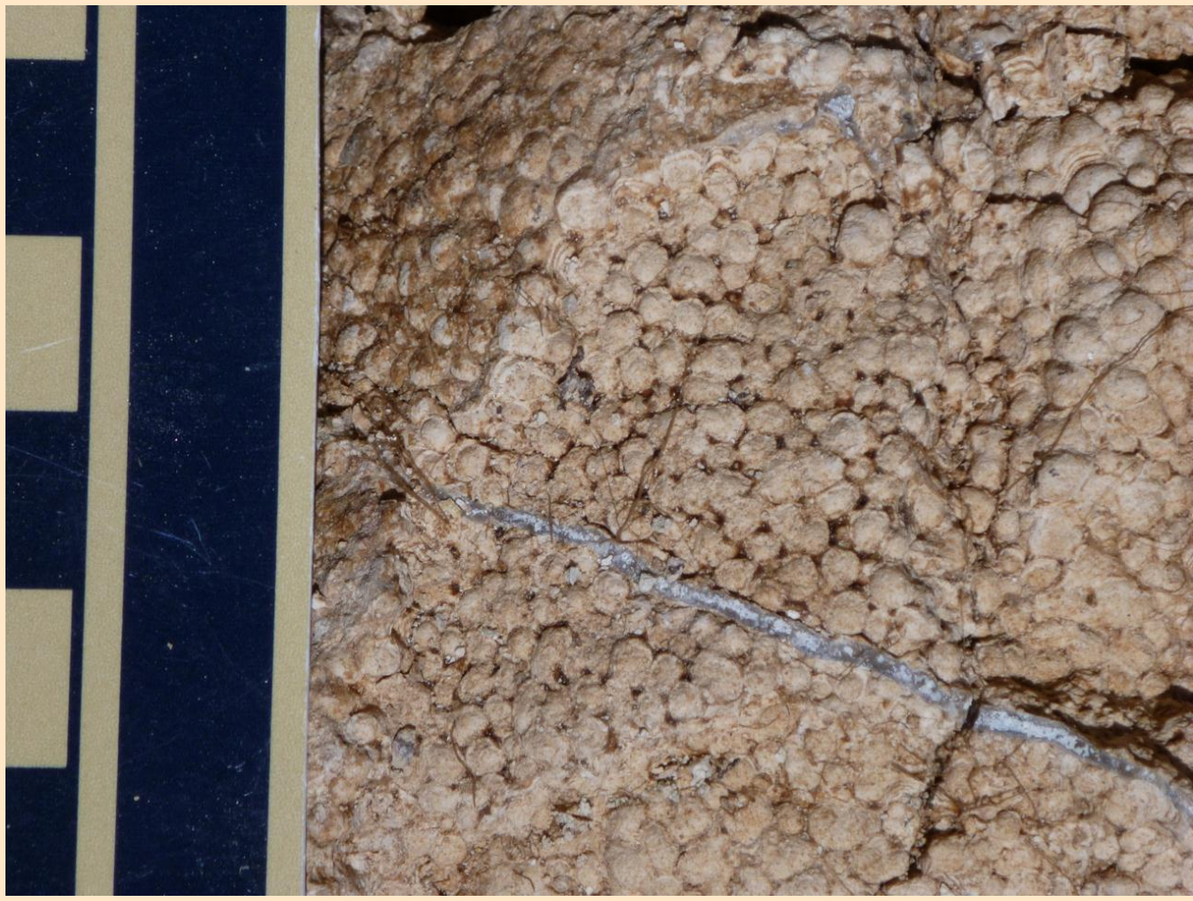


Oolites and microbialites in upper member

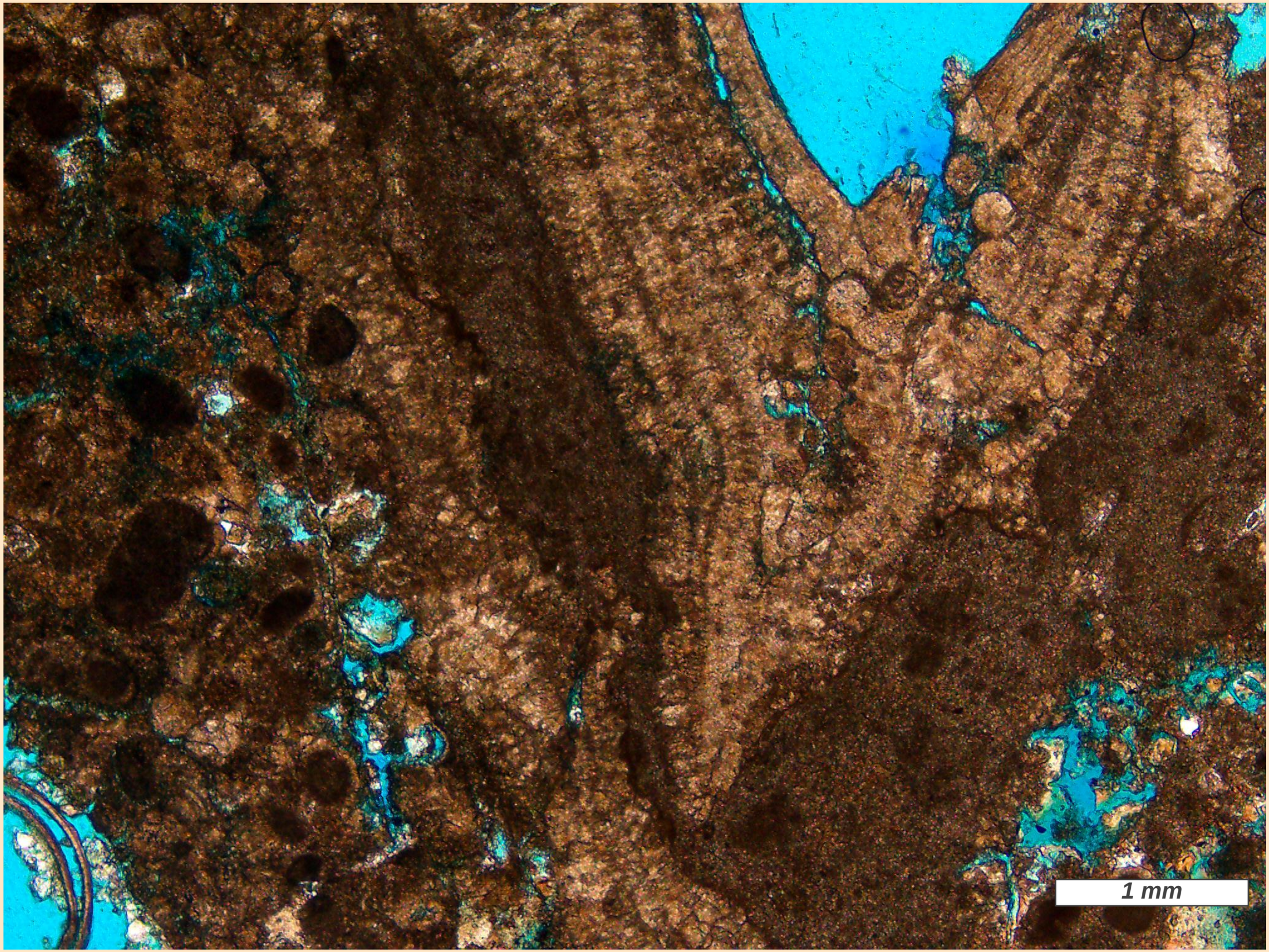
