Cretaceous Period in Alabama

The Cretaceous Period, which dates to between 145 to 66 million years ago, is the last geological time unit of the Mesozoic Era, popularly known as the "Age of Dinosaurs." It was preceded by the Jurassic Period, which ranged from 200 to 145 million years ago, and followed by the Paleogene Period (sometimes called the first half of the Tertiary Period), which ranged from 66 to 23 million years ago. The Cretaceous Period is important for its contributions to the fossil record and to geological science. But it was also important to the development of Alabama's economy because its deposits were in part responsible for the initial fertility (quickly depleted by cotton cultivation) of Black Belt soils that drove the rise of plantation agriculture. Subsurface Lower Cretaceous deposits may also become a source of oil and natural gas, as they are in the neighboring Gulf states, although that is as yet unproven.

In Alabama, sedimentary rocks of the Early Cretaceous (145 million to 100 million years ago) are entirely buried below ground; geologists know that they are there, however, because they have been found when drilling wells for oil and gas. The Late Cretaceous Epoch (100 to 66 million years ago) is well represented by a series of sedimentary deposits exposed on the surface in the Eastern Gulf Coastal Plain physiographic section, which encompasses the southern and western portion of the state. These sediments were deposited initially by rivers draining over the roots of the exposed ancient Appalachian Mountains from Birmingham eastward and over interior plateau sediments to the west, flowing south to the coast. Later, approximately 85 million years ago, shallow to moderately deep ocean waters flooded the southern half of the state, creating thick wedges of marine sediments that were deposited through the later Cretaceous Period until the seas withdrew southward toward the Gulf of Mexico at the very end of the Mesozoic Era. Late Cretaceous deposits are exposed in a belt that ranges from 80 kilometers (~50 miles) to 120 kilometers (~75 miles) wide across Alabama, as shown in Figure 1. They are inclined very gently toward the south, where they are covered over by younger rock layers beginning around (west to east) Choctaw, Marengo, Wilcox, Butler, Crenshaw, Pike, and Barbour counties.

During the Late Cretaceous, sea level in general was approximately 90 meters (~ 295 feet) above current sea level, in large part because of higher ocean temperatures resulting from a warmer climate and the absence of polar ice. The higher sea levels partially account for the shallow seas that flooded the southern portion of the state. The waters over west

and central Alabama were deeper than 90 meters and produced the Black Belt's characteristic chalky sedimentary deposits and the numerous fossils of open-marine animals found in them. The best fossil record of Cretaceous life in Alabama comes from deposits in this area.

By the time of the Cretaceous Period, the supercontinent of Pangaea, which assembled during the latest Paleozoic Era, had broken up into approximately the same continental units present on today's Earth. However, the continents were not yet in their present positions. Notably, Africa and Europe were at least 1,000 kilometers (~600 miles) closer to Alabama than at present because the Atlantic Ocean was only 50 million years old at the beginning of the Cretaceous Period, widening approximately four centimeters (about one and a half inches) per year.

Sedimentology

Cretaceous formations in Alabama are undeformed, meaning that they have not been folded or faulted through geologic activity. In fact, in some areas, they can hardly even be called "rocks," being instead mostly loosely compacted sediments. There are two main kinds of sedimentary materials: detrital (or clastic) sediments such as sand, gravel, and mud (silt and clay), and carbonate sediments, such as chalk and other limestones.

Detrital sediments are formed by the breakdown of Paleozoic rocks north of the Coastal Plain. During the warm, wet Cretaceous, these very old rocks weathered, eroded, and decomposed, and the resulting loose sediments were carried south by rivers and deposited at the coastline. Currents in the shallow seas picked up these sediments and spread them along the shore. Studies of the resulting layers, known as strata, show that they were deposited in coastal settings such as beaches, barrier islands, lagoons, estuaries, and marshes. Just offshore, fine-grained muds accumulated and were interlayered with thin beds of storm-swept sand. Even farther offshore, muds mixed with limey sediments to form rocks called marls.

