Mississippian Algal Structures within the Bangor Limestone Formation at Raccoon Mountain, Chattanooga, Tennessee

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Abstract

Raccoon Mountain Caverns is a privately owned cave system located approximately 6 miles east of Chattanooga, Tennessee. The cave system formed in the Bangor Limestone formation, which was deposited during the Mississippian period. Samples with possible microbial textures were collected from a recently excavated pit near the entrance of the adjoining campground. The samples collected in the lower strata of the pit were markedly different from the overlying dark-gray carbonate strata. They are tan-colored and have irregular, conical to domical shaped layers that appear to be microbial textures. Although the presence of the algal mats at Hugden Branch on Raccoon Mountain is mentioned by Bergenback and Lance (1992), the algal textures and associated rocks are not described in the literature for Tennessee. Algal mat fabrics have, however, been identified in Northwest Alabama as part of the lower Banger formation. This research describes the algal textures and their associated strata and compares the fabrics observed at Raccoon Mountain to those described in the Black Warrior Basin of Alabama.

Geologic Background

The Chattanooga area of Tennessee was part of a carbonate environment deposited in an epicontinental sea during Mississippian period (Dinnean, 1974). During this period, the Pennington formation, Bangor Limestone, Hartselle Sandstone, Monteagle Limestone, and Tuscambia Limestone formations were deposited. Both the Bangor and Monteagle formations are known for their extensive cave formations, such as Ruby Falls and Lookout Mountain Cave. According to the Tennessee Cave Survey (2021), there are over 11,400 reported caves in the state alone.

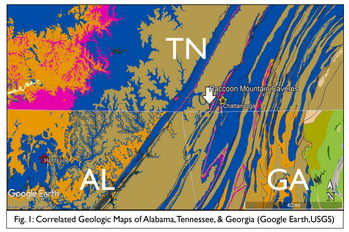


Fig. 1: Correlated Geologic Maps of Alabama, Tennessee, & Georgia (Google Earth,USGS)

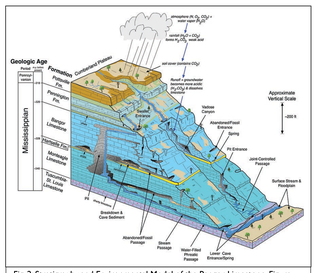


Fig. 2: Stratigraphy and Environmental Model of the Bangor Limestone. Figure courtesy of SaveYourCaves.org

Raccoon Mountain Caverns is cave system which formed within the Bangor Limestone and Monteagle Limestone Formations.

- The Bangor Limestone is a thickly-bedded, highly-fossiliferous limestone formation found throughout Alabama, Georgia, and Tennessee (Emerson, 1964).
- Bergenback and Lence (1992) interpreted the strata in this area to represent a tidal environment (Fig. 4).

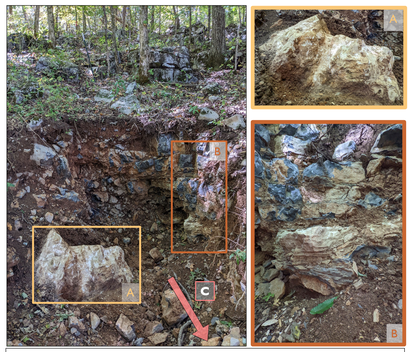


Fig. 5: Photos of sample collection site. Located on Raccoon Mountain near Chattanooga, Tennessee.

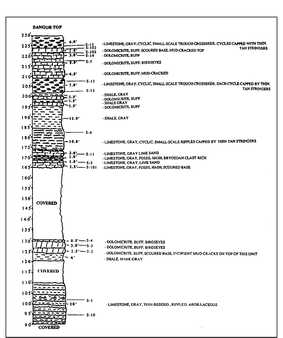


Fig. 3: Strat column in the area of Raccoon Mountain. Image modified from Bergenback and Lence (1992).

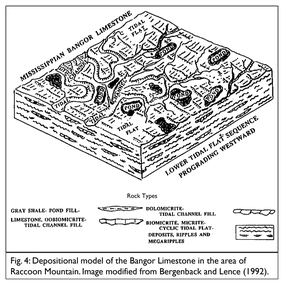


Fig. 4: Depositional model of the Bangor Limestone in the area of Raccoon Mountain. Image modified from Bergenback and Lence (1992).

The cave is privately owned, and operates year-round as a tourist attraction. On our first trip to Raccoon Mountain, our research team discovered a recently excavated pit near the entrance of the cave's adjoining campground. We found that the pit was host to finely-laminated carbonate structures with dome-like and conical structure.

Question

Are the carbonate structures found near Raccoon Mountain Caverns the same algal mats described within the previous works on the Bangor Limestone Formation?

Methods & Materials

Site A – Sample OB-6/22-3

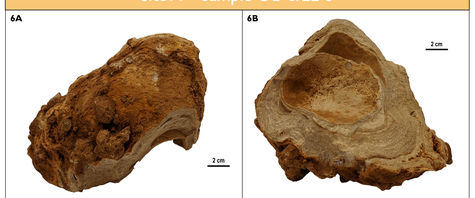


Fig. 6: Originally interpreted as a domical algal structure.
6A – side view, 6B – view from the bottom.

