WETUMPKA IMPACT CRATER

Discovery AND VISITOR CENTER

WETUMPKA IMPACT CRATER

1 Rockstar Handbook supplemental material

The Wetumpka Impact Crater and the Cretaceous Period
An Integration of Visual Art, Paleontology and Geologic History
Docents & Internships

Responsibilities:

1. Pre-education about the Wetumpka Impact Crater and the Cretaceous Period
2. Become familiar with the Power Point presentations and other information on the website (wetumpkacraterart.org) and in the Discovery Center & Alleyway.
    1. Wetumpka Crater
    2. Cretaceous Marine Life
    3. Cretaceous Dinosaurs
    4. Cretaceous Plant Life
    5. Impact Effects: Tsunami, Earthquake, Flash Fires
    6. Meteorites, Asteroids, Comets
    7. Inland Sea and Barrier Islands
    8. Fossils
    9. The Rise of Mammals
    10. Sedimentary Formations & Geology
    11. Flying Reptiles and Bird-Like Dinosaurs
    12. Cretaceous Insects
    13. Story Boards
    14. Self Guided Tour Booklet
    15. Discovery Center Videos
    16. Discovery Center Supplemental Material Package

3. Become familiar with the collection & artists work:
    - Karen Carr, New Mexico: paleoartist
    - Jerry Armstrong, Georgia: cosmic artist
    - Jonathon Hughes, Thailand: paleoartist
    - Asher Elbein, Texas: artist
    - Hope Brannon, Alabama: artist
    - Barry Chrietzberg, Alabama: photographer
    - Shirley Esco, Alabama: artist
    - Brooks Barrow, Alabama: sculptor

4. Read and Understand the Docent Handbook
5. Be prepared;
    A. Create Docent Scripts
    B. Conduct Impromptu Tours and Answer Questions for Visitors
    C. Attend to and Engage with Visitors
    D. Spread the Word: Upcoming Events & Lectures.
    E. Conduct Scheduled Tours: Adults or Students
    F. Short Docent Talk Featuring Specific Works in the Collection
    G. Story Boards- include info in your tour
    H. Engage Students through Museum Activities:
    Studio Workshop: Hands-On Activities for School Age Students
    (Small Groups - 45 minutes) - Visual Art Activity

GEOLOGIC TIME SCALE

ERA	PERIOD	m. y. ago
CENOZOIC	QUATERNARY	0.012
	HOLOCENE	
	PLEISTOCENE	2.58
	NEOGENE	23.03
	PALEOGENE	66.0
MESOZOIC	CRETACEOUS	145.0
	JURASSIC	201.3
	TRIASSIC	251.90
PALEOZOIC	PERMIAN	298.9
	CARBONIFEROUS	323.2
	PENSYLVANIAN	358.9
	MISSISSIPPIAN	419.2
	DEVONIAN	443.8
	SILURIAN	485.4
	ORDOVICIAN	541
	CAMBRIAN	2500
PRECAMBRIAN	PROTEROZOIC	4000
	ARCHEAN	4560
	HADEAN	

CENOZOIC — MAMMALS — Age of Ice — Mammals Inherit the Earth

MESOZOIC — BIRDS | REPTILES | DINOSAURS — Reptiles Rule the Earth

PALEOZOIC — MARINE INVERTEBRATES | FISHES | AMPHIBIANS | INSECTS — A World of Water — Fins, Limbs & Land Plants — Swamp Forests — Super-Continents — Deserts to Lush Forests

PRECAMBRIAN — Earth Forms — Simple Life Like Single Cells — Proterozoic Life Progressed from Single to Multicelluar Forms

QUATERNARY
"Possible sixth mass extinction due to rapid global warming after the last glacial cooling."
ICE AGES

NEOGENE

PALEOGENE
Eocene-Oligocene extinction event

Basilosaurus cetoides
Alabama's State Fossil

CRETACEOUS
Cretaceous-Tertiary (K-Pg Extinction): 66 m.y. ago
Wetumpka Impact Crater: 85 m.y. ago

JURASSIC

TRIASSIC
Triassic-Jurassic Extinction: 201 m.y. ago

PERMIAN
Permian-Triassic Extinction: 252 m.y. ago

CARBONIFEROUS

DEVONIAN
Permo-Carboniferous (formerly Karoo) Ice Age: 360-255 m.y. ago
Late Devonian Extinction: 375-360 m.y. ago

SILURIAN

ORDOVICIAN
Ordovician-Silurian Marine Extinction: 444 m.y. ago

CAMBRIAN

PROTEROZOIC
Marioan Glaciation (Snowball Earth) 635-650 m.y. ago
Cryogenan Ice Age: 720-635 m.y. ago
Huronian Ice Age: 2,400-2,100 m.y. ago

ARCHEAN
Oxygen starts to build up in atmosphere: 2300 m.y. ago
Worlds Oldest Fossils (algae): 3,400 m.y. ago
Emergence of Life
Worlds Oldest Rock: 4,000 m.y. ago

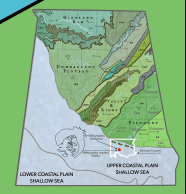
HADEAN

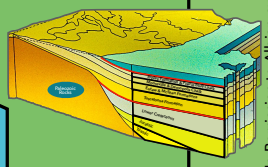
ERA	PERIOD	EPOCH	AGE	m. y. ago
MESOZOIC	CRETACEOUS	LATE	MAASTRICHTIAN	66.0
				72.1
			CAMPANIAN	
				83.6
			SANTONIAN	85
			CONIACIAN	86.3
			TURONIAN	89.8
			CENOMANIAN	93.9
		EARLY	ALBIAN	100.5
			APTIAN	113
			BARREMIAN	125
			HAUTERIVIAN	129.4
			VALANGINIAN	132.6
			BERRIASIAN	139.8
				145

Pteranodon: (tuh-ran-uh-don)

Span of Upper Cretaceous geological formations in Alabama.

No Berriasian to Albian exposures in the state of Alabama: 145-100 Ma





ALABAMA CRETACEOUS LIFE

Dinosaurs, Pterosaurs, Birds, Insects, small Rodents, small Mammals, giant Marine Reptiles, Sharks, Fish, Turtles, Invertebrates (many forms such as: Ammonites, Belemnites, Mollusks, Jellyfish, Corals, Crustaceans, Echinoderms, Gastropods, Brachiopods, Pelecypods), Ferns, Palms, Cycads, Conifers, and Angiosperms (Flowering Plants).

Eotrachodon orientalis (ee-oh-track-oh-don)
Lophorhothon atopus (lo-for-rho-fon)
Bee
Ichthyornis (ik-fee-or-nis)
Nodosaurs: (no-do-sawrs)
Dromaeosaurs: (dro-me-oh-sawrs)
Alphadon: (al-fa-don)
Appalachiosaurus montgomeriensis: (ap-a-lay-chi-o-sawr-us munt-gum-er-e-in-sis)
Belemnite (bel-em-nite)
Pachyrhizodus (pack-ee-rye-zo-dus)
Deinosuchus (dai-nuh-syoo-kuhs)
Squalicorax (skwa-lih-cor-ax)
Elasmosaurus (elas-mo-sau-rus)
Polycotylid Pliosaur (polly-cot-eye-lid plio-saur)
Mosasaur (moe-sa-sawrs)
Xiphactinus (zai-fact-in-us)
Protosphyraena (pro-to-s-fy-ray-nah)
Inoceramid clam (ino-cer-a-mid)
Exogyra oyster (ex-o-gy-ra)
Protestega (pro-toe-steg-a)
Ammonite (am-mo-nite)
Cretoxyrhina (kree-tox-ee-rye-nuh)

WETUMPKA IMPACT CRATER

The offshore area of an ancient interior seaway eventually became the land on which downtown Wetumpka was built and through which today's Coosa River runs. The area became the site of future Alabama's greatest disaster as the ground zero bull's eye of an explosion caused by the impact of a huge object from outer space.

During the age of Dinosaurs, (late Cretaceous) a meteor the size of Bryant-Denny Stadium or Jordan-Hare Stadium blasted 2,000 feet deep into bedrock under a shallow sea and coastal area. At the time of impact, marine reptiles inhabited the water and dinosaurs lived on nearby land. The meteor impact created a 2.3 billion ton TNT explosion, equivalent to the energy of 175,000 times the nuclear bomb at Hiroshima in 1945, causing heavy damage and death; affecting both land and sea.

The Wetumpka Impact Crater (4.7 miles in diameter) is the only confirmed impact crater in Alabama and one of only 200 world-recognized craters. Its age is based on fossils found in the youngest disturbed deposits of a geological formation known as the Mooreville Chalk. The hills east of the Coosa River and downtown Wetumpka are the eroded remains of the Wetumpka Impact Crater rim.

Guided Crater Tours occur annually in late February or early March. For more information visit wetumpkaimpactcrater.org

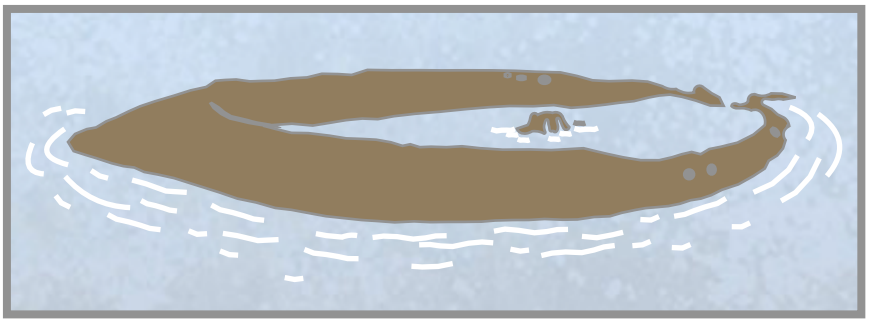
WETUMPKA IMPACT CRATER | EDUCATIONAL VIEWPOINTS

AHA ALABAMA HISTORICAL ASSOCIATION MARKER: 6501 US Highway 231
1 EDUCATIONAL VIEW #1: 715 Wilson Street, behind First Community Bank
2 EDUCATIONAL VIEW #2: Bald Knob Road at the Utility Clearing
3 EDUCATIONAL VIEW #3: Harrogate Springs Road at The Cliffs
4 EDUCATIONAL VIEW #4: Buck Ridge Road at the Gas-line Clearing
5 EDUCATIONAL VIEW #5: Trotters Trail at the Gas-line Clearing
6 EDUCATIONAL VIEW #6: 2350 Coosa River Pky, Wetumpka Sportsplex
7 EDUCATIONAL VIEW #7: Behind Hill Street on the Riverbank

CRATER MAPS ARE AVAILABLE IN DOWNTOWN WETUMPKA AT: ELMORE COUNTY COURTHOUSE, CITY ADMINISTRATIVE BUILDING & THE WETUMPKA CHAMBER OF COMMERCE.

Wetumpka's paleogeographic setting. -- Neathery *et al.* (1976) note that the Wetumpka impact crater is unique in its geologic setting because nowhere along 1600 kilometers (994.2 miles) of coastal plain-piedmont (fall-line) is there reported a combination of geologic conditions and effects that so clearly define an impact structure.

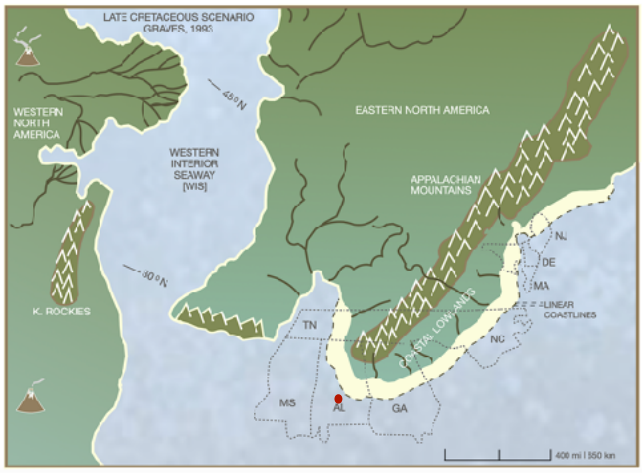
Considering that the Late Cretaceous shoreline approximately paralleled the arched modern fall-line, the target area was likely just a few 10s of km (1km equals .62 miles) offshore (assuming Late Cretaceous impact).[1] The meteor struck what is now Elmore County on the eastern side of what is now the city of Wetumpka. All that remains of the meteoritic impact crater formed by the collision is a crescent-shaped ridge of hills rising up to 300 feet above the surrounding river plains. Bald Knob, the highest point on the rim, and other parts of the crater remnant are clearly visible to travelers entering Wetumpka on US Highway 231 and Alabama Highway 14.[2]



Wetumpka Impact Crater, Cretaceous Period (after Jerry Armstrong,)
Digital Drawing, 2021, © P. Hope Brannon

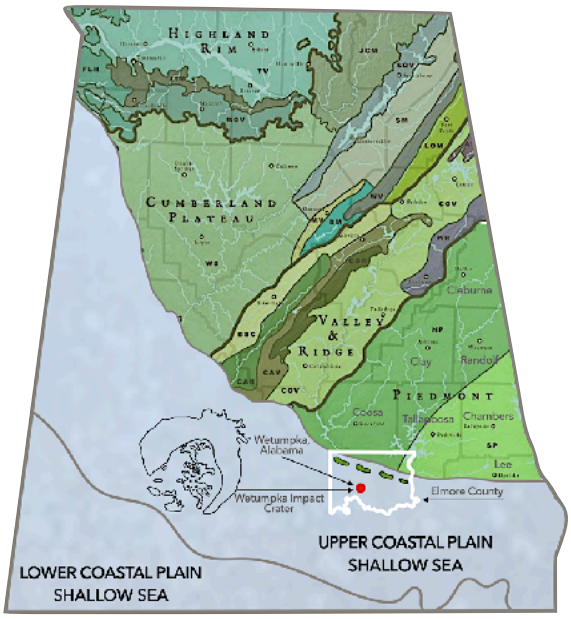
The crater structure was first noted in 1969 by a group of geologists from the Geological Survey of Alabama, including team leader Thornton L. Neathery. In 1976, Neathery and his co-workers published a paper proposing that a meteor had created the feature, which they called the Wetumpka astrobleme (star-wound). Its origin was not proven conclusively until 1999, when a team of scientists, including Neathery and Auburn University geologist David T. King Jr., completed a 630-foot-deep drilling operation at the crater's center. The scientists found that the minerals contained in the subsurface samples revealed evidence of deformation characteristics resulting from high pressure and massive sudden impact. Such minerals are found only in structures formed by cosmic impacts and at nuclear-test sites. In addition to the physical analysis, the material was subjected to geochemical testing at a laboratory in Vienna, Austria, which revealed meteoritic elements such as iridium, cobalt, nickel, and chromium that helped confirm their meteoric origin. In 2002, the research team published its results in *Earth and Planetary Science Letters* and officially established Wetumpka as the 157th known impact crater on Earth.[3]

