



Readings and Notes

An Introduction to Earth Science

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The Cretaceous Period

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The Cretaceous Period

World: A global rise in sealevel occurred during the Cretaceous; as a result, sealevel stood as high during the Late Cretaceous than at any other time in the Phanerozoic history of Earth. Although Pangea had begun to breakup during the Early Mesozoic Era, the smaller continents remained tightly clustered at the beginning of Cretaceous time. The continued breakup of Pangea and the dispersion of the newly created continents were among the most important events that occurred during the global geography of the Cretaceous. Especially important was the breakup of Gondwana. Gondwana was still intact at the beginning of the Cretaceous. However by the end of the period, South America, Africa, and India had all become individual continental masses; only Antarctica and Australia remained attached to each other.

With the breakup of Pangea, new oceans were formed among which were the South Atlantic, the Gulf of Mexico and the Caribbean Sea. During the early Cretaceous, while these basins were connected with the rest of the world's oceans, the connections were narrow, resulting in evaporates to accumulate along the basin margins. In fact, evaporates were deposited over a large portion of the Earth during the Early Cretaceous, a condition reflecting the warm climates of the time. These conditions also allowed the growth of coral reefs as far as 30° from the equator. Other indications of a warm global climate were the fossils of breadfruit trees in Cretaceous deposits of Greenland.

The dominant feature of the Cretaceous world was the great Tethys Seaway between tropical Africa and boreal Eurasia that allowed the prevailing trade winds to drive waters westward without obstructions. Early in Cretaceous time, the Arctic Ocean remained essentially isolated from the Atlantic and continued to be so until the huge landmass of North America was split into North America, Greenland, and Eurasia.

The Mesozoic Era came to an abrupt end with a sudden mass extinction. Life forms that had existed for tens of millions of years disappeared. Foremost among these in the minds of most people are the dinosaurs, while many other groups of animals and plants died. Flowering plants suffered heavy losses. In the oceans, "sea monsters" such as mosasaurs, plesiosaurs and giant turtles also went to extinction. Discoveries over the past few years have convinced many geologists

that the Cretaceous extinction was the result of a cataclysmic collision of one or more large extraterrestrial objects.

North America: The stratigraphic record of the Cretaceous Period in North America is one of the most widespread of all geologic periods. Later Cretaceous marine deposits are more extensive than any other period since the Ordovician. Uplift in the western portion of North America that started in Jurassic time continued through the Cretaceous, ultimately forming mountains from eastern California to Denver, Colorado. Sedimentation was widespread along the Gulf and Atlantic coasts, creating thick deposits of material while, along with the Jurassic deposits, formed the modern coastal plains.

The Rocky Mountain Seaway: Marine waters covered the western interior of the continent by Late Cretaceous time as seas transgressed southward from the Arctic and northward from the Gulf following the general trend of the Sundance Sea, eventually meeting in Wyoming. Thereafter, the combined seaway spread eastward to form a strait nearly 1,000 miles wide, forming a giant inland sea that divided the continent into two land masses, an eastern landmass that was low and tectonically stable and a western landmass that was narrow, mountainous, and tectonically active.

Atlantic Coast Submergence: From New Jersey southward, the Atlantic Coastal Plain is underlain by Cretaceous formations that dip seaward. This is a marked change from the Paleozoic history of the region. Up until the Cretaceous, the older sedimentary formations of the eastern North America were transported westward and deposited in the Appalachian Basin. But by Cretaceous time, the Appalachian Basin ceased to exist and the sediments created from the land were being transported eastward to the Atlantic Ocean where waves were breaking on the eastern shoreline as they do today.

Gulf Coast Submergence: During Cretaceous time, the entire Gulf coast was submerged and for a time, with an embayment reached as far north as Cairo, Illinois. As was the case with the Atlantic Coast, the Cretaceous deposits dip seaward and increase in thickness.

Growth of the Mesocordilleran Highland: Foreshadowed in Triassic time, the Mesocordilleran Highland continued to rise during Jurassic time and eventually were uplifted during the Cretaceous Nevadan Orogeny into a bold mountainous

region. While the highland rose, pulses of uplift moved the mass of the highland further east. The amount of sediment carried eastward into the Rocky Mountain Basin during Cretaceous time was enormous; having been estimated at a billion cubic miles. In order to provide this amount of sediment, it would require the weathering and erosion of 5 miles of rock from the entire area of the Mesocordilleran Highland.