In eastern Alabama, the bottom layers of the Upper Cretaceous sequence are composed mainly of river sediments and take the form of a combination of river and coastal deposits in western and west-central areas of Alabama; these oldest deposits are called the Tuscaloosa Formation. Younger detrital strata are found mainly in eastern and east-central Alabama (Figure 2), where they are called, from bottom to top, the Eutaw, Blufftown. Cusseta, Ripley, and Providence Formations. The sandstone beds of these formations are typically porous and form excellent groundwater aquifer systems, notably the Black Warrior River aquifer in the northern and central Coastal Plain, and the Chattahoochee River aquifer in the eastern Coastal Plain.

In western Alabama (and across much of the world), most of the Cretaceous deposits are composed of chalk, a type of limestone that is made up almost entirely of the microscopic fossils of planktonic marine organisms called coccolithophores (Figure 3). These tiny organisms

flourished in oceans all over the world until the end of the Cretaceous, when they were reduced to a fraction of their former diversity. Indeed, the name Cretaceous comes from the Latin word for chalk (*creta*). In Alabama, chalks comprise, from bottom to top, the Mooreville, Demopolis, and Prairie Bluff Formations. They represent marine deposits formed on the continental shelf far offshore from the sands, muds, and marls of the coast.

One interesting sidelight of Alabama's Cretaceous formations is the Wetumpka Crater, or Astrobleme. Located northeast of Montgomery, this crater-shaped feature contains Coastal Plain layers that are bent up at very high angles; this is the only place in Alabama's Coastal Plain where the strata are so highly deformed. It is apparently the result of a meteorite impact that occurred at some time after deposition of the Mooreville Formation, as those layers are part of the structure.

Fossil Record

Although the Cretaceous Period ended some 66 million years ago, the marine fossil record in Alabama contains many organisms that are not extraordinarily different from modern forms. Common Cretaceous shelled invertebrates included snails, clams, crabs, sea urchins, and a host of creatures that anyone would recognize. The seas also contained about as many types of fishes as at present, including some very close to modern types of sharks and rays. However, many Late Cretaceous marine genera are long extinct, such as *Protosphyraena*, *Enchodus* and *Xiphactinus* (discussed below). And because the Cretaceous marked the end of the "Age of Dinosaurs," the fossil record of Alabama includes several dinosaur species, as well as flying reptiles (pterosaurs) and many marine reptile groups that disappeared at the end of the Mesozoic Era, including plesiosaurs and mosasaurs, which are also discussed below.

Invertebrates: Among the common extinct late-Mesozoic shelled fossils are three distinct mollusk groups: exogyrine oysters, inoceramids, and ammonites. The exogyrines (Figure 4) were free-living oysters (in contrast with modern *Crassostrea* species, which attach to substrates and each other), with one coiled valve (one half of a bivalve shell) and one smaller cap valve. These are ubiquitous in nearshore deposits, and five sequentially evolving species provide a useful series of index fossils (rapidly evolving fossils that tell us the age of rocks) for the Late Cretaceous. The inoceramids were large (in some species up to 1.0 meter across, or around three feet), thin-shelled bivalves with distinctly corrugated ornamentation that are found abundantly in Alabama chalks. In some of their habitats, their large, flat shells formed a pavement on the sea bottom and a substrate for larvae of other mollusks to settle upon. Ammonites were cephalopods distantly related to the modern *Nautilus*, but their ancestors diverged more than 380 million years ago. They had complexly chambered, coiled shells (Figure 5) housing a soft body and appeared much like a giant squid coiled in a shell. Some ranged to nearly a meter (~ three feet) across and were predatory animals, as well as food

themselves for even larger marine predators, such as mosasaurs.

Vertebrates: The fossil record of vertebrates in Alabama is naturally biased toward marine species, as much of the landmass was covered by salt water for millions of years. Among the common distinctly Cretaceous marine fish are remains of the giant bony *Xiphactinus* (Figure 6), large (to 4.0 m or more, or about 13 feet), toothy predators represented by two species in deposits across the state: X. *audax* and X. *vetus*. The recognition that there were two species of slightly different ages was based on their occurrence in different strata near Montgomery.

Marine reptiles disappeared at the end of the Cretaceous, but they were the top marine predators right up to the end of the Mesozoic. Best known from Alabama are mosasaurs, which were giant marine lizards, and plesiosaurs, a diverse group of long-finned, long-necked marine reptiles; neither type has surviving relatives in modern seas. Isolated teeth and vertebrae of mosasaurs and plesiosaurs (Figure 7) are common fossils in Late Cretaceous deposits across Alabama, with the chalks of west-central Alabama yielding partial to nearly complete skeletons of several species.

Along the Late Cretaceous Alabama shorelines, between 83 and 77 million years ago, the largest and most common predators were not carnivorous dinosaurs, but, rather, a giant crocodylian species named *Deinosuchus rugosus*. *Deinosuchus* was a distant relative of modern alligators, reaching known sizes of 9.0 meters (almost 30 feet) and weights of up to 2.5 tonnes (more than 5,000 pounds) in Alabama and even larger in a western species. Its teeth and isolated bones are common fossils in the nearshore deposits in western Alabama, and a well-preserved skull and partial jaws have been found in the Mooreville Chalk in Lowndes County (Figure 8). Because *Deinosuchus* lived in the nearshore estuaries and bays, the Mooreville specimen was probably a carcass that washed out to the open ocean.

Dinosaur specimens in general are rare in Upper Cretaceous deposits in the eastern United States because most are marine sediments and dinosaurs were terrestrial. However, as with the *Deinosuchus* skull, some dinosaurs apparently floated out to open ocean waters after death, and quite a few left teeth and bones in nearshore deposits. In fact, two of the four dinosaur species known from partial skeletons in the eastern United States come from Alabama chalks. The first discovered was a young *Lophorhothon atopus* (Figure 9), a hadrosaur (duck-billed dinosaur) representing a new genus and species, from the Mooreville Formation at Harrell Station, Dallas County. Hadrosaurs are the most common dinosaurs in all eastern U.S. Cretaceous deposits, but the *Lophorhothon* type specimen is the only one known in this region with sufficient skull preservation to show that it had a "Roman-nosed" nasal structure and several unique details.

A second, relatively well-preserved dinosaur, Appalachiosaurus montgomeriensis, is an important transitional member of the tyrannosaur

lineage (Figure 10). Discovered in the Demopolis Formation in Montgomery County in the 1980s, it was not formally described and named until 2005. The original specimen, like the original specimen of *Lophorhothon*, was a half-grown individual and is preserved just enough to show that it is both similar to known members of the tyrannosaur group but sufficiently different to justify the new genus and species designation. It was a large predator (adults may have reached 2 tonnes, or about 4,400 pounds), with the characteristic small-armed, big headed, large-toothed form of tyrannosaurs, but considerably smaller than *Tyrannosaurus rex.* Two additional dinosaur groups recognized from isolated bones and teeth in Alabama are nodosaurs, which were four-legged, heavily built herbivorous dinosaurs covered with bony plates and spikes; and the chicken-sized velociraptor *Saurornitholestes*. Undoubtedly more dinosaurs were present and await discovery.

End of the Cretaceous

It is generally accepted by geologists that the mass extinction event that caused the demise of dinosaurs and the other distinctive Mesozoic animals was due in large part to an asteroid impact. The crater for the impact site has been found at sea off the Yucatan Peninsula in Mexico, and there are several sites in the world where distinctive quantities of rare elements found commonly in extraterrestrial bodies are concentrated in a thin horizon marking the exact date of the impact. One of the era-boundary sites is near Braggs, Lowndes County. At this unimposing site (Figure 11), a thin clay layer apparently spans the era boundary and has been drilled for core samples to test for the presence of microfossils characteristic of the transition from latest Cretaceous to earliest Paleogene. The Braggs site is especially important because is it among the very few nearshore marine deposits that transcend the Cretaceous-Paleogene (K/Pg) boundary. However, it is not absolutely certain that the deposits at Braggs contain the complete boundary section, because a very brief period of receding sea levels may have occurred right at the end of the Cretaceous.

Additional Resources

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