The Wetumpka impact crater (approximately 4.7 miles wide) formed during a time in geological history when the sea level was much higher than it is today. Much of southern and central Alabama was under the shallow waters of an interior seaway. The great Western Interior Seaway separated the eastern half of North America (*Appalachia*) from the west (*Cordillera.*) The northeast part of the state would have featured the Appalachian mountains, taller than today but still weathered significantly from their highest points. The land in between the mountains and the shoreline would have been dominated by tropical jungles, where dinosaurs like “Appalachiosaurus" roamed, and the shoreline ran roughly from present day Tuscaloosa County to northern Elmore County and eastward to northern Russell County.[4]



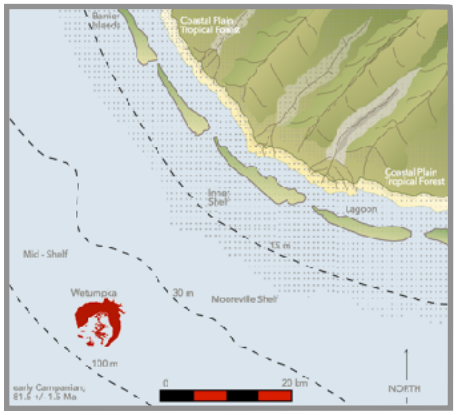
Late Cretaceous Scenario (after Graves, 1993,) Digital Drawing, 2021, © P. Hope Brannon

The Wetumpka impact thus occurred about 10-15 miles offshore from the coast and barrier islands, in water about 100 feet deep. The rim is made of hard, crystalline rocks, and the interior area is composed of softer, sedimentary materials. There is also an area of highly disturbed sediments outside the crater's rim on the southern side of the crater that were washed into place by the catastrophic resurgence of sea water forced away from the area by the impact.[5]



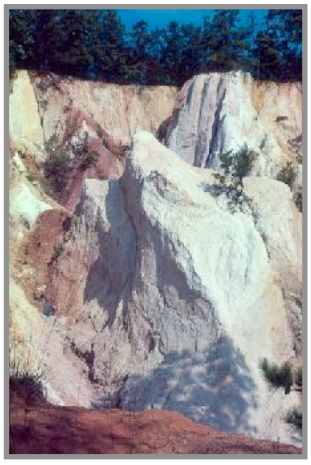
Alabama Geologic Map, Karen Carr, (Overlay, P. Hope Brannon)

The collision produced an earthquake, a tsunami, an atmospheric blast wave (hurricane-force, straight-line winds), and a cascade of falling rocks that would have blasted out of the developing crater bowl. Many thousands of living things including dinosaurs, reptiles, and aquatic life along the shoreline of todays Elmore County were decimated by this event. The Wetumpka impact (a subglobal disaster) did not have global consequences, however, and is not linked to any global extinction of animals or plants in the geological record.[6]

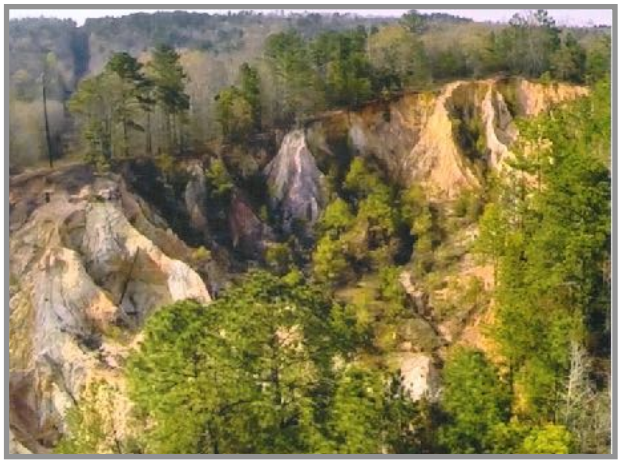


Wetumpka Impact Location and Barrier Islands (after King,) Digital Drawing, P. Hope Brannon

The unusual feature shown here, found just inside the western rim of the crater, is known by local residents as “The Cliffs.” Scientific research indicates that the cliffs themselves were part of a major post impact event, which caused a massive landslide that brought vast quantities of very large blocks of sandy and clayey target sediment back into the crater and up to this point at the cliffs. The effect of this event can be seen in the widespread interior crater-filling deposits. Good examples of this are the red and tan sands of “The “Cliffs” and other areas along Harrogate Springs Road. These red and tan layers were moved from the southern (Upper Coastal Plain) rim of the crater to their present locations during this massive event. This “trans-crater slide” came to rest against the crater wall in the vicinity of the cliffs, where – thanks to erosion in that spot – we can see slide layers folded up against the sands and harder rocks of the crater rim.



The Cliffs, 1982
Photograph courtesy of M. Edwards



The Cliffs, 2015 (Drone Photograph)
Photograph courtesy of the Wetumpka Impact Crater Commission

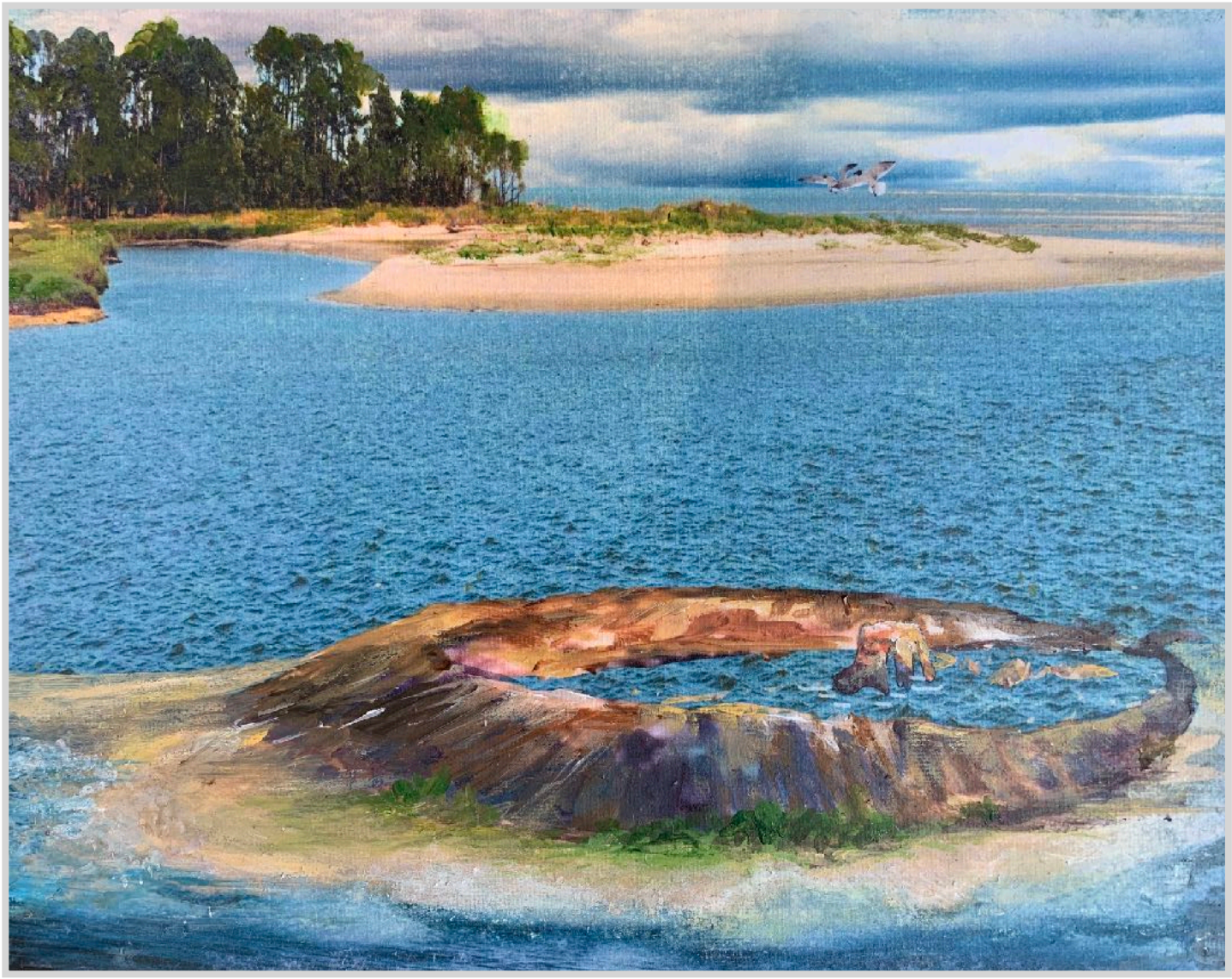
The Wetumpka impact event, a subglobal disaster, caused minor, but notable, ecosystem alterations to the biologic system because of the physical effects of the 2.6-gigaton impact explosion. The impact structure served as a local reservoir for an impact-entombed fossil record in two main ways: (1) course-to-fine fragments of terrestrial vegetation, probably from the adjacent tropical forest, were swept up and were incorporated and (2) intact blocks of sedimentary units containing internal fossil components of their own were swept up and were incorporated into the wash back and surge back deposited breccias and sands. Some of these sedimentary red blocks include “updip” sedimentary deposits that no longer exist in outcrops anywhere in the region and are recognizably distinct from adjacent sediments.[7]

Wetumpka Impact Crater, Outward Tsunami Generation, King

The town of Wetumpka, (Elmore County) Alabama, giving its name to the Wetumpka impact crater took its unusual-sounding name from a term in the Creek native people's language: we-tum-cau, which is derived from the union of we-wau (water) and tumcau (rumbling); (Read, 1984). Thus in the Creek Indian language, Wetumpka means rumbling water or alternatively sounding or tumbling water.

These names are not entirely inappropriate for an impact crater that probably formed in shallow sea waters during the Late Cretaceous.[8]

The area of Wetumpka and its crater eventually began to heal, and, “as unlikely as it may seem considering the overall marine setting of the crater, the Wetumpka impact crater apparently functioned as a minor terrestrial (island) ecosystem that was embedded within the shelfal marine realm for several thousand years until its final, and catastrophic, rim collapse.”[9]



HOW WAS THE WETUMPKA IMPACT CRATER DISCOVERED?

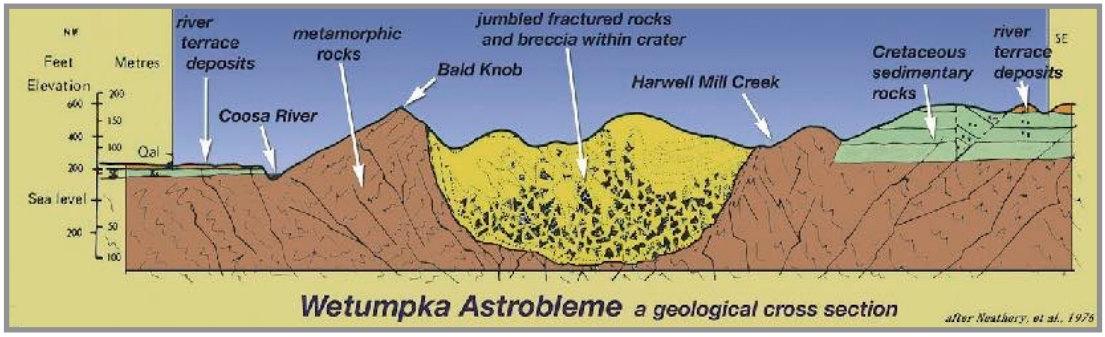
Eugene Allen Smith

1891, Alabama State Geologist Eugene Allen Smith (born in Washington Ferry, Autauga County, AL on October 27, 1841) noted the unusual geographical nature of the Wetumpka area. For many years, the area was marked on geological maps as "structurally disturbed."[10]

Tony Neathery

1969-1970, Geologist Tony Neathery headed a team making detailed geologic maps of Elmore County as part of the Geological Survey of Alabama. As they approached Wetumpka, they found rock layers bent at dramatically different angles and in very different directions from other rocks in the area. It soon became clear that the unusual features were related to a disturbance centered in the hills east of downtown Wetumpka. Within this area, rocks were chaotically disturbed and intermixed, unlike the evenly layered horizontal rocks surrounding the area.[11]

1976, When Tony Neathery's findings were published, this feature was called an "Astrobleme," literally, a star wound. For a number of years, this conclusion was greeted with skepticism.[12]

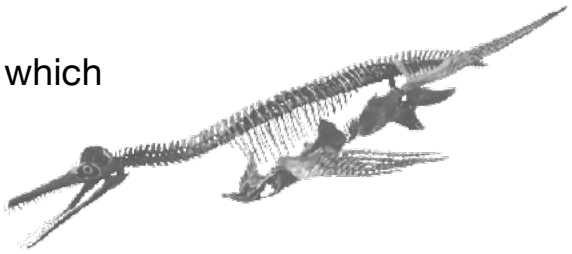


Wetumpka Astrobleme, A Geological Cross Section

Dr. David T. King, Jr.

1998, Two cores were drilled and core samples were extracted for testing. Geologists hoped to find materials proving the "Astrobleme" theory. Dr. David T. King, Jr., Professor of Geology at Auburn University, headed the research team. The researchers indeed found that the core contained shocked quartz, which can only be formed by pressures exerted during an enormous explosion such as a large meteor impact. The research team also found chemical traces of the meteorite elements embedded in the local bedrock.[13]

2009, Dr. David T. King, Jr., Professor of Geology at Auburn University, headed the research team that drilled nine boreholes down into the crater at depths ranging from 70 to 700 feet. This drilling program, funded by NASA, provided much more information about the crater-filling materials and the role of water in the Wetumpka impact event. Drilling in 2009 did not reach the bottom of the crater, which is estimated to be a kilometer or about 3,200 feet below the present land surface.[14]



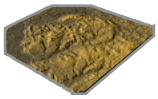
Interestingly, Wetumpka's impact crater has what arguably must be the most bizarre form of ***stratigraphic leakage*** (the process in which sediments or fossils of a younger age are deposited within or under older rocks) ever described. In the original abstract announcing discovery of Wetumpka's impact crater, Bentley *et al.* (1970) refer to a centrum from a polycotylid pliosaur, *Discosaurus* (within a small block of Mooreville Chalk), that was embedded, owing to impact pressure, within strata of the Tuscaloosa Formation at Wetumpka (see Thurmond and Jones, 1981). Thus, by extraterrestrial force, an early Campanian (83-72 Ma) vertebrate fossil was thrust down into a Cenomanian (100-93 million years ago) formation.[15]

Above: Drill crew from Vulcan Materials Company; Marsha Andrews at left (July 1998).