Microbialite

Travertine or tufa -like

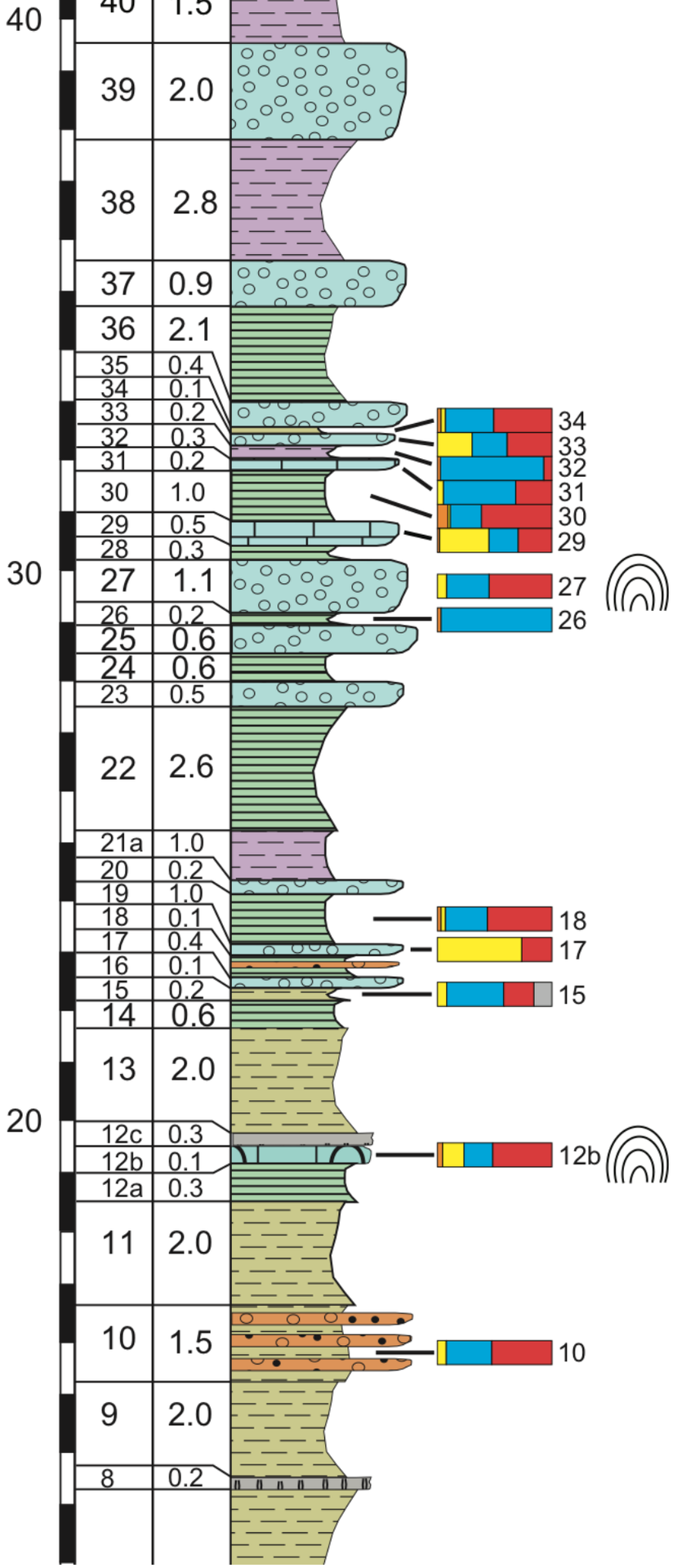
Microbialites

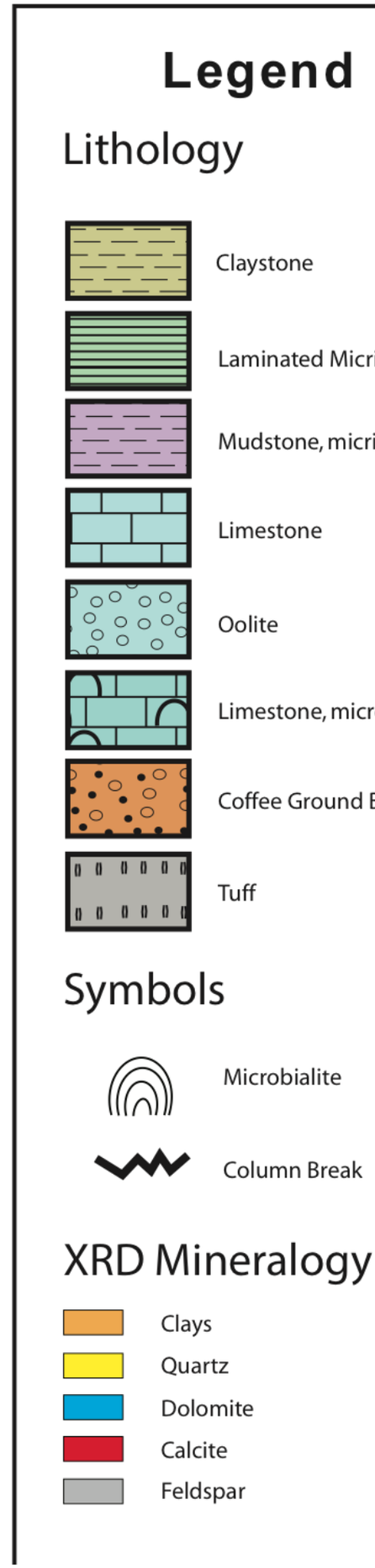


Microbialite Petrology



Stevensite- “Coffee Grounds”





