The Gunlock Member: Describing a New Member of the Carmel Formation (Middle Jurassic) of Southwestern Utah

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Abstract

This Independent Study investigates the paleoecology and stratigraphy of the lower Carmel Formation in southwestern Utah. The Co-op Creek Member and the here proposed Gunlock Member of the Carmel Formation are mostly limestone units formed during the Bajocian (Middle Jurassic). During the Middle Jurassic, much of western North America was covered by an epicontinental seaway called the Sundance Sea, which stretched from southern British Colombia to Utah. In this study there are four principle locations (Eagle Mountain Ranch, Manganese Wash, Dammeron Valley, and Jackson Peak) of study. The proposed Gunlock Member was formed in a low energy, intertidal environment. It is characterized by stromatolite and thrombolite layers, trace fossils, and bivalves. The overlying Co-op Creek Member was formed after a transgression in a high energy, subtidal environment and is characterized by its ooid-rich limestones, shales, and abundant fossils.

The boundary between the Co-op Creek and proposed Gunlock divides these members into the underlying stromatolitic member and the overlying ooid-rich member, and indicates a significant transgression. The Bajocian saw a few notable global transgressions that roughly coincide with that of the Sundance Sea; while there are several theories as to the cause of these rises in sea level, tectonic and glacial activity are the most likely.

Methods

Field Methods

At the 4 principle study locations in SW Utah (Manganese Wash, Eagle Mountain Ranch, Jackson Peak, Dammeron Valley), samples were taken at irregular intervals where found in place. Stratigraphic columns were also produced at Manganese Wash and Eagle Mountain Ranch.

Laboratory Methods

Samples were cut using a rock saw into small pieces, roughly 1 inch x 2 inches. These were sent to an external lab for thin section processing. Thin sections were analyzed for lithology and photos were taken. A sample of unconsolidated sand from Manganese Wash was sorted using a Ro-Tap sieve shaker (fig. 1).

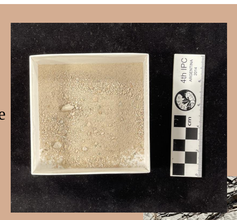

Figure 1

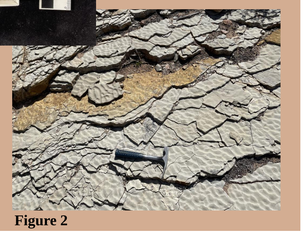

Figure 2

Paleogeography

Figure 3: The epeiric Sundance Seaway during the Middle Jurassic (Bajocian). The area of study is marked with a black star. Courtesy of Ron Blakey and Colorado Plateau Geosystems (2013).

The Carmel Formation was formed by an epeiric seaway called the Sundance Sea. The principle study locations, previously on the southern edge of the seaway, are in southwestern Utah today.

The Carmel Formation's bottommost member is the Co-op Creek. The goal of this Independent Study was to describe both units of the Co-op Creek Member and rename the lower to the Gunlock Member. This is because a rise in sea level changed the lithology of the rock. This means that the two units are composed of different rock types.

This transgression took place in the Middle Jurassic, ~170 – 168 million years ago. This age of the Jurassic is called the Bajocian.

Gunlock and Co-op Creek Members

The upper unit (the now truncated Co-op Creek Member) is light tan. Samples from this member have sparry and micritic matrices and a high content of quartz sand and ooids. This member also has a higher number of trace fossils, most notably *Lockeia* and *Gyrochorte*.

The Co-op Creek Member is exposed over more land area than the proposed Gunlock Member. It represents the subtidal ("carbonate factory") depositional environment of the location after the transgression.

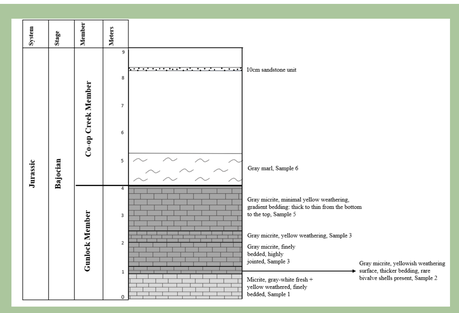

Figure 4: Updated stratigraphic column of the Eagle Mountain Ranch (C/W-772). Strata measured above and below the boundary.

The proposed Gunlock Member is currently the lower unit of the Co-op Creek Member (Sprinkel et al., 2011). This lower unit is light brown to off-white. Samples from this member have a sparry matrix with a mixture of quartz sand grains, ooids, broken shells, and bryozoans among stromatolites and thrombolites.

This unit represents the intertidal depositional environment of the location before the transgression.

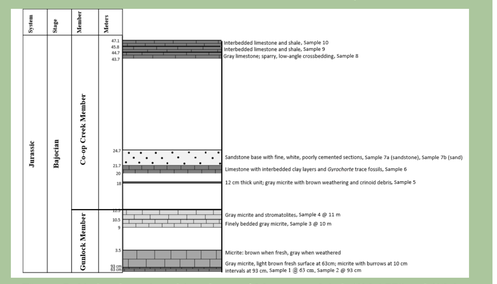

Figure 5: Updated stratigraphic column of Manganese Wash (C/W 770 and C/W 771). Strata measured above and below the boundary.