Right: David King and Tony Neathery taking a break during drilling at Mr. Schroeder's home (June 1998).

Photographs courtesy of David King

WHERE IS THE WETUMPKA CRATER?



The most common question that is asked about the Wetumpka Impact Crater is *Where is the Crater?* And, the most common answer, depending on where you are located in Wetumpka, is *You're standing in it!*

Wetumpka Impact Crater Icon, Digital Drawing, 2021, © P. Hope Brannon

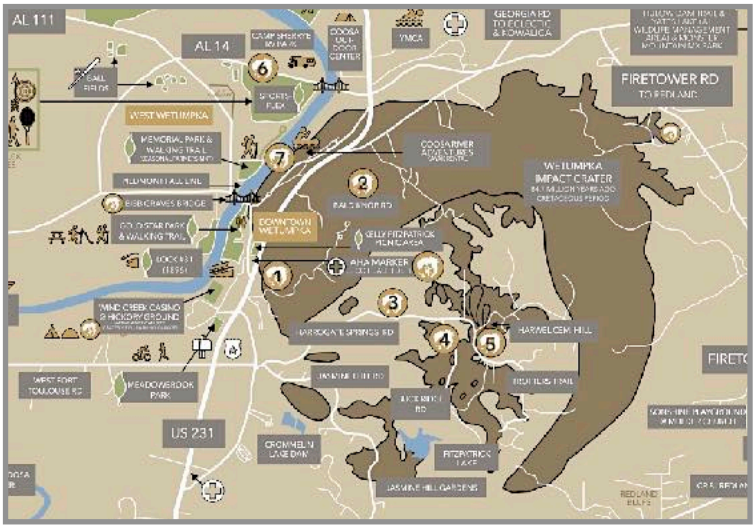
Wetumpka is one of those towns that was built in, on, and around the Crater! For years and years, no one even knew it was a crater! Because of the unusual terrain, people thought that it was the last outcropping, or the "foothills," of the Appalachian Mountains, and these jumbled and fractured hills kept their secret until 1976 when Tony Neathery and his team labeled them as an astrobleme (star wound).

Barringer Crater, Arizona

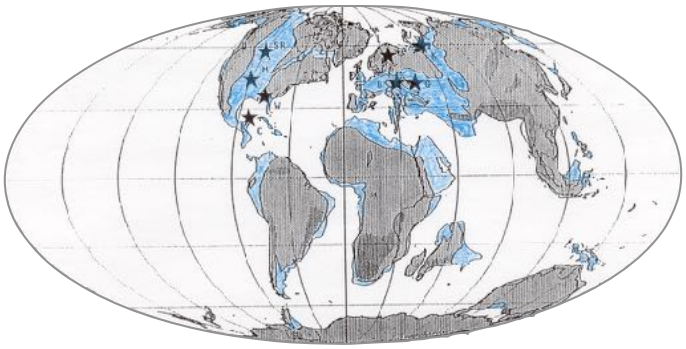
Unlike the "Barringer Crater" in Arizona which is in the middle of a high arid desert with no trees, little foliage, and extremely easy to see, the Wetumpka Impact Crater is filled with some tributaries and creeks of the Coosa River, beautiful hills, trees and under growth, homes, businesses, roads, highways, and people who live in it, on it, and around it. Ours is one of those craters that is more challenging to identify from the ground. If you want to see the Wetumpka Impact Crater in its entirety, you need to be in the air! After all, it is 4.7 miles wide.

Wetumpka Impact Crater, Digital rendering of a topographic map.

Don't have a plane? You need not despair! The Wetumpka Impact Crater Commission has created a public "Crater Route" and map that enables one to drive to specific viewpoints and educational locations of note. Maps are available at the Elmore County Courthouse, City Administrative Building, and the Wetumpka Chamber of Commerce, all in Downtown Wetumpka.



THE EARTH IS A TOUGH PLACE TO BE A CRATER!



Late Cretaceous Terrestrial Craters (King)

Once formed, impact craters are immediately subjected to wind, rain, earthquakes, landslides, volcanism, and even plate tectonics. All of these processes act slowly, and not so slowly, to change their original appearance, making them hard to identify.[29]

In addition to these natural geologic processes at work, there are biologic ones as well--craters can be covered by plant life and trampled by animals. Humans have even built cities over them, never realizing they were there! Take Wetumpka for example![30]

But how can that be? Something that big ought to be pretty easy to spot, even if it is worn down, right? Well, things can look very different on the ground than they do from the air.[31]

A nice, fresh, small crater might be easy to identify, even looking at it from an angle.[32]

But what about much larger craters? They too can be very difficult to identify. You might be standing right in, or next to one, and not even realize it.[33]

And then…once you think you have found a crater, you have to get scientists and geologists involved to do the research and field work and to drill test, find evidence and get confirmation by the scientific community…this takes a lot of time and work!

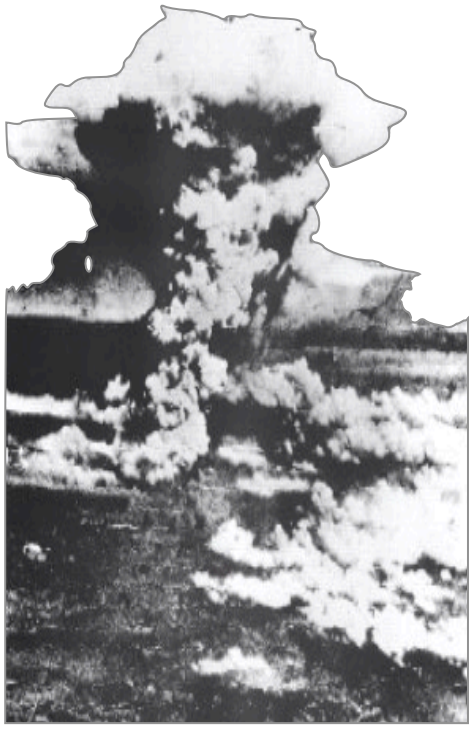
- **Late Cretaceous Period Impact Craters:**
  Including Wetumpka, there are nine Late Cretaceous terrestrial impact craters known, ranging in size from 6 to 170 kilometers (3.73 - 105.6 miles) diameter, and all are situated in the northern hemisphere. Two of these impact craters are temporally correlated with global marine mass extinctions. Steen River impact crater (25 kilometers or 15.5 miles in diameter; Canada) may be related to the terminal Cenomanian (91 million years ago) mass extinction of 14 to 19 percent of all marine genera. Chicxulub (170 kilometers or 105.6 miles diameter; Mexico) is firmly established as a significant causal factor in the well-documented terminal-Cretaceous (66 million years ago) mass extinction that included 39 to 47 percent of all marine genera and many terrestrial genera as well.77

AN IMPORTANT THING TO KNOW

An impactor does not create a hole by pushing aside material to form an impact crater. What really happens is that an explosion creates the crater![34]

Even small craters are created by very energetic events; impactors that plow into a planet like the Earth are moving very fast. The Wetumpka impactor was traveling 20 kilometers per second; that is around 44,738 miles per hour!! Compare that to a jet fighter, which may travel 1800 miles per hour, or a rifle bullet that *only* reaches speeds of 2200 miles per hour.[35]

All that speed means a lot of momentum, and a lot of energy. That energy gets transferred right into the ground, making dramatic changes to the rocks, the most noticeable of which is the huge explosion that creates the impact crater itself. Because of the energies involved, it doesn't take a very big impactor to create a big crater.[36]



Hiroshima Hydrogen Bomb Explosion: Similar to an Impact Explosion (Only Smaller!)

Take the Wetumpka Impact Crater for example--we know that the impactor was was a mostly stoney meteorite about 1200 feet in diameter, about the size of the Auburn University or the University of Alabama football stadiums), but the crater is 4.7 miles (24,816 feet) across! A crater is usually 20 times the diameter of the impacting object.

It's also important to remember that most meteors are small and burn up when entering the earth's atmosphere. We see them all the time as "shooting stars."

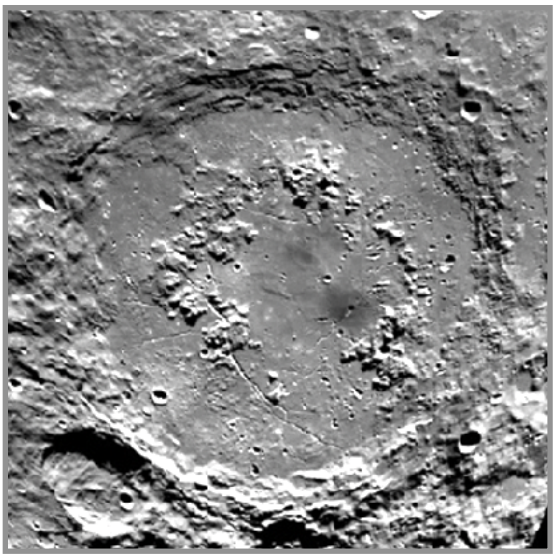
REGIONAL AND LOCAL ATMOSPHERIC EFFECTS:

The Wetumpka impact or any impact event large enough to register a crater equal to, or exceeding, Wetumpka's may have included (1) cooling and photosynthetic suppression due to atmospheric dust loading, wafted soot from large-scale fires, shock pressure-generated nitrous-oxide, and target-generated sulphur dioxide; (2) large-scale fires and associated atmospheric injection of pyrotoxins; (3) acid rain from pollution by burning, nitrous-oxide generation, and sulphur dioxide injections; (4) ozone loss due to nitrous- oxide generation; (5) mechanical pressure effects due to shock waves; (6) destruction and drowning due to tsunami; (7) global warming due to H_2O and CO_2 injections; (8) and water, food, and soil poisoning due to heavy-metal dispersion (Toon et al., 1994).[75]

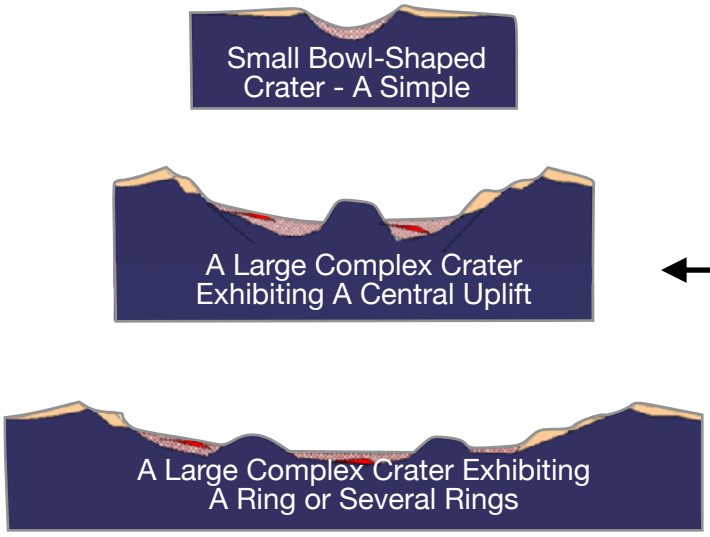
SO… JUST HOW DOES A CRATER FORM?

There Are Three Basic Types of Craters With Different Stages!

As mentioned before, not all craters are the same. While the smallest craters on a planet will be nice, simple bowl shapes, the medium to large-sized craters will have a more complex form. Scientists refer to these as 'complex' craters. Like the crater shown here, they can have ridges or 'terraces' inside of their rims with flatter floors, and a central peak, or ring of peaks.[42]



A Large Complex Crater, Aerial View on the Moon, This is the ring of peaks, which was formed by the collapse of a large central uplift, as in the third diagram below.



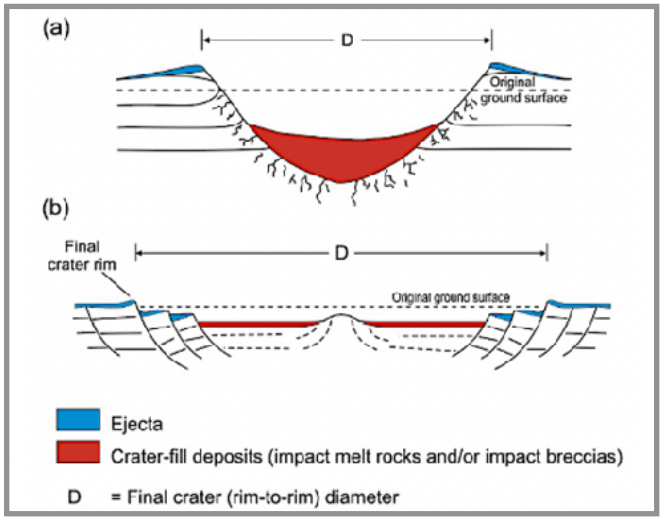
Crater Types Diagram

Most large complex craters are like this, however Wetumpka is different and has achieved some notoriety for the fact that it is large enough to have a central uplift but it does not have one.

