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Sponge-microbial Mound in Tuscumbia Limestone, Subsurface Walker County, Alabama

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A new core from the Black Warrior basin of Alabama contains a hitherto unknown mound lithofacies in the Meramecian Tuscumbia Limestone. The Tuscumbia is a platform carbonate unit that is commonly dominated by skeletal grainstone. The unit contains lesser amounts of muddy limestone, and is commonly cherty. The Tuscumbia overlies the Fort Payne Chert of Osagean age, and underlies the Chesterian Pride Mountain Formation in southeastern Walker County.

The Gorgas #1 well was cored to a depth of 919 m (3015 ft). The core contains at its base 37.5 m (123 ft) of carbonate rock assigned to the Tuscumbia. This formation underlies the Lewis Lime of the Pride Mountain Formation, which is here a thick bed of laminated argillaceous fenestrate-bryozoan-rich carbonate and gray shale. The basal 3 m (10 ft) of the Tuscumbia and the underlying Fort Payne Chert were not cored in this well.

The basal 2.8 m (9.25 ft) of the core consists of sponge-microbial boundstone (Unit 1). This is overlain by 13.7 m (44.8 ft) of mixed carbonate strata dominated by mixed-particle grainstone, which increases in abundance upward (Unit 2). This rock type is interbedded with lesser amounts of argillaceous cherty peloidal carbonate, sponge-microbial boundstone, and mixed-particle rudstone. Glauconite is common in the basal 5.8 m (19 ft) of this unit. Peloid skeletal grainstone (Unit 3, 6.9 m (22.75 ft) thick) conformably overlies the heterogeneous interval, and is abruptly overlain by 14.3 m (47 ft) of bryozoan crinoid grainstone (Unit 4) containing breccia beds and paleosols. This unit is in turn abruptly overlain by the Lewis Lime.

Half of Unit 1 was cored. The unit consists of sponge-microbial boundstone composed primarily of clusters of spicules embedded in a particle-supported detrital matrix. The matrix is dominated by spicules, with peloids, echinoderm ossicles, brachiopod and trilobite fragments, intraclasts, and glauconite pellets. Much of the matrix is bound together with clots and ribbons of microcrystalline carbonate. Cm-scale shelter voids are filled with light brown very-fine sand size mixed-skeletal packstone, some of which also is bound together with microcrystalline carbonate. Much of the unit has been partially or entirely replaced by fabric-retentive chert. Vertical fractures in Unit 1, which are up to several cm across and have irregular boundaries, are sealed with calcite cement. The mound is not Waulsortian: stromatactis is absent and the matrix is not muddy. The upper contact is sharp and irregular; borings are locally abundant.

Unit 2, which overlies Unit 1 abruptly, is a heterolithic succession dominated by fine mixed-particle grainstone, with sponge-microbial boundstone and mixed-particle pack-grainstone beds up to about a meter thick, both of which decrease in thickness and number upward. Grainstone

predominates in the upper third of the unit. Particles are dominated by peloids, brachiopods, pelecypods, echinoderms, bryozoans, and intraclasts. Glauconite pellets, which are common in the lower part of the unit, diminish in abundance upward. A few thin crinoidal rudstone layers attest to transient higher energy conditions. Primary voids contain both calcite and silica cement. These rocks are partly replaced by chert. Chert nodules have complex shapes influenced by pre-existing carbonate fabrics. The smoothly rounded bulbous chert nodules, so common elsewhere in the Tuscumbia, and especially in the underlying Fort Payne, are scarce. Dolomite replacement is patchy and relatively minor. Pores, filled with solid hydrocarbons, occur patchily in both chert and limestone.

Unit 3 conformably overlies Unit 2 and is dominated by stacked normally graded beds of fine to coarse peloid skeletal grainstone. Sequences range up to about 5 feet thick, and are dominated by echinoderm debris, brachiopods, bryozoans, peloids, and calcite cement. Several sponge-microbial boundstone layers less than a foot thick punctuate this predominantly detrital interval. A three-foot calcareous siltstone and two-foot very cherty laminated lime mudstone occur in the upper part of Unit 3.

Unit 4 abruptly overlies Unit 3 and is dominated by bryozoan crinoid grainstone with a few thin breccia beds. Sedimentary structures include laminae, low-angle cross laminae, symmetrical ripples, and horizontally elongate fenestrae. Exposure surfaces are erosional contacts underlain by brecciated carbonate without significant discoloration.

The basal part of the core records growth of a subtidal sponge-microbial mound that formed below wave base. Deepwater deposition is not indicated because the mound matrix is granular. Abundant glauconite suggests that bottom waters were commonly reducing, or that glauconite was continuously imported from nearby. The mound was buried by mixed-particle grainstone fore-shoal strata. The upper part of the Tuscumbia at this locality is bryozoan-crinoid grainstone formed in a mobile shoal high-energy setting that quickly aggraded to sea level. Although the upper Tuscumbia here has a familiar aspect, the skeletal shoal buried a mound facies not previously reported from the Tuscumbia.