Stevensite- “Coffee Grounds”

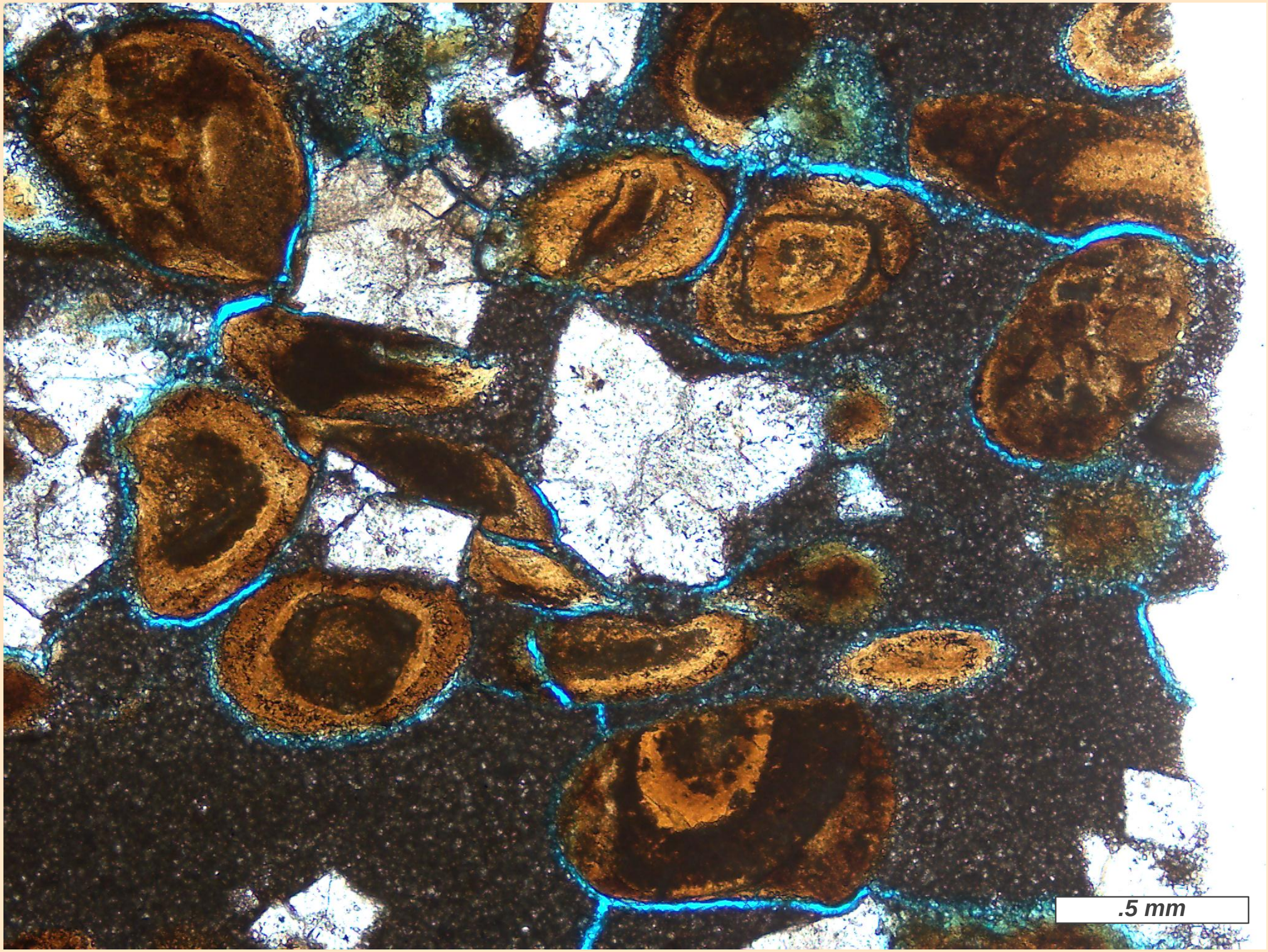
$(Mg_{2.44}A1_{.07}Fe^{+}_{.03})Si_{4.13}O_{10}(OH)_2$

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.