SIMPLE VERSUS COMPLEX CRATERS

Another way of thinking about simple and complex craters is to see them from their sides. Imagine if we were to slice a crater and remove one half, so we can see the inside. The diagram below is a slice through or 'cross section' of the two types of craters you've been reading about.[43]

The first, (a) is a simple crater. 'D' is the diameter of the crater from rim to rim, and the red areas are crater fill materials, such as rocks that were melted, cooled and



Simple vs Complex Crater Diagram

re-hardened from the impact event. The blue areas are materials that were thrown out, or ejected from the impact event, and cascaded down around the crater. This material is called 'ejecta' and it can sometimes be found many tens of crater diameters away from the site of the impact.[44]

The second, (b) is a complex crater. The floor is much flatter, and is also covered by hardened melt rocks. Ejecta is also cast out over the rim. Notice the many terraces inside the final crater rim.[45]

THE THREE STAGES OF IMPACT CRATER FORMATION

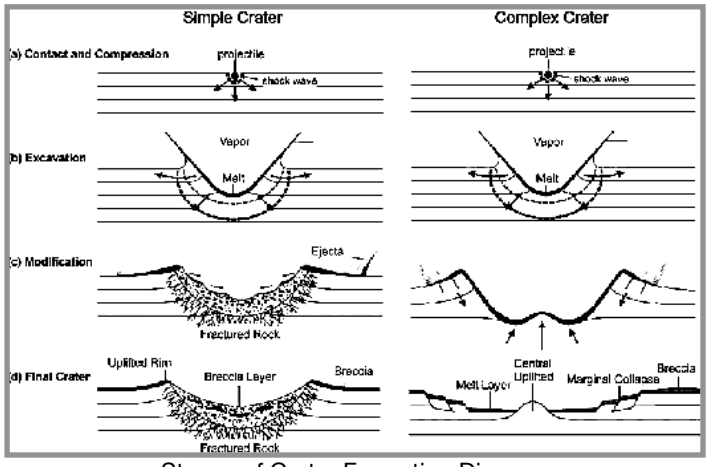
In impact research, the subdivision of the crater-forming process into three main stages has generally been accepted. These stages are:

1. the contact and compression stage
2. the excavation stage
3. the modification stage

But what does the impact process look like step-by-step? The diagram to the right shows the stages of crater formation. When an impactor plows into a target (makes contact), it brings a lot of energy with it. That energy is what drives the creation of the impact crater.[46]

During the first stage, the energy forces the target rocks down and compresses them. A transient crater starts to form-- we call it 'transient' because this early crater will change, and the cratering process continues after the excavation flow comes to rest. Material is then melted, even vaporized, and starts to be thrown out of the rapidly expanding crater during the excavation stage. For relatively small impact events the transient crater is relatively stable and we end up with a simple crater.[47]

For larger impact events, however, this transient crater is unstable--it's basically too deep and wide. Rocks at the bottom of these craters resist being compressed and deformed and eventually 'snap back' during the modification stage. This is the process that pushes up the central peak in complex craters. Finally, the ejecta falls to the ground, and the rim and center of the crater slump a bit and settle into their final shapes.[48]



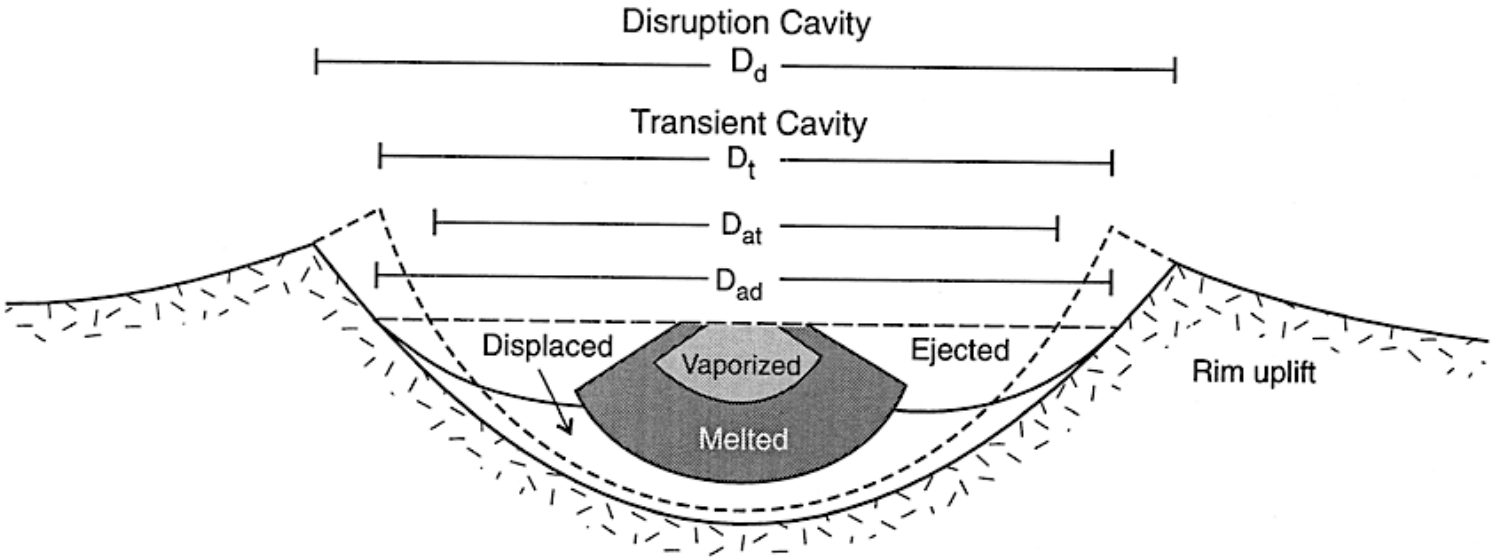
Stages of Crater Formation Diagram

All of this happens within a few minutes (but Wetumpka was formed in less than a minute.) For larger craters the melted rocks can take a very long time to cool and harden again, and the rim and peaks may fall and slump a bit more. And then of course...there is time.[49]

WHAT HAPPENS TO THE TRANSIENT CRATER?

This depends on how large the crater is. In the case of small transient craters, modifications are moderate. On relieving of pressure, there is an elastic rebound at the crater floor now hosting a layer of brecciated rocks. The structure of the transient crater is widely preserved, and we are left with a simple or bowl-shaped impact crater.[50]

For larger transient craters, the modifications may take on a dramatic scale. Elastic rebound and collapse cause the excavation trajectories to go into reverse in a way, and the rock masses tend to move upwards and centripetally thus, accompanied by large-scale downfaulting, largely backfilling the transient crater. This will result in the formation of central uplifts and ring systems, and we may now refer to these as central-uplift or central-peak craters, peak-ring craters or multi-ring craters establishing the group of so-called complex impact craters or complex impact structures.[51]



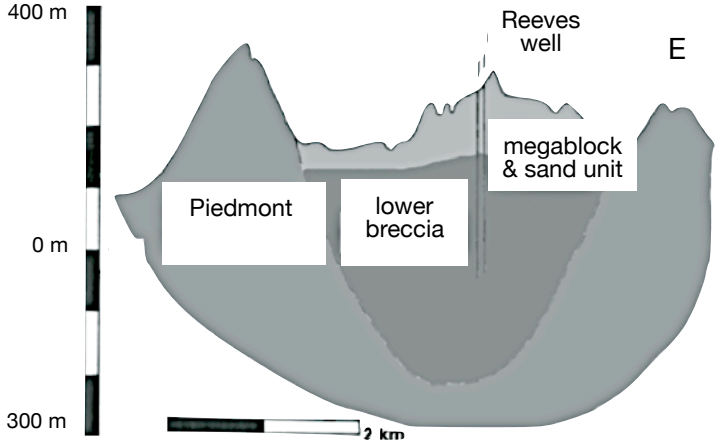
THE WETUMPKA IMPACT CRATER: DATE & DESCRIPTION

The Wetumpka impact crater in Alabama is a 4.7 mile (rim to rim) diameter complex crater that formed during early Campanian (a stage within Cretaceous) 84.4 million years ago, during Cretaceous. It is an intensively eroded crater; rapid erosion/leaching rates in Alabama's tropical to subtropical environments since Late Cretaceous could easily have lowered the Wetumpka crater's rim by stripping off all sedimentary formations.[52]

It is composed of a chaotic mixture of piedmont and sedimentary clastic particles ranging from micron-sized clay to large boulders. In this chaotic mix, are internally deformed as well as relatively undeformed mega-boulders, commonly supported on one another with a sheared, finer-grained interstitial matrix. The internal stratigraphy of the Wetumpka assorted crater mix may be divided into two parts: (1) deformed blocks of Upper Cretaceous strata and clastic matrix; or (2) deformed blocks of crystalline piedmont rocks and sheared piedmont matrix.[53]

Drilling & Field Research

- *Target stratigraphy:* In this region, three soft Upper Cretaceous units lie unconformably on top of crystalline pre-Cretaceous Appalachian bedrock. In age order, they are: Tuscaloosa Group (60 meters); Eutaw Formation (30 meters); and Mooreville Chalk (30 meters).[54]



Wetumpka Impact Crater Cross Section, King

- *Post-impact geology:* Surface crater geology consists of two main terrains: (1) a heavily weathered, semi-circular rim composed of Appalachian piedmont bedrock, which has up to 87 meters modern relief, and (2) a highly dissected crater floor composed of contiguous tracts of slightly to highly disturbed strata (consisting of Tuscaloosa Group and minor, but significant, irregularly shaped tracts of Eutaw Formation and Mooreville Chalk). Only one, small outcrop of impactite facies (impact rocks and materials appearance), which encompasses an area of a few hundred square meters, occurs within this crater.[55]

- *Subsurface geology*: All three stratigraphic units mentioned previously plus crystalline bedrock were involved in this impact event and contributed clastic material to the Wetumpka crater's subsurface impactoclastic crater-filling unit. Core drilling at Wetumpka crater's center reveals that disturbed target strata are only 64 meters (209.9 feet) thick and that over 130 meters (426.5 feet) of impactite facies occur below that level. In the Wetumpka cater's subsurface crater-filling unit, impactite facies, consisting of impactite sands and monomict and polymict impact breccias, are intercalated with 1 to 5 meters (3.3 to 16.4 feet) thick blocks of target strata and crystalline basement. (And, finally, shocked quartz, which was conclusive proof that this was indeed an impact crater).[56]

The story hidden in land of Wetumpka, AL began millions of years ago. Long before humankind disturbed Alabama's forests and streams and long before the meteor impact in Wetumpka, AL, enormously powerful natural forces bent, broke, shaped, and reshaped its landscape. Seismic convulsions and shifting tectonic plates shoved mountains above the waters of ancient seas that reached north of Montgomery, submerging Wetumpka area and the southern half of Alabama below the fall-line.[78]

By the Permian period (290-248 million years ago) amphibians, reptiles and land plants had evolved. All of the earth's landmasses had assembled to form the supercontinent Pangea. The landforms clashing about and crashing into each other (over millions of years like a bunch of bumper cars, but in slow motion) had largely formed the landscape of Alabama. Africa, South America and India were attached to the southeastern portion of North America, and the inhabitants of Pangea were free to roam for a few million years. But…during the Jurassic Period, the Earth's forces were at work again, and Pangea began to break apart. Africa, South America and India began to break away from southeastern North America and thus Alabama pulling lower half of Alabama below the fall-line with them.

During the Cretaceous period (144-65 million years ago), sea levels were much higher than today. Eastern and western North America were divided by the Western Interior Seaway and were teeming with life. As the continents continued to shift and ocean waters began their slow move south toward the present-day Gulf of Mexico, the deep valleys became the natural conduit for swiftly moving waters that cascaded over rocky bottoms, falling toward the sea. These waters carried with them the sediments that would slowly begin to fill in the shallow southeastern Gulf and form lower Alabama's Coastal Plain.

Along the Late Cretaceous Alabama shorelines (**estuaries and bays along the coastal shoreline and barrier islands**), 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. Because Deinosuchus lived in the nearshore estuaries and bays along the shoreline and barrier islands, the Mooreville specimen was probably a carcass that washed out to the open ocean.

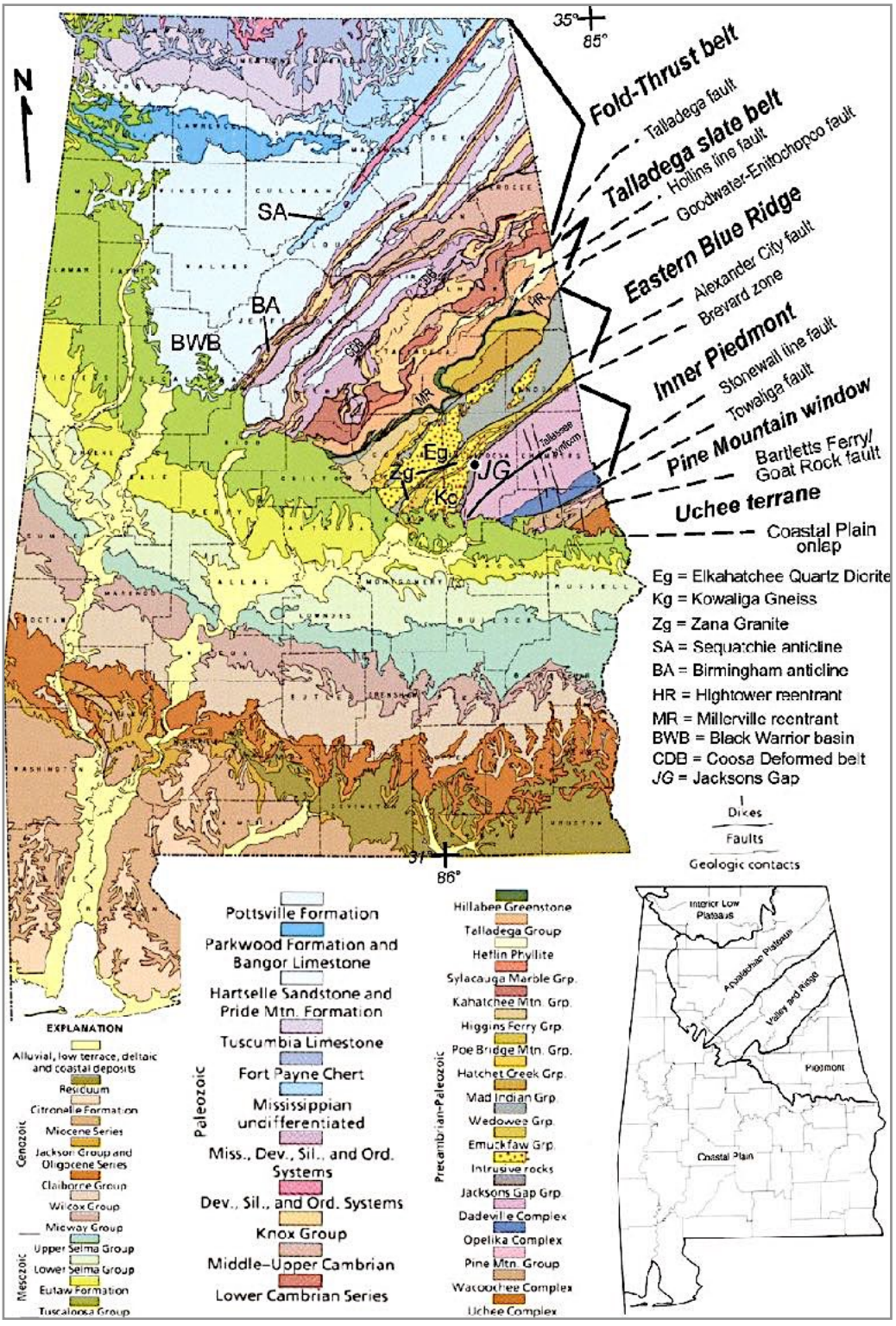
GEOLOGIC REGIONS OF ALABAMA:

[1] AL Highland Rim Formed: Middle- to Upper-Paleozoic sedimentary rocks (490 to 323 million years ago), Most of which formed during the Mississippian period (353 to 323 million years ago).[79]

[2] AL Cumberland Plateau Formed: Cambrian to Pennsylvanian in age (approximately 550 to 290 million years ago).[80]

[3] AL Valley & Ridge Formed: Paleozoic sedimentary rocks that range in age from Cambrian to Pennsylvanian, around 540 to 290 million years ago. The ridges are composed of Pennsylvanian sandstone belonging to the Pottsville Formation.[81]

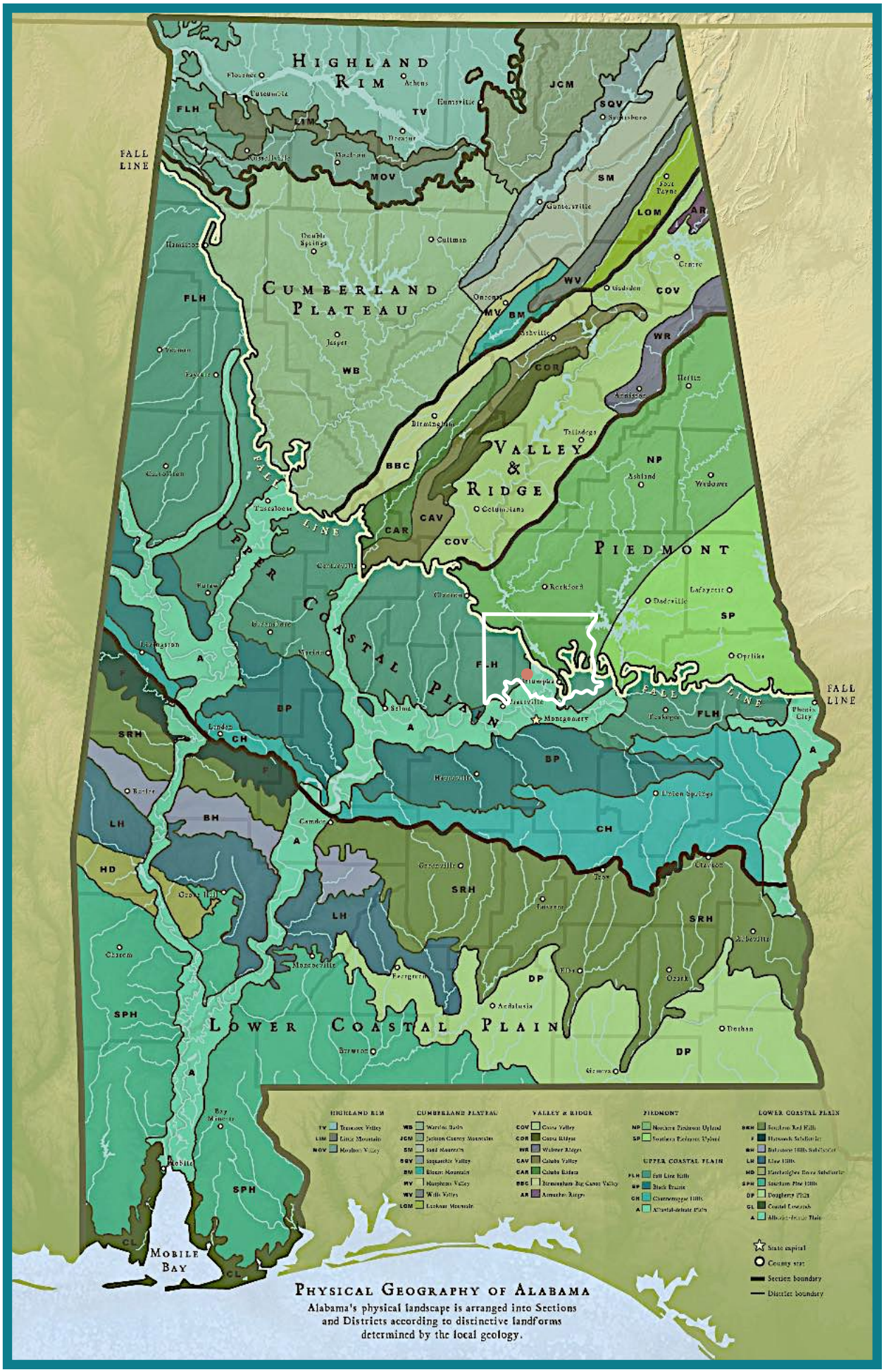
[4] AL Piedmont Uplands Formed: Northeast-Southwest trending belts of Precambrian to Paleozoic (around 2.5 billion years to about 300 million years ago,) consisting of metamorphic rocks that are highly deformed and bordered by faults.[82]



Alabama Geological Formations & Time Periods, Digital Drawing,

Note: Part of the Wetumpka crater lies in the southernmost part of the Upper Piedmont, part in the Upper Coastal Plain. It intersects the Fall Line in Wetumpka and a small part of the western rim is located in the Coosa River at downtown Wetumpka. *Formations:* In the crater area, three soft Upper Cretaceous units lie unconformably on top of crystalline pre-Cretaceous Appalachian bedrock. In age order, they are: Tuscaloosa Group (60 m); Eutaw Formation (30 m); and Selma Group: Mooreville Chalk (30 m).[83]

[5] AL Coastal Plain Formed: Young Mesozoic to Recent (from about 140 million years ago to the present) sedimentary rocks and sediment are still forming.[84]


HIGHLAND RIM
CUMBERLAND PLATEAU
VALLEY & RIDGE
PIEDMONT
UPPER COASTAL PLAIN
LOWER COASTAL PLAIN
FALL LINE
MOBILE BAY
Florence
Athens
Huntsville
Guntersville
Gadsden
Centre
Jasper
Birmingham
Talladega
Ashland
Wedowee
Tuscaloosa
Columbiana
Rockford
Lafayette
Opelika
Selma
Montgomery
Tuskegee
Phenix City
Demopolis
Union Springs
Camden
Greenville
Troy
Clayton
Monroeville
Evergreen
Andalusia
Ozark
Dothan
Brewton
Grimes
Robile
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COR
WR
WB
BBC
NP
CAV
CAR
SP
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SRH
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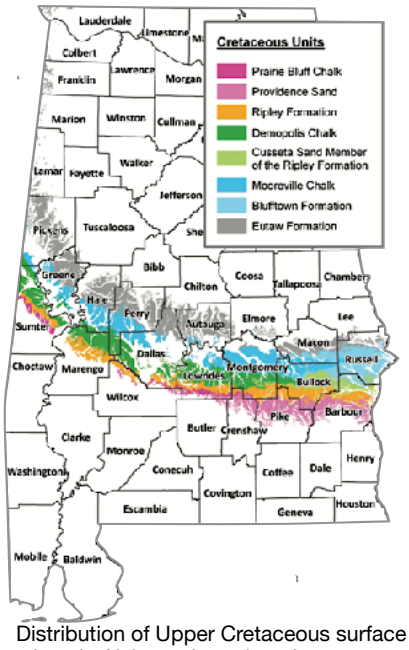
Physical Geography of Alabama
Alabama's physical landscape is arranged into Sections and Districts according to distinctive landforms determined by the local geology.
State capital
County seat
Section boundary
District boundary

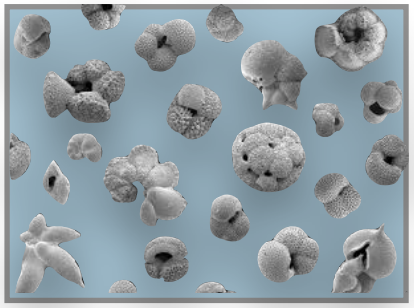
LATE CRETACEOUS GEOLOGY OF ALABAMA

Although Alabama has one of the most complete geologic sections in the United States, we are missing the first 3/4 of the Mesozoic Era, commonly known as "The Age of Dinosaurs." Alabama does have rocks from the first two of the three periods of the Mesozoic, the Triassic and Jurassic Periods, and from the Early and Middle parts of the Cretaceous Period and the last of the three time periods that make up the Mesozoic, but they are buried beneath thousands of feet of younger rocks in south Alabama. The only rocks from the Mesozoic that occur at the surface in Alabama are those of the Late Cretaceous, with fossils ranging in age from 85 to 66 million years old.[85]



Distribution of Upper Cretaceous surface geology in Alabama based on the 1:250,000-scale digital state geology (GSA, 2006).

In Alabama, rocks of Late Cretaceous age outcrop in a narrow east-west trending band across the central part of the state, commonly referred to as the "Black Belt," located in the Upper Coastal Plain (due to the rich black soil that is produced from the weathering of the rocks). Fossil-bearing rocks in this area are all marine in origin. Although there are older Late Cretaceous rocks in Alabama that were deposited in freshwater and associated terrestrial settings, they are largely unfossiliferous. The Late Cretaceous rock formations in Alabama are largely composed of Chalk. Chalk consists primarily of the limy-fossilized skeletons and body parts of microscopic organisms that lived in the rich Cretaceous seas. The name Cretaceous, itself, is derived from the Latin word for chalk. Chalk contains many tiny plates of calcium carbonate (calcite) produced by marine algae known as coccolithophorids. Other important microscopic fossils found in chalk are the foraminifera, or "forams." These minute marine creatures also build protective skeletons of calcite that become visible under high magnification.[86]

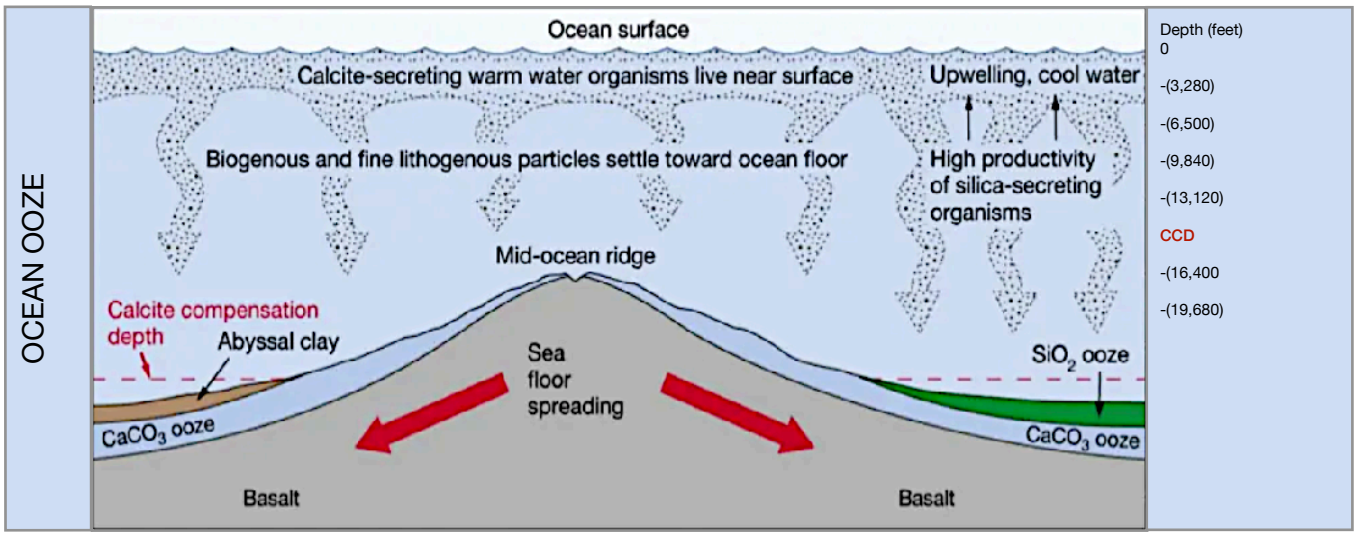

Foraminifera, Southampton University

The oceans today cover almost 71% of the earth's surface. About 20% of the oceans lie over the shallower continental margins, while the rest covers the deeper ocean floor, which is blanketed by a variety of sediments. Amongst these are what is known as *oozes*, so-called because more than 30% of the sediment consists of the shells of microorganisms such as foraminifera and coccolithophores. About half of the deep ocean floor is covered by light-colored calcareous (calcium


Coccolith, Encyclopedia of Alabama

carbonate-rich) ooze generally down to depths of 4,500–5,000 meters. Below these depths the calcium carbonate shells are dissolved. Even so, this still means that about one quarter of the surface of the earth is covered by these shells — rich deposits produced by these microscopic plants and animals living near the surface of the ocean.[87]

Geologists think that these *oozes* form as a result of these microorganisms dying, with the calcium carbonate shells and coccoliths falling slowly down to accumulate on the ocean floor. It has been estimated that a large 150 micron (0.15mm or 0.006 inch) wide shell of a foraminifer may take as long as 10 days to sink to the bottom of the ocean, whereas smaller ones would probably take much longer. It is through this slow accumulation of calcareous ooze on the deep ocean floor that geologists think chalk beds originally formed. A sugar-cube sized piece of chalk contains an estimated 3 billion individual coccoliths![88]



Ocean Oozes, Diagram,
Prentice and Hall

THE LATE CRETACEOUS CLIMATE IN ALABAMA

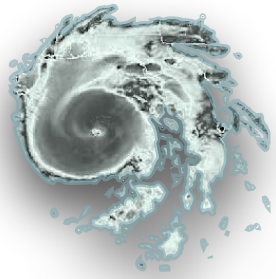
During the Late Cretaceous, the climate was one of the warmest in Earth's history. This was a result of a variety of factors including:

1) The continents were in different positions so that a world-spanning equatorial ocean current distributed warm ocean water even as far north and south as the poles.
2) Atmospheric carbon dioxide was approximately 4 to 6 times high than modern levels.
3) Increased area covered by oceans (melted ice caps). Water retains heat from the Sun more efficiently than land.[89]