Diagenesis was complex. Interparticle voids are filled with a mixture of calcite cement, replacive chert, and solid hydrocarbons. Syndepositional fracturing of certain layers and late-stage tectonic fracturing of the entire section were ubiquitous. Fractures were healed with calcite cement. Irregular nodules of chert replaced parts of the mound and the overlying heterogeneous unit. Chert is uncommon in units 3 and 4. Dolomite partially replaced heterolithic strata of Unit 2 overlying the mound. Patches of once-porous rock in Unit 2 contain solid hydrocarbons, but porosity and permeability are today near zero. Porosity retention (before pores were clogged) and relatively minor dolomitization did not correspond.

The well bottomed in sponge-microbial mound strata, near the bottom of the Tuscumbia (based on well-log interpretation). A carbonate mound about 6 m (20 ft) thick comprises the initial deposits of the Tuscumbia Limestone at this locality. Thin boundstone units are scattered through the overlying 14 m (45 ft) of section. The cored mound is nonporous, but Tuscumbia mounds on the order of 10 or 20 m (30 to 60 feet) thick could exist along strike and might form viable hydrocarbon reservoirs.

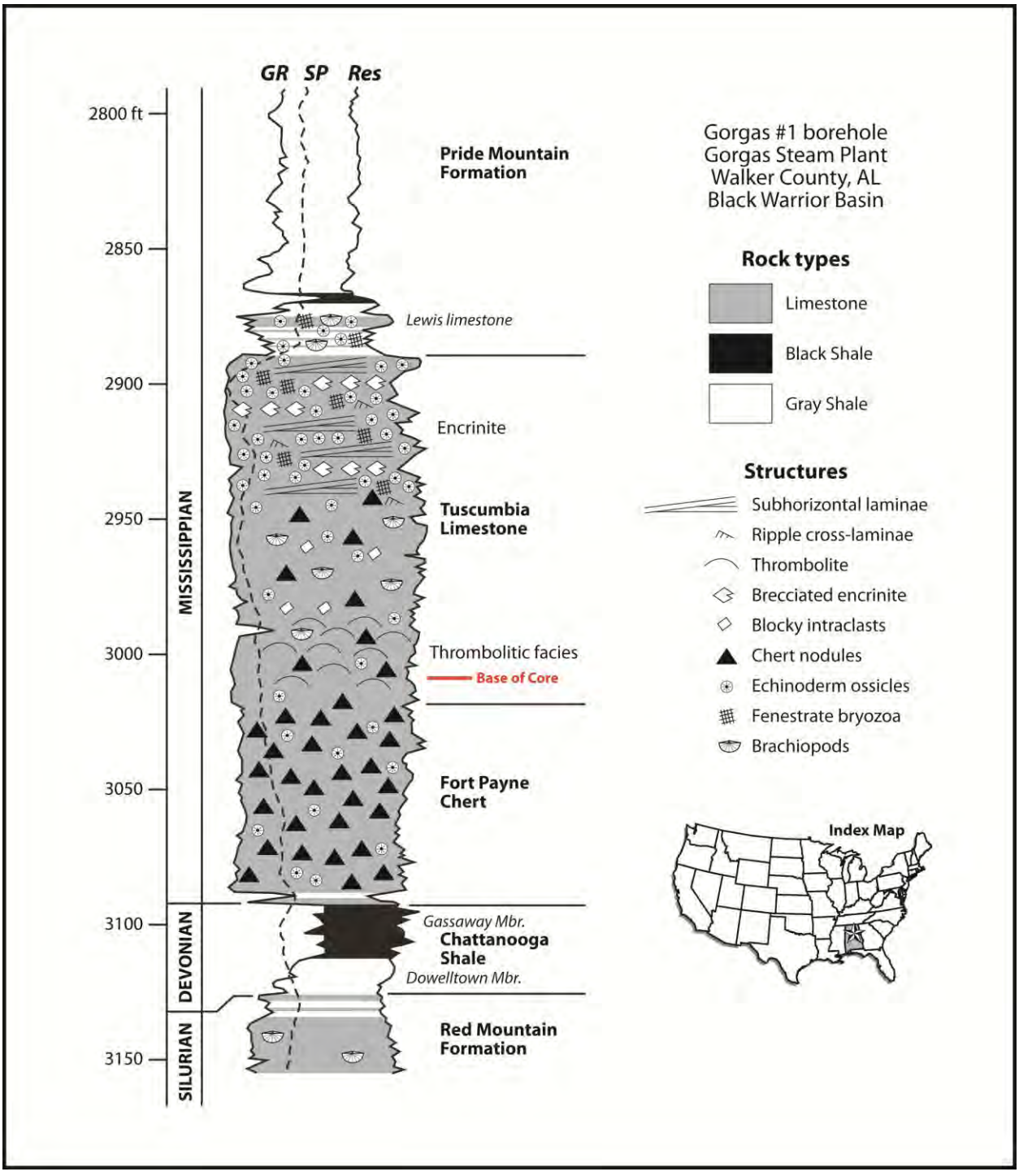

Figure 1. Graphic log of lower part of Gorgas #1 borehole, Walker County, Alabama. Depths marked in feet. Base of core is just above base of Tuscumbia Limestone.