Transgression

The distinct boundary between the Gunlock Member and the Co-op Creek Member in the Carmel Formation represents a dramatic rise in sea level. The underlying Gunlock Member is full of stromatolites and thrombolites which grew in an intertidal environment.

The overlying Co-op Creek Member's lithology represents a much higher energy, subtidal environment ("subtidal ooid factory"). The ooid-rich matrices of the samples, along with the fossils from marine invertebrates, differ greatly from the samples from the Gunlock Member, pointing to a significant transgression

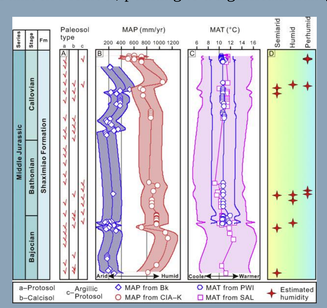

Figure 6: Mean annual precipitation and temperature data derived from paleosol samples from Sichuan Basin, China (Li et al. 2022, fig. 10).

There are several possible causes for this transgression; however, evidence from ocean cores (fig. 6) and paleosols (fig. 7) from around the world suggest a dramatic change in climate during the Bajocian.

This change likely caused a deglaciation, which would contribute to a dramatic transgression like the one seen in the record of the Carmel Formation. Evidence for this theory includes rises in temperature, atmospheric CO_2 levels, and humidity throughout the Bajocian.

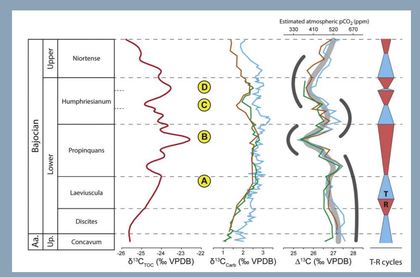

Figure 7: Transgressions and regressions based on isotopic analysis of marine sediment samples of the Bajocian of the Central High Atlas Basin in Morocco (Bodin et al., 2020, fig. 8).

Thin Section Photographs

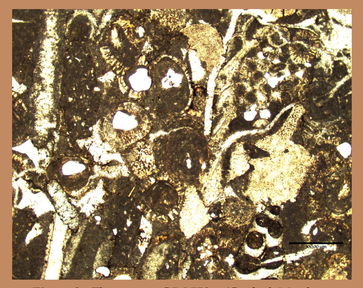

Figure 8 : Thin section C/W 770-1 (Gunlock Member, Manganese Wash).

Figure 11: Thin section C/W 774-1 (Gunlock Member, Jackson Peak).

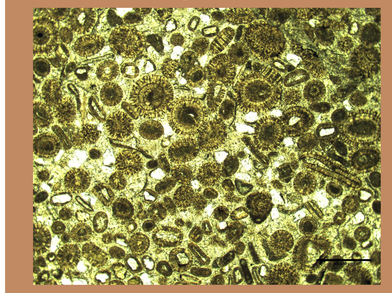

Figure 9: Thin section C/W 771-10 (Co-op Creek Member, Manganese Wash).

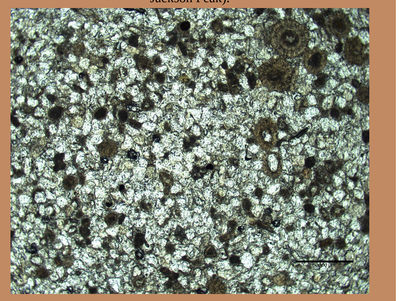

Figure 12: : Thin section C/W 774-2 (Co-op Creek Member, Jackson Peak).

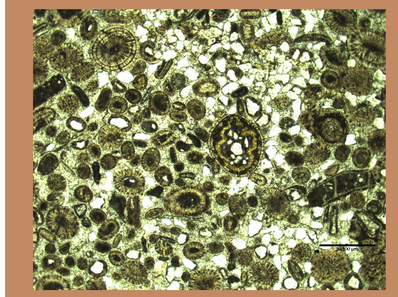

Figure 10: Thin section C/W 772-8 (Co-op Creek Member, Jackson Peak).

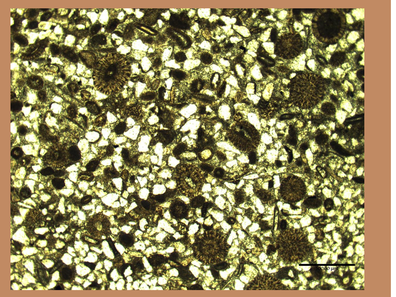

Figure 13: Thin section C/W 771-8 (Co-op Creek Member, Manganese Wash).

Acknowledgments

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Key References

Sprinkel, D.A. and Kowallis, B., 2011, Early results of a study of Middle Jurassic strata in the Sevier fold and thrust belt, Utah: UGA Publication, v. 40, p. 151-172.

Nielson, D.R., 1990, Stratigraphy and sedimentology of the Middle Jurassic Carmel formation in the Gunlock area, Washington County, Utah: Brigham Young University Geology Studies, v. 36, p. 153-192.

Bodin, S., Mau, M., Sadki, D., 2020, Transient and secular changes in global carbon cycling during the early Bajocian event: Evidence for Jurassic cool climate episodes: Global and Planetary Change, v. 194, p. 1-13, https://doi.org/10.1016/j.gloplacha.2020.103287