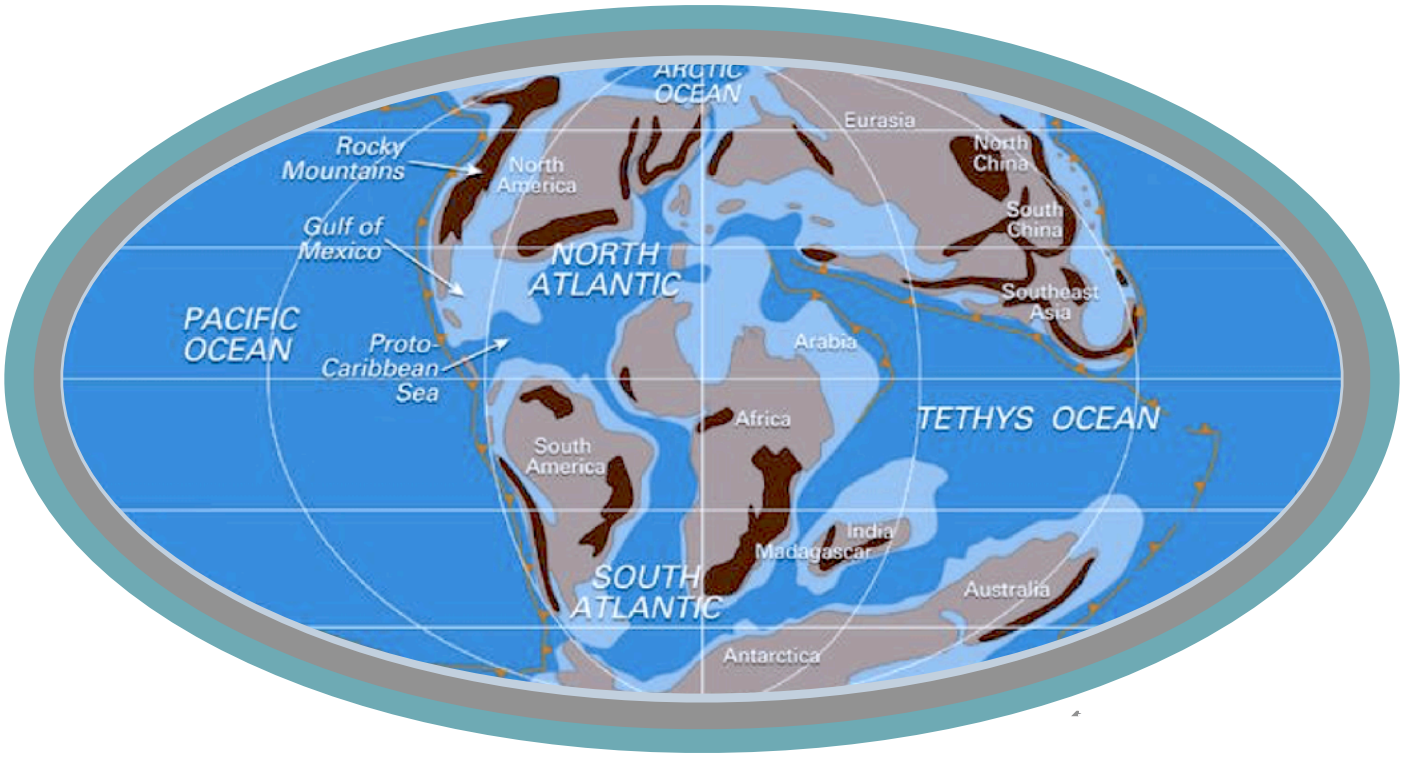
The combination of these and other factors resulted in a climate so warm that there were no glaciers or ice caps anywhere on Earth, and all of that ice volume was added to the oceans as water. This resulted in the second highest sea level in all of Earth's history, and flooded about one-third of the present day land surface with shallow seas.[90]

In North America, the Western Interior Seaway extended from the Gulf of Mexico to the Arctic Ocean. This divided North America into a western half, known as Cordillera (Laramidia on map), and an eastern half, known as Appalachia. Cordillera and Asia were still connected by land, but to a much lesser extent Africa and Europe were connected. However, Appalachia was completely isolated from other dinosaur populations, so the Late Cretaceous dinosaurs that lived in what is now the Eastern U.S. are unique, having evolved in isolation for some 30 million years.[91]

Cretaceous Western Interior Seaway, North America, Diagram

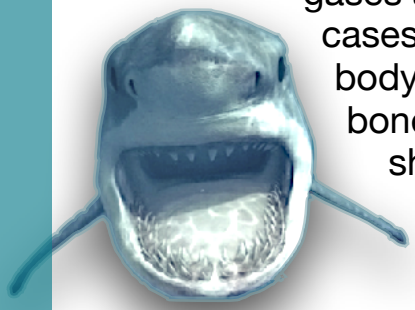


A variety of evidence indicates that hurricanes, which derive their energy from sea surface temperatures, were a common phenomenon. They basically followed a course similar to the present day track of hurricanes, but seem to have most often moved through the Gulf of Mexico and straight up the Western Interior Sea, all the way to present day Canada. This track brought them right over present day central Alabama.[92]



ALABAMA CRETACEOUS LIFE

The Late Cretaceous rocks that are exposed in Alabama today are nearly all marine in origin. This means that all of the dinosaurs and other land-based animals of this period represent the carcasses of dead animals that filled with decomposition gases and floated down rivers and out to sea before sinking. In many cases shark scavenging may have been the thing that ruptured the body cavity allowing the carcass to sink to the sea floor, as many bones of these animals bear deep scratches and cuts that match sharks teeth. Occasionally shark teeth are even found embedded in the bones. Once the carcass came to rest on the sea floor, a variety of scavengers such as sharks, fish, crabs, and worms reduced the carcass to a skeleton, often

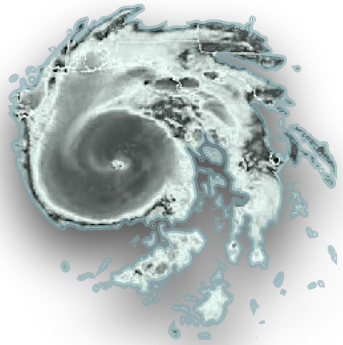


Fossilized Worm Tubes

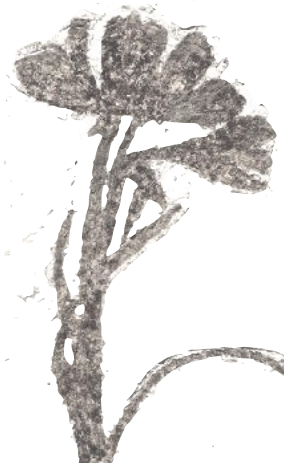
Fossilized Crab

Cretaceous Fish

scattering the bones. If the skeleton came to rest in shallow waters, hurricane-driven storm currents could rearrange the bones, in a manner similar to the way modern-day storms sometimes uncover old shipwrecks. Analyzing the patterns created in storm-arranged skeletons can in fact help establish the presence of storm systems in the Late Cretaceous as well as indicate the direction from which major storms struck the coast.[93]



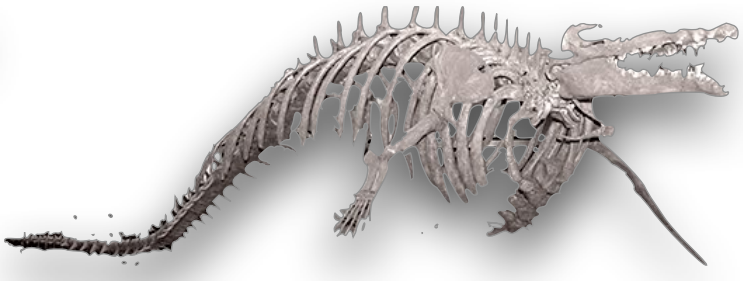
Alabama Cretaceous Plants: The Late Cretaceous forests in Alabama represented a time when old types of plants that had long dominated the Mesozoic were giving way to the Angiosperms (flowering plants). The flowering plants comprise the vast majority of plant species on earth today were just evolving in the Cretaceous. About 40% -60% of the forests appear to have been composed of flowering plant species, with the remainder composed of ferns andallied plants, including tree ferns, and the Gymosperms, the group to which conifers belong. Pine trees seem to have been confined only to the western edge of the state.[94] Common Alabama plant fossils include treelike lycopods, such as *Lepidodendron*, which are preserved as trunks, branches, leaves, flowers, and roots; ferns of many kinds; and giant horsetails.



Angiosperm
(flowering plant)

Alabama Cretaceous Marine Life: During the Late Cretaceous, the southern half of Alabama was covered by a warm shallow ocean. Teeming with a variety of aquatic life, the shallow sea in Alabama was full of monstrous creatures.

Fossilized Alabama Turtle

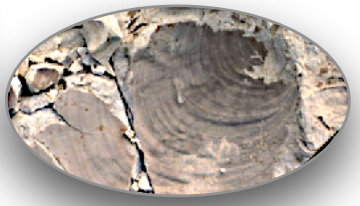


Alabama's State Fossil, *Basilosaurus cetoides*. Alabama Museum of Natural History (Whale, Cenozoic Era- Ecocene period, 35-40 Ma years ago, grew to 60 or 70 feet long) **A lovely fossil but NOT Cretaceous.**

Alabama Cretaceous Invertebrates: Three commonly found Late Cretaceous invertebrate fossils include exogyra oysters, inoceramid clams, and ammonites.

Fossilized Alabama Exogyrine: Cretaceous Oysters

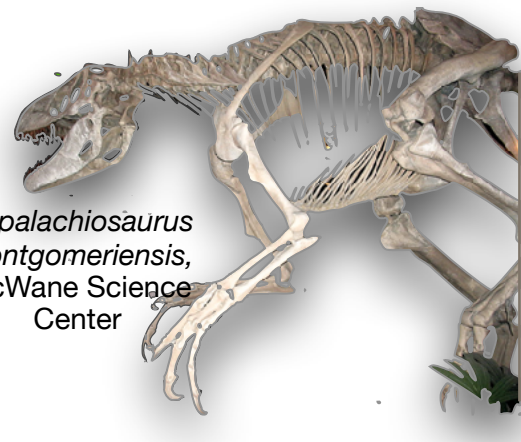
Fossilized Alabama Ammonite



Fossilized Alabama Inoceramids: Clams

- *Exogyra* is an extinct genus of free-living oyster.
- *Inoceramids* were large thin-shelled clams that could grow up to three-feet in diameter.
- *Ammonites*: 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 housing a soft body and appeared much like a giant squid coiled in a shell. Some ranged to nearly three feet across and were predatory animals, as well as food themselves for even larger marine predators, such as mosasaurs.[96]

Alabama Cretaceous Dinosaurs: The discovery of dinosaurs in Alabama is extremely rare. To date, three dinosaurs have been named from Alabama, *Lophorhothon atopis*, *Appalachiosaurus montgomeriensis*, and *Eotrachodon orientalis* – all of which were new species. However, several other types of dinosaurs, like ornithomimids, nodosaurs, and



Appalachiosaurus montgomeriensis, McWane Science Center

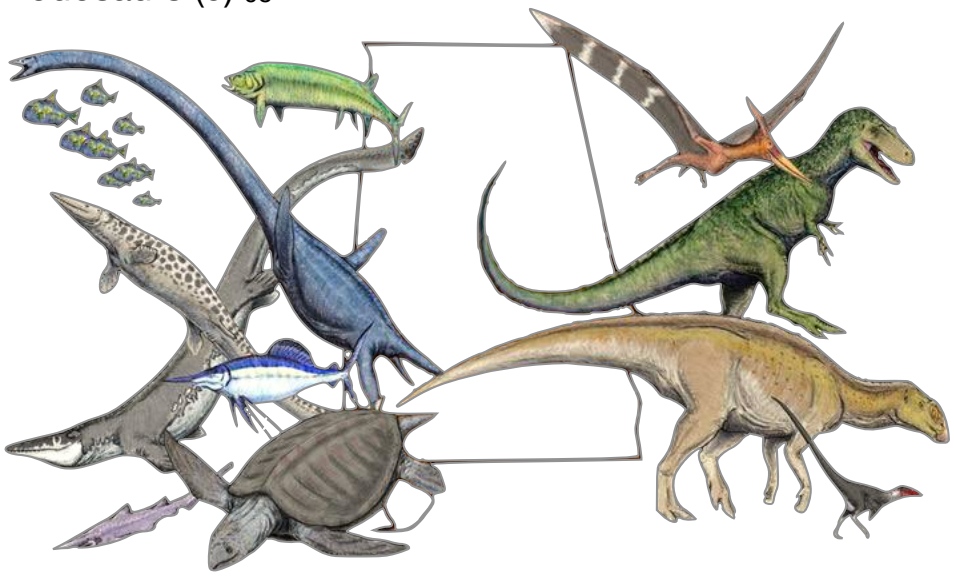
dromaeosaurs, are known from Alabama, but scientists have yet to determine what particular species they belong. 97 Jun

- To understand southeastern U.S. dinosaurian modes of occurrence, and those of eastern North America in general, one must understand eastern North American paleogeography adjacent to the Appalachian Mountains during Late Cretaceous. Dinosaurs probably inhabited a narrowly restricted zone of coastal lowlands (alluvial plains) and supratidal reaches of linear coastlines adjacent to the Appalachian Mountains.

- In southeastern states, especially Alabama, Georgia, Mississippi, and Tennessee, coastal lowlands formed an arc around the prominent Appalachian headland. Minor third-order fluctuations in relative sea level probably caused alternate inundation and exposure of coastal lowlands (comprising both dwelling habitats and migration routes), and zero width of coastal lowlands is highly probable during some third-order sea-level high-stands.

- Three modes of occurrence are evident in Late Cretaceous southeastern U.S. stratigraphy:
  (1) shallow-marine concentrations;
  (2) shelf tempestites (or sandy event beds); and
  (3) open-marine accumulations.

- Late Cretaceous dinosaurs of the southeastern U.S. comprise 51 specimens that are divided into four taxonomic groups:
  tyrannosaurids (12);
  hadrosaurines (22);
  ornithomimids (12);
  and nodosaurs (5).98 *



Artist Reconstruction, Alabama
Cretaceous Animals, Asher Eilbein

STORYBOARDS
WHEN DINOSAURS ROAMED: the Wetumpka Impact Crater

• Storyboard: About the Exhibition

The city of Wetumpka, Alabama sits right on the bull's eye of what is thought to be the greatest natural disaster in Alabama's history. Approximately 85 million years ago, near the end of the "Age of Dinosaurs," a crater was created by a blast into the bedrock. The hills just east of downtown are the eroded remains of the rim of a five-mile wide impact crater.