The Laramide Orogeny and the Birth of the Rockies: Although crustal unrest occurred during the close of the Mesozoic in many parts of the world, nowhere was it more profound than in the western half of North America. The first episode of deformation was generated by compressive forces generated by the convergence of the North American and Pacific plates. Referred to as the Sevier Orogeny, the sediments that had accumulated in the large Cretaceous Basin were folded and driven by low angle reverse faults one layer upon another eastward as far as 100 miles. Numerous examples of older rocks being thrust upon Late Cretaceous rocks exist. A well-known example is Chief Mountain in Glacier-Waterton Park where Precambrian rocks were moved by the Lewis Thrust Fault almost 50 miles and placed on top of Late Cretaceous shales.

A second wave of mountain building called the Laramide Orogeny followed the Sevier Orogeny. This second wave of deformation was characterized by vertical uplifts located east of the Sevier Mountains, mainly including the middle and southern Rockies of Colorado and Wyoming and eastward to the Black Hills of South Dakota. In North America, the combination of the Sevier and Laramide orogenies has long been referred to by most geologists as the Laramide Orogeny after the Laramide Range which forms the Front Range in Wyoming. The combined efforts of the two mountain building episodes resulted in the creation of the Rocky Mountain System that extended from Alaska to Central America with a width of 500 miles. It was the most profound orogeny experienced by the western North America since Precambrian time. When combined with its counterpart in South America, the Andes Mountains, it was one of the greatest mountain building episodes of all time.

Volcanic activity was active on the Mesocordilleran Highland as the eastern portion of the Pacific plate subducted under the westward-moving North American continental plate. During the crustal movements, several enormous

granite batholiths were emplaced into the rising mountains. One of these, the Sierra Nevada Batholith, actually consists of several individual granitic batholiths that when combined formed a granitic mass about 400 miles long and 80 miles wide. The Coastal Range Batholith extends approximately 1,100 miles from northern Washington state to Alaska while the eroded summit of the Idaho Batholith is exposed over an area of about 16,000 square miles. Of economic interest is the fact that much of the metallic ores for which the West is famous were injected during Cretaceous time including the copper at Butte, Montana and the gold of the California Mother Lode.

The pattern of orogenies from the Nevadan and Sevier orogenies in Late Jurassic and Cretaceous time and the Laramide Orogeny in Cretaceous and Early Tertiary time suggests a more or less continuous wave of crustal deformation of the western portion of North America from west to east

The Spread of Modern Plants: Deciduous trees suddenly became conspicuous in the Early Cretaceous and dominated landscapes on all continents long before the close of the period. Among the oldest are the magnolia, fig, sassafras, and poplar, all of which appeared before the middle of the Lower Cretaceous. By the Middle Cretaceous, the forests were essentially modern with trees such as birch, beeches, maples, oaks, walnuts, tulip trees, sweet gums and breadfruit along with shrubs such as laurel, ivy, hazelnut, and holly. Evergreens were also present but did not dominate the landscape as they previously had. A conspicuous conifer was the sequoia, although not so large as those in the modern forests of California. Cycadeoids were the dominant plant of the upland slopes. Besides the hardwood trees mentioned above, the order includes grasses and cereals as well as seed and fruit-bearing shrubs, annuals, and our common vegetables.

Most deciduous trees were angiosperms, the highest order of the plant kingdom. Second only to the spread of plants on land during Devonian time, the appearance of the angiosperms was the second most significant event in the evolution of plant life. One cannot forget their importance to the evolution of higher forms of animals in that they provide nearly all the plant food for the mammals that now dominate Earth. First appearing in abundance simultaneously in New Zealand, Texas, and in the coastal plain of Maryland, they now comprise more than 90% of the plants of the Upper Cretaceous. The resting stage

represented by the ripening of the seeds and the shedding of the foliage is clearly an adaptation to seasonal rigorous climates, be it either of winter cold or of drought.

The Culmination of the Reptilian Dynasty: Dinosaurs dominated Earth until the close of Cretaceous time. The great sauropods persisted locally and are known from the Lower Cretaceous in Wyoming and the Upper Cretaceous in New Mexico, Utah, and Texas. The plated dinosaur, *Stegosaurus* was almost extinct by the end of the period. The largest carnivore of all time, *Tyrannosaurus rex*, reached its maximum size in the Late Cretaceous measuring a length of about 45 feet while carrying its head 20 feet above the ground. Bipedal herbivores (Ornithomimids) such as the “duckbilled” dinosaur, *Trachodon*, were among the most common dinosaurs of the Late Cretaceous. The great tribe of “horned” dinosaurs such as *Triceratops* survived until the very end of the Cretaceous.

Marine Reptiles: While Ichthyosaurs had passed their climax before the close of Jurassic time, the plesiosaurs attained their greatest size in the Cretaceous. The dominant group of marine reptiles were the mosasaurs which appeared during Cretaceous time. The animal had a scaly skin similar to a snake and possessed a jaw with extra joints which allowed the animal's mouth to open wider in order to grasp and swallow large prey. The mosasaur used five-fingered flippers for locomotion. The largest known mosasaur was some 35 feet long. Armed with speed and a gaping, tooth-lined jaw, the mosasaur was undoubtedly the most dominant predator in the Mesozoic seas. Marine turtles were present, the largest of which was a specimen of *Archelon* that measured 11 feet in length and 12 feet across the flippers. In addition, crocodiles, both broad-snouted and narrow-snouted varieties, were present in the rivers and streams.

The Last of the Winged Reptiles: Pterosaurs, although less numerous than during Jurassic time, were large and more specialized. The largest had a wingspan of about 25 feet making it the largest winged animal of all time. Even with such a wingspan, the body was only the size of a goose. Pterosaurs were quite helpless on the ground. In fact, pterosaurs are thought to have spent most of their lives soaring over the sea like a modern albatross. Unlike the Jurassic specimens that had teeth, the Cretaceous pterosaurs were toothless.

The Appearance of Birds: The first bird was *Hesperornis regalis* of which numerous specimens were found in the chalk deposits of Kansas. With only vestigial wings, *Hesperornis* was flightless and was adapted to life in the sea where it could swim and dive much like the modern penguin.

Mammals: With the presence of the dinosaurs and with food supplies such as cereals and fruit not yet common, the mammals had to bide their time. Fragmentary remains have been found in the Lower Cretaceous in Texas and in the Upper Cretaceous in the Western Interior. Of these, apparently only the Multituberculata were present; the other four types had failed to survive to Cretaceous time. However, two new orders made their appearance in the Cretaceous, the marsupials (pouch bearers such as the opossum) and the insectivores to which modern shrews and moles belong.

The Invertebrates: Ammonites and belemnites were on the decline. Clams and gastropods were present in many kinds and were essentially modern in appearance. Oysters were very common while brachiopods were no more abundant than they are today. While insects are very difficult to preserve, we can probably assume that by Cretaceous time they had adapted themselves to feeding upon the nectar of the newly evolved flowering plants, thus establishing their important role in pollination.

The Great Dying: The end of the Cretaceous was a great crisis in the history of life. Several stocks of animals declined during the period and became extinct by the end of the period. While the dinosaurs were adaptive to nearly all niches on Earth, none is known to have lived until the dawn of the Cenozoic Era. While some consider the demise of the dinosaurs to be the result of a cataclysmic event such as a meteoroid impact, most dinosaurs were already in decline when the much referred to meteoroid plunged into the Yucatan Peninsula. Too highly adapted perhaps, the pterosaurs died out long before the end of the Cretaceous. Of all the marine reptiles, only the turtles were to survive. The extinction of the ammonites, the belemnites and of several stocks of reef-forming clams indicates that the marine invertebrates did not escape the crisis. It is difficult to explain the simultaneous extinction of so many different tribes of animals with such diverse life styles. More than likely there was not a single cause but perhaps the combined effects of dwindling epeiric seas and the subsequent loss of marine

habitats, the affect upon the climate of the rise of the western highlands, the elimination of the wetlands plus other forces of which we are unaware. Whatever the cause or combination of causes, much of the animal life of the time was not able to adapt.