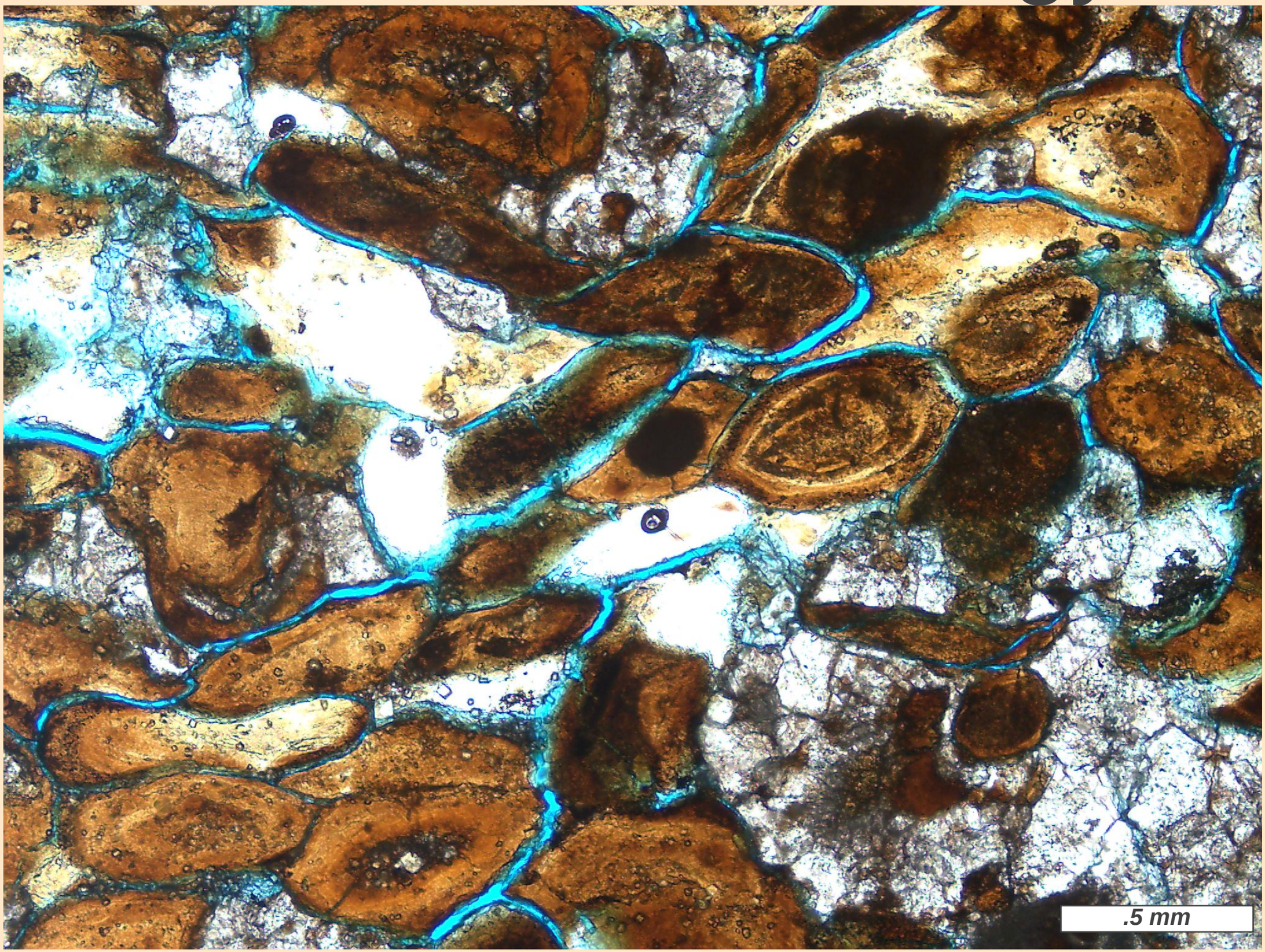
Stevensite “Coffee

Stevensite "Coffee Grounds"

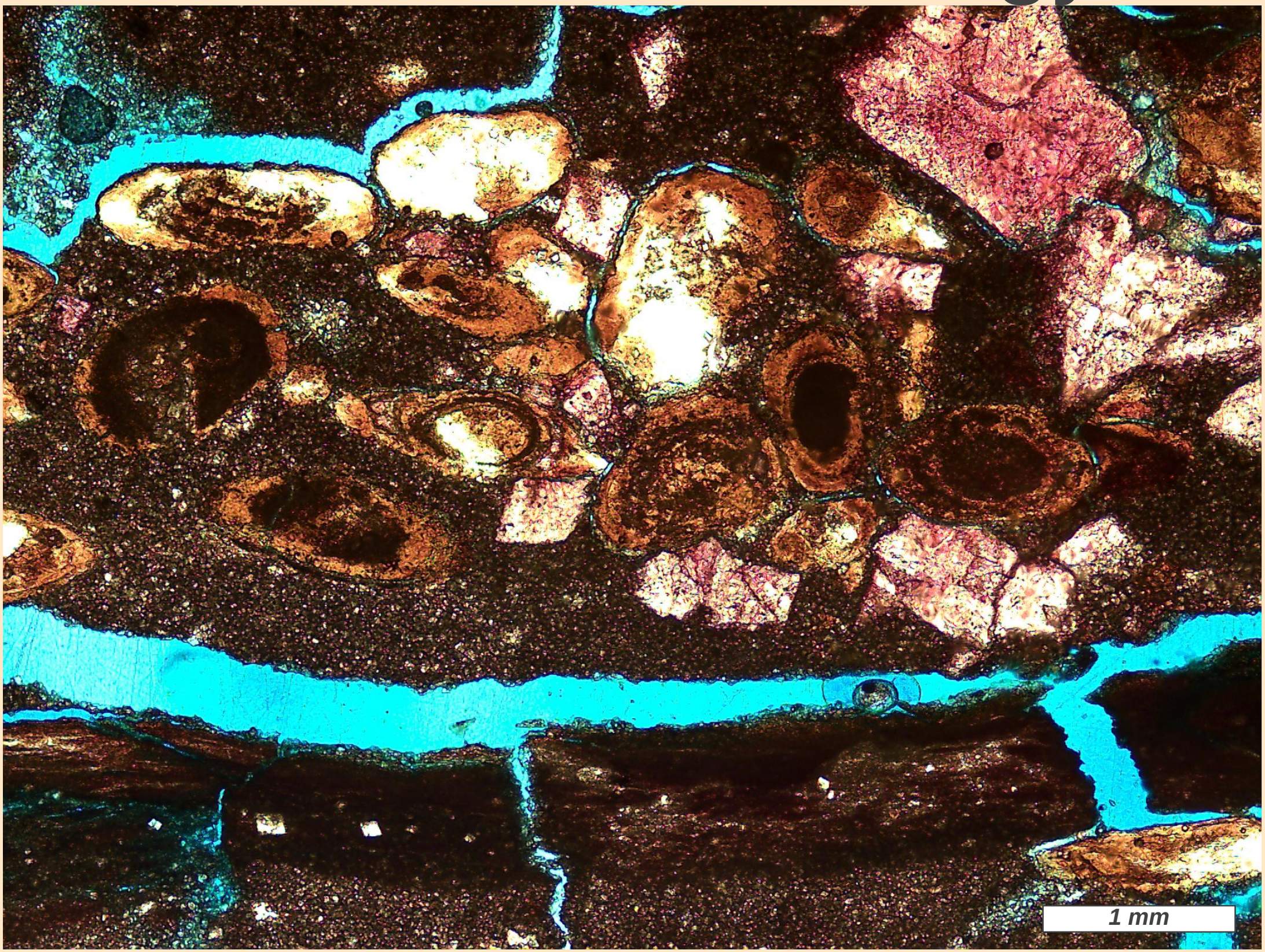
Stevensite Petrology



Stevensite Petrology



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