All samples were collected from a recently excavated pit near the campground entrance of Raccoon Mountain Caverns on Raccoon Mountain near Chattanooga, Tennessee. All samples were tested with HCL in the field to confirm carbonate mineralogy. Each sample was thoroughly scrubbed with soap and water to remove loose debris and sediment. After drying, each sample was briefly described. All samples were photographed, strategically cut to expose the fine layering within the rocks, then re-photographed. 3 samples were chosen, marked, and sent to Wagner Petrographic to be made into thin sections.

All thin sections were examined on campus using the Leica DM6 B petrographic microscope and accompanying LAS X software. Using the microscope, photomicrograph mosaics of each slide were produced. Following petrographic analysis, each mosaic image was briefly described.

Site B – Sample OB-6/22-1

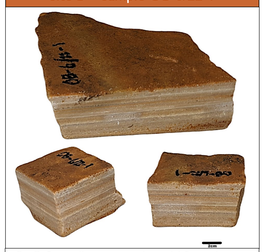


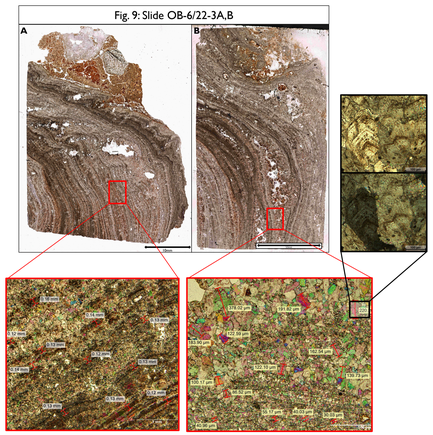
Fig. 7: Originally interpreted as tidal flat carbonate sandstone.

Site C – Sample OB-6/22-5

Fig. 8: Sample collected from excavated debris in front of the pit. Originally interpreted as a conic algal structure or speleothem.
8A – side view, 8B – anterior view of cut sample, 8C – posterior view.

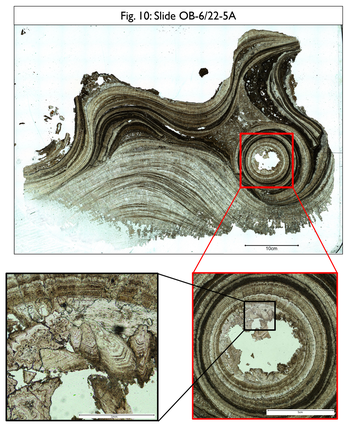
Results

Fig. 9: Slide OB-6/22-3A,B



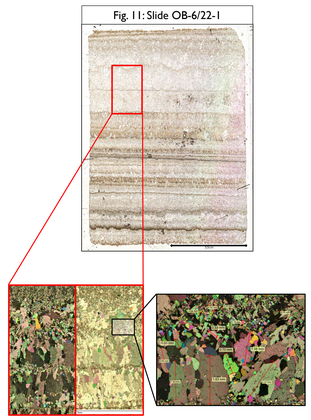
- Layer spacing is notably consistent in both samples
  - ~0.12mm to 0.16mm
- Well-developed calcite matrix
  - Crystal size ranges from ~30µm to 400µm
  - Size of crystals increase from bottom to top of each layer
  - Crystal cleavage incorporates trace amounts of organic matter

Fig. 10: Slide OB-6/22-5A



- Alternating light and dark layers
  - Layer spacing and alternating bands of color within the structure suggest an abiotic formation process
  - Dark bands suggests heavy incorporation of organic matter
- Calcite-rich crystal matrix, well-developed crystals
  - Change in size and structure of calcite crystals within the center of the sample suggest diagenetic processes

Fig. 11: Slide OB-6/22-1



- Distinctly parallel horizontal laminae
  - Alternating bands of color
  - Mostly uniform layer spacing
- Much larger crystals
  - Clear progression of crystal size
  - Size ranges from ~50µm to >1600µm
  - Possibly aragonite crystals

Discussion & Conclusions

Our initial interpretation of the pit was that we were possibly seeing the algal structures and tidal flats identified in the Bangor Limestone by Bergenback and Lence (1992).

- Based on their shapes and fine lamination in the field, samples OB-6/22-3 and OB-6/22-5 were considered to be domal and conical algal mat structures, respectively.
- Laminae of sample OB-6/22-1 are distinctly horizontal and parallel, which was interpreted to be the tidal flat sedimentary rocks discussed by Bergenback and Lence (1992).

Petrographic analysis of the microfabrics in thin section indicate that the field interpretations were incorrect.

- The dark layers of laminae incorporate organic matter.
- Laminae are isopachous in all samples, which suggests they formed through inorganic processes.
- Laminae made up of large crystals (>1mm) observed in OB-6/22-1, are perpendicular to the laminae composed of smaller (< 80 µm)carbonate crystals

Algal mats are generally characterized by fine-grained, irregular to wavy laminations. The samples from the pit have a more uniform lamination that alternate between larger grains and smaller grains.

- The microstructure of these samples appears more like that of travertine (Porras-Toribio et al., 2022), which forms from the rapid precipitation of carbonate minerals, namely aragonite, from supersaturated calcium carbonate brines in caves, lagoons, and hot springs.

Future Work

New questions to be addressed:

- What is the depositional environment of these samples?
  - How old are the samples collected?
    - Are these rocks part of the Bangor Formation or are they the result of diagenetic alteration?

To test these questions, we will use:

XRD analysis will provide mineralogic data, such as the distinction between carbonate minerals.

Scanning electron microscopy will be used to explore microfabrics and the distribution of elements in these laminae.

Cathodoluminescence microscopy will be used to identify diagenetic alteration of the carbonate.

References

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