More than a year in the making, this multifaceted 2015 exhibition included artwork by professional paleoartists Karen Carr of New Mexico; Jonathon Hughes of Thailand; Rick Spears and Jerry Armstrong of Georgia; Larry Percy and Wayne Atchison of Alabama and Ashere Eilben of Texas. Also included in the exhibit were 96 works of art from a juried competition organized in conjunction with the Wetumpka Impact Crater Commission. This portion of the exhibition featured original student and adult artwork related to the Wetumpka Impact Crater and the Cretaceous Period. The exhibit also included oversized storyboards documenting scientific research about the Wetumpka Impact Crater.

The exhibition and project was funded through a grant from the Alabama State Council on the Arts and spearheaded by curator, Hope Brannon. At the close of this exhibition, hosted by the Kelly Fitzpatrick Memorial Gallery a large portion of this exhibit was donated to "Gateway" for the Wetumpka Impact Crater Commission's use. The donated components will serve as a foundation for what will become a permanent Wetumpka Impact Crater Exhibit.

• Storyboard: #1, The Age of Dinosaurs

During the late Cretaceous Period, the continents were starting to take on their modern shapes. There were no ice caps at the poles and the global climate was very warm. At this time the dominant land vertebrates were dinosaurs. Mammals had already been around for some time, but they were small and generally insignificant.

- Additional information: During the Mesozoic no great extinction or burst of diversity separated the Cretaceous from the Jurassic Period that had preceded it. In some ways, things went on as they had. Dinosaurs both great and small moved through forests of ferns, cycads, and conifers. Ammonites, belemnites, other mollusks, giant turtles and fish were hunted by great "marine reptiles," and pterosaurs and birds flapped and soared in the air above. On land, mammals were generally small sized, but a very relevant component of the fauna. At about the same time, many modern groups of insects were beginning to diversify. The Cretaceous saw the first appearance of many lifeforms that would go on to play key roles in the coming Cenozoic world. Perhaps the most important of these events, at least for terrestrial life, was the first appearance of the flowering plants, also called the angiosperms.

Many scientists believe that debris from asteroid impacts resulted in fires that, combined with the ash and smoke from continuing volcanic activity, significantly reduced the global temperatures for a few decades. The resulting lower temperatures may account for the extinction of both dinosaurs and giant marine reptiles, the largest animals of the time. It could also explain how smaller animals, such as the mammals and other animals with more modest energy requirements, managed to survive and diversify in the new Cenozoic Era.

Today all over North America, Cretaceous fossils are found directly beneath a thin layer of sediment that contains unusual amounts of iridium, an element otherwise uncommon in Earth's crust. Also within this layer of sediment are indications of "shocked quartz" and tiny glass-like globes called tektites. Tektites form when rock is suddenly vaporized, then immediately cooled. This happens when an extraterrestrial object such as an asteroid strikes the Earth with great force. Temperatures from asteroid strikes could have reached levels high enough to cause flash fires in many locations and a tsunami over much of the Eastern United States.

• Storyboard: #2, North America Prior to the Impact

North America Near the End of the Age of the Dinosaurs: Appalachia was an island land mass separated from Laramidia to the west by the Western Interior Seaway. The seaway eventually shrank, divided across the Dakotas, and retreated towards the Gulf of Mexico and Hudson Bay. This left the island masses joined in the continent of North America as the Rocky Mountains rose.

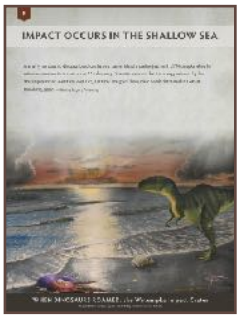
• Storyboard: #3, 85 Million Years Ago

There are millions of asteroids, most thought to be the shattered remnants of planetesimals that never grew large enough to become planets. A majority of asteroids orbit in the asteroid belt between the orbits of Mars and Jupiter. However, other orbital families, including the near-Earth asteroids, exist with significant populations. Near-Earth asteroids, or NEAs have orbits that pass close to the orbit of Earth. Sometimes, because of the attraction of other planets, these asteroids change their orbit and collide with other asteroids. The resulting fragments that break off and fall to earth without being burned up are called meteorites.

Depending on their size, meteorites hit the Earth anywhere from every day to once in 10,000 years. Specks of stardust are tiny meteorites and settle on our Earth every day. Larger meteorites fall to Earth about 1,500 times each year. The very large meteorites, weighing upwards of 50,000 tons, however, are believed to hit only once in every 10,000 years.

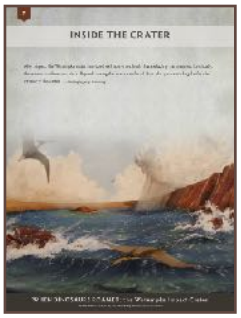
A meteoroid is a solid body in space before it reaches the Earth's atmosphere. When a tiny meteoroid strikes the Earth's atmosphere and burns up, the result is a fiery streak or “shooting star.” If a larger meteoroid survives the fiery passage through the Earth's atmosphere as a meteor and strikes the Earth’s surface, it is called a meteorite. Approximately 85 million years ago, scientists believe one such meteorite struck Earth at the site of present day Wetumpka, Alabama.

• Storyboard: #4, The Asteroid Approaches
A large marine reptile catches a fish in the Gulf of Mexico waters 85 million years ago as an asteroid streaks through the sky on its approach to the area now known as Wetumpka. There is strong evidence that at the time of the impact, the area now known as Wetumpka was covered by a shallow sea of 100 feet in depth. —Painting by Jerry Armstrong



• Storyboard: #5, Impact Occurs in the Shallow Sea
A small tyrannosaurid dinosaur beach-combs on a barrier island shoreline just north of Wetumpka when he witnesses a meteorite impact about 15 miles away. Scientists estimate that the energy released by the Wetumpka impact event was over 175,000 times energy of the nuclear bomb detonated in 1945 at Hiroshima, Japan. —Painting by Jerry Armstrong

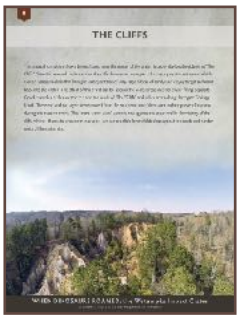
• Storyboard: #6, The Tsunami Approaches
The intense heat from the enormous impact blast sets the shoreline woods on fire and a tsunami wave generated by the impact strikes the shore about 15 miles north of Wetumpka, as the crater walls begin to form in the shallow sea. —Painting by Jerry Armstrong



• Storyboard: #7, Inside the Crater
After impact, the Wetumpka crater rim stood well above sea level, thus excluding the seawater. Eventually, the weaker southwestern rim collapsed causing the interior to flood. Pterodactyls are circling the flooded interior of the crater. —Painting by Jerry Armstrong

• Storyboard: #8, Ground Zero 2015

The above map highlights a five-mile, semi-circular pattern of hills that make up the remaining rim of the Wetumpka Impact Crater. The hard rocks of the Piedmont are bent sharply and point away from the center of the impact area. The normally horizontal layers of more recent surface rocks are mixed in and around the crater, suggesting an incredible explosion that would have destroyed all life within a radius of many miles and created an earthquake equal to 8.5 to 9.0 on the Richter scale.



• Storyboard: #9, The Cliffs

The unusual formation shown below, found near the center of the crater, is known by local residents as “The Cliffs.” Scientific research indicates that the cliffs themselves were part of a major post-impact event, which caused a massive slide that brought vast quantities of very large blocks of sandy and clayey target sediment back into the crater. The effect of this event can be seen in the widespread interior crater-filling deposits. Good examples of this are the red and tan sands of “The “Cliffs” and other areas along Harrogate Springs Road. These red and tan layers were moved from the southern rim of the crater to their present locations during this massive event. This “trans-crater slide” came to rest against the crater wall in the vicinity of the cliffs, where – thanks to erosion in that spot –we can see slide layers folded up against the sands and harder rocks of the crater rim.

• Storyboard: #10, How Was It Discovered?

In 1891, Alabama State Geologist Eugene Allen Smith noted the unusual geographical nature of the Wetumpka area. For many years the area was marked on geological maps as “structurally disturbed.”

In 1969-1970, Geologist Tony Neathery headed a team making detailed geologic maps of Elmore County as part of a Geological Survey of Alabama. As they approached Wetumpka, they found rock layers bent at dramatically different angles and in very different directions from other rocks in the area. It soon became clear that the unusual features were related to a disturbance centered in the hills east of downtown Wetumpka. Within this area, rocks were chaotically disturbed and intermixed, unlike the evenly layered horizontal rocks surrounding the area.

In 1976, when the findings were published, this feature was called an “Astrobleme,” literally, a star wound. For a number of years, this conclusion was greeted with skepticism.

During 1998, two cores were drilled and core samples were extracted for testing. Geologists hoped to find materials proving the “Astrobleme” theory. Dr. David T. King, Jr., Professor of Geology at Auburn University, headed the research team. The researchers indeed found the core contained shocked quartz, which can only be formed by pressures exerted during an enormous explosion such as a large meteor impact. The research team also found chemical traces of fallen meteorite embedded in the local bedrock.

In 2002, the research team published all of the evidence and established the site as an internationally recognized impact crater. There is very strong evidence that at the time of the impact, a shallow sea of approximately 100 feet deep covered the area. The Wetumpka Impact Crater is now recognized as one of the best preserved marine impact craters in the world.

• **Storyboard: #11, Science & Interpretive Center Master Plan**
The City of Wetumpka has set aside a 26-acre tract of land for the site of the Wetumpka Impact Crater Science & Interpretive Center. This land was donated by the State of Alabama. The image above highlights the master plan for the future development of the site, located on US Highway 231 on the southwestern edge of the crater rim.

CRETACEOUS LIFE

FAUNA:	FAUNA:	FLORA:
Terrestrial Reptiles:	Invertebrates	Ferns
- Dinosaurs	Ancient Fish	Cycads
Marine Reptiles	Ancient Birds	Conifers
Flying Reptiles	Mammals	Angiosperms
	Insects	Diatoms

During the Mesozoic no great extinction or burst of diversity separated the Cretaceous from the Jurassic Period that had preceded it. In some ways, things went on as they had. Dinosaurs both great and small moved through forests of ferns, cycads, and conifers. Ammonites, belemnites, other mollusks, and fish were hunted by great "marine reptiles," and pterosaurs and birds flapped and soared in the air above. ucmp.berkley On land, mammals were generally small sized, but a very relevant component of the fauna, with cimolodont multituberculates (rodents) outnumbering dinosaurs in some sites. Neither true marsupials nor placentals existed until the very end of the Cretaceous, but a variety of non-marsupial metatherians and non-placental eutherians had already begun to diversify greatly, ranging as carnivores, aquatic foragers and herbivores.

- Various “archaic mammal” groups like eutriconodonts were common in the Early Cretaceous, but by the Late Cretaceous northern mammalian faunas were dominated by multituberculates and therians, with dryolestoids dominating South America.

At about the same time, many modern groups of insects were beginning to diversify, and we find the oldest known ants, beetles and butterflies. Aphids, moths, grasshoppers, and gall wasps appear in the Cretaceous, as well as, termites in the later part of this period. Another important insect to evolve was the eusocial bee, which was integral to the ecology and evolution of flowering plants.

The Cretaceous saw the first appearance of many lifeforms that would go on to play key roles in the coming Cenozoic world. Perhaps the most important of these events, at least for terrestrial life, was the first appearance of the flowering plants, also called the angiosperms or Anthophyta. First appearing in the Lower Cretaceous around 125 million years ago, the flowering plants first radiated in the middle Cretaceous, about 100 million years ago. By the close of the Cretaceous, a number of forms had evolved that any modern botanist would recognize. The Cretaceous also saw the first radiation of the diatoms (photosynthesizing algae) in the oceans (freshwater diatoms did not appear until the Miocene).

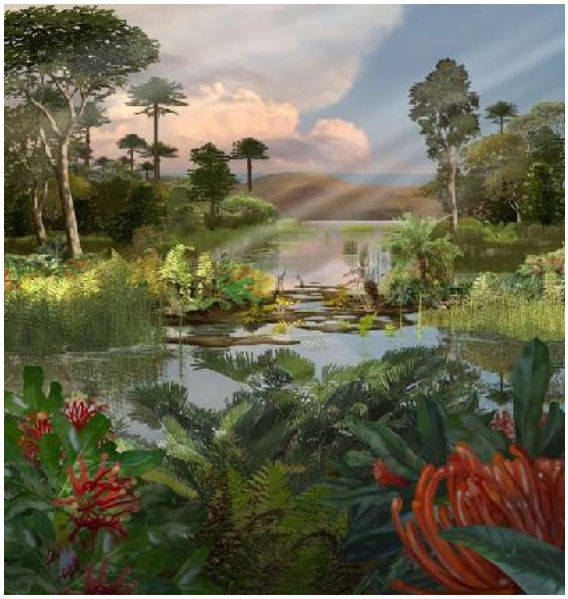
Karen Carr

Digital Painting

42” w x 46” h

Geologic Period: Cretaceous

Australian Museum Plant Community Pictured: ferns, benettitaleans, seed-ferns, angiosperms, araucarians, ginkgoes, treeferns, horsetails



Karen Carr

Digital Painting

42” w x 46” h

Geologic Period: Cretaceous

Australian Museum Plant Community Pictured: angiosperms, gymnosperms, nothofagus, araucarians, podocarps, cycads, proteacea, flowering plants, stenocarpus

Karen Carr

Digital Painting

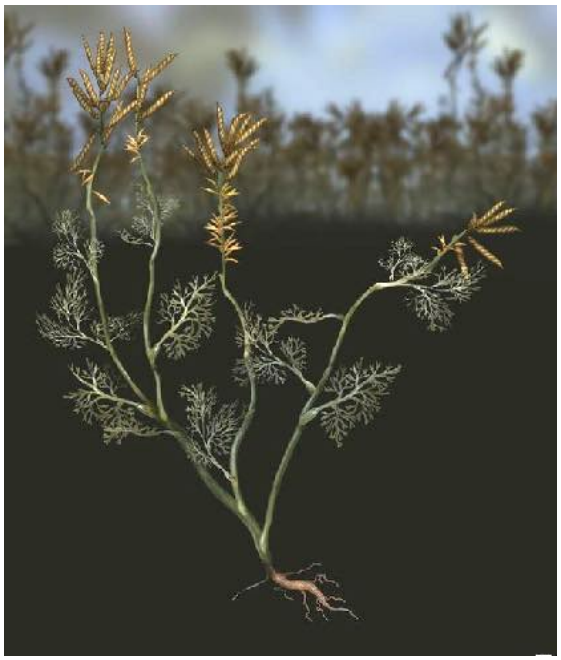
42” w x 46” h

Geologic Period: Cretaceous

Australian Museum Plant Community: Cretaceous Flora

Pictured: ferns, benettitaleans, seed-ferns, angiosperms, araucarians, treeferns, magnolia, conifers

33 Karen Carr
Digital Painting
24” w x 29” h
Geologic period: Cretaceous
Archaefructus
Pictured: Archaefructus



About this image:
Archaefructus is a water plant from the early Cretaceous, and based on its distinctive structures it is considered one of the earliest known flowering plants.

Did you know?
Dating of Archaefructus places it right at the boundary of the Jurassic and Cretaceous, at about 125 million years.

Notes:
Read more about this amazing find here: Early Cretaceous Archaefructus eoflora sp. nov. with Bisexual Flowers from Beipiao, Western Liaoning, China

Karen Carr
Digital Painting
24” w x 29” h
Geologic period: Cretaceous

Pictured:
Cretaceous cycads: Dinosaurs of Denali

Karen Carr

Digital Painting

48” w x 25” h

Geologic period: Permian

Audubon Insectarium: Wall 2, Ancient Life Mural

About this image:
Audubon Insectarium will be the largest museum in the United States devoted to the 900,000+ known species of insects and their relatives. It will be an encounter with nature like no other featuring thousands of live insects, mounted specimens, interactive experiences and engaging exhibit interpreters.

Located in 23,000 sq. ft. of exhibit space in the U.S. Customs House in New Orleans Audubon Insectarium is a member of Audubon Nature Institute’s family of museums and parks dedicated to nature including Audubon Zoo, Audubon Park, Audubon Aquarium of the Americas, Entergy IMAX® Theatre, Woldenberg Riverfront Park, Audubon Louisiana Nature Center, Audubon Center for Research of Endangered Species, Freeport-McMoRan Audubon Species Survival Center and Audubon Wilderness Park.

Jon Hughes

Digital Painting

23” h x 34” w

Sinoconodon

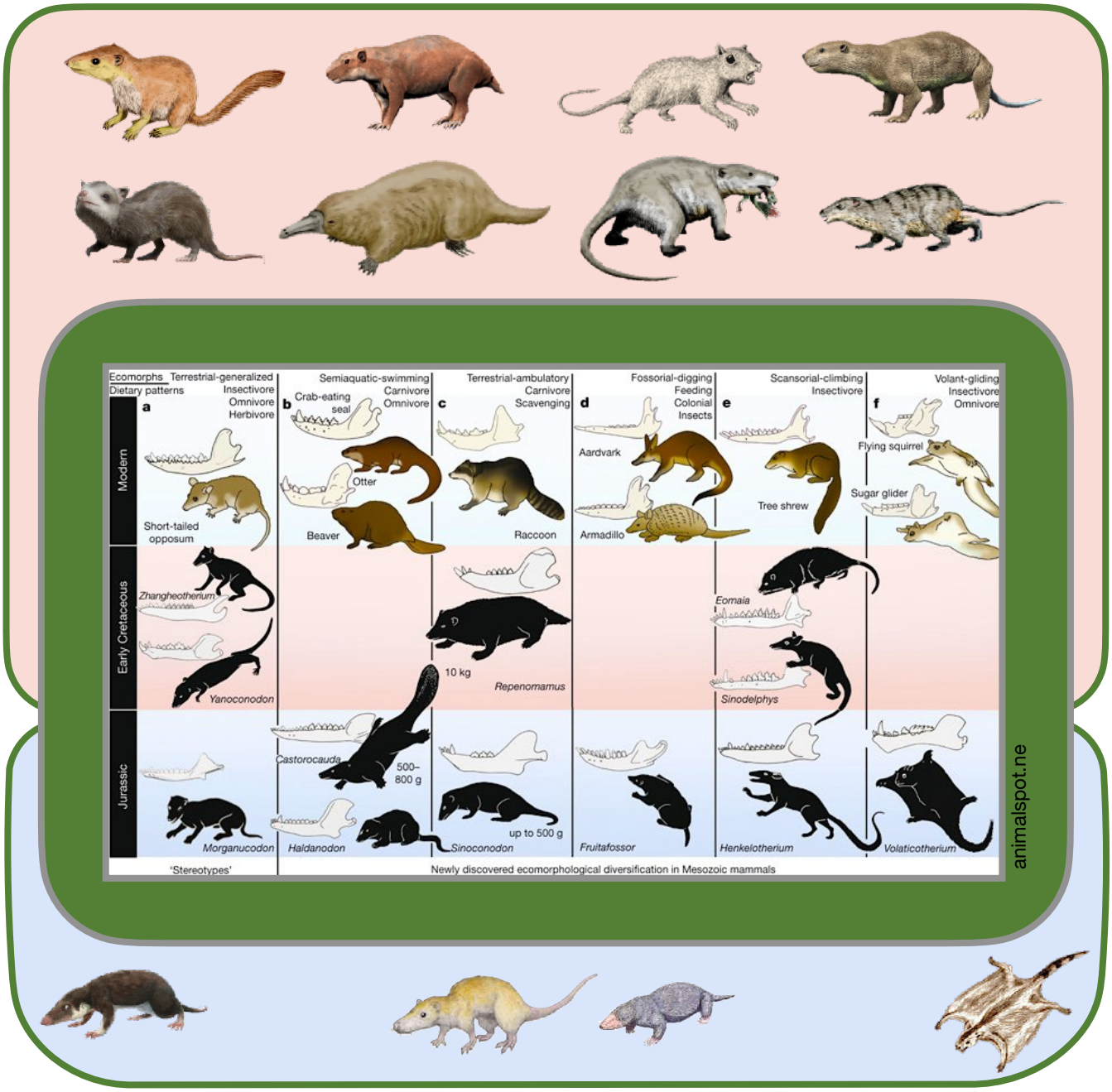
About this Image:
There wasn’t a single "Aha!" moment when the latest therapsids ("mammal-like reptiles") evolved into the earliest mammals. Paleontologists have found a number of intermediate forms, one of which was the late Triassic Sinoconodon, which sported a small, furry, vole-like body and a relatively large brain, as well as reptilian teeth that seem to have constantly replaced themselves throughout this creature's lifetime. Judging by its anatomy, some paleontologists classify Sinoconodon as one of the earliest mammals, while others maintain it belongs firmly in the reptile camp.

Sinoconodon (Greek for "Chinese spiky tooth") and is pronounced SIGH-no-CO-no-don. It inhabited the woodlands of Asia. It was about six inches long and weighed only a few ounces. It had a sleek body and large eyes and the diet was omnivorous.

CRETACEOUS LIFE: MAMMALS

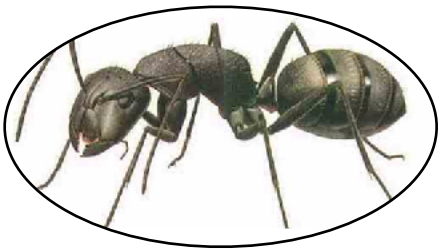
On land, mammals were generally small sized, but a very relevant component of the fauna, with cimolodont multituberculates (rodents) outnumbering dinosaurs in some sites. Neither true marsupials nor placentals existed until the very end of the Cretaceous, but a variety of non-marsupial metatherians and non-placental eutherians had already begun to diversify greatly, ranging as carnivores, aquatic foragers and herbivores.

Various “archaic mammal” groups like eutriconodonts were common in the Early Cretaceous, but by the Late Cretaceous northern mammalian faunas were dominated by multituberculates and therians, with dryolestoids dominating South America.



CRETACEOUS INSECT LIFE

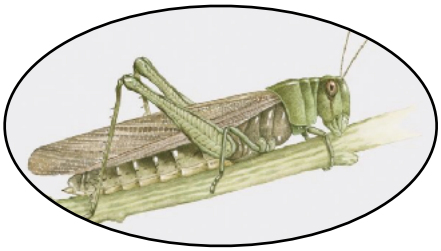
At about the same time, many modern groups of insects were beginning to diversify, and we find the oldest known ants, beetles and butterflies. Aphids, moths, grasshoppers, and gall wasps appear in the Cretaceous, as well as, termites in the later part of this period. Another important insect to evolve was the eusocial bee, which was integral to the ecology and evolution of flowering plants. There were actually loads of insects during this time period. Below are just a few examples.



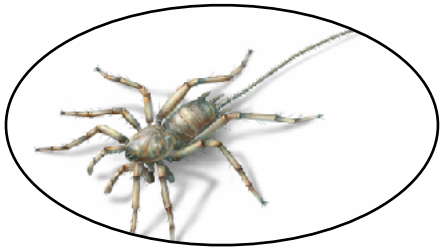
Ant

Bee: Anna Mason

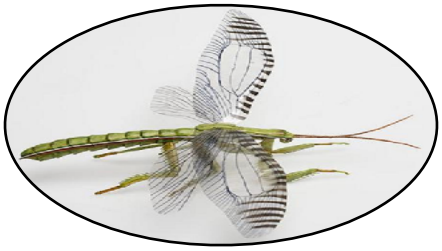
Fly: J.A. Penas



Grasshopper

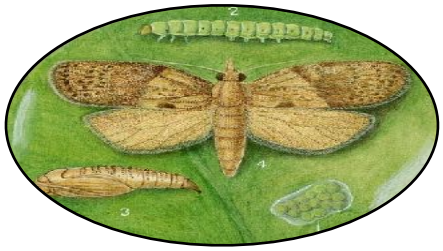


Spider: Bo Wang

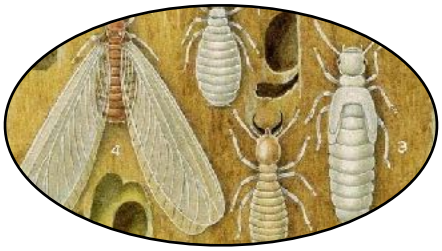


Dragonfly

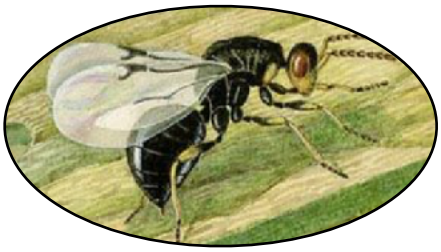
Butterfly



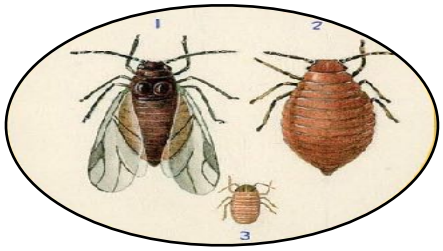
Moth: E.H.Zeck



Termite: E.H.Zeck

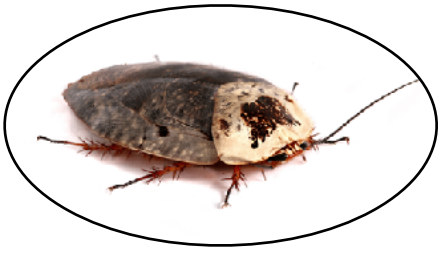


Gall Wasp: E.H.Zeck

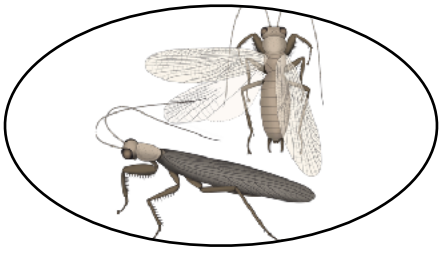


Aphids: E.H.Zeck

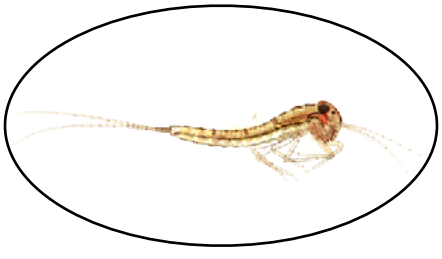
Beetle: Ding-hau Yang



Cockroach: Dominic Anthony Evangelista, Ph.D.



Praying Mantis: Marie Hoernig



Mayfly: Marek Mis

CRETACEOUS FLORA

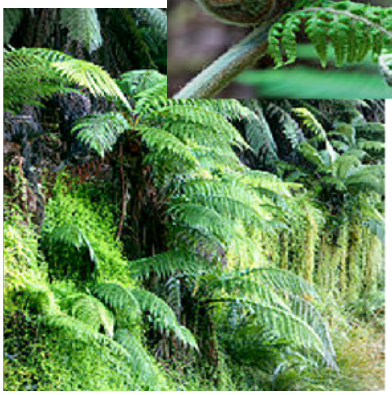
Alethopteris

Cycadeoidea

Calamites Carintaus

Gunnera

Equisetum; horsetail, snake grass or puzzlegrass)



Dicksonia - a genus of tree ferns

Equisetum macrozamia

Filicinophyta (Pterophyta)

CRETACEOUS FLORA

Palmae: Palmus- palm

Podocarpus

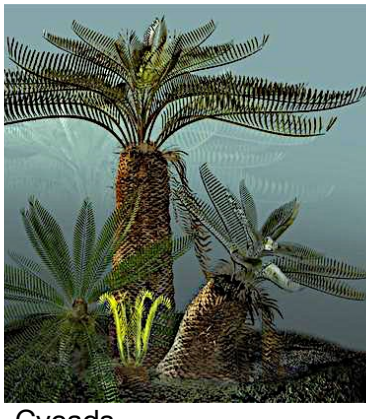
Pleuromeia

Williamsonia

Sabel Palm- Palmetto

Staghorn Fern

Pandanaceae: Pandanus



Cycads

CRETACEOUS FLORA

Ferns

Gold Dust Acuba

Leatherleaf Mahonia

Bleeding Heart

Zebra Grass

Chamaecyparis “fernspray”, Cypress

Juniper

Sego Palm

Weeping Youpon

BEFORE IMPACT | CRETACEOUS FLORA | 85 MILLION YEARS AGO

CRETACEOUS FLORA

Ginger

Fig

Elephant Ears

Grape

Waterlilly

Lotus

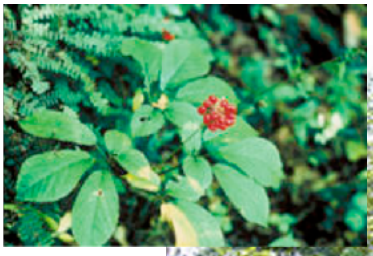
Acanthus- bears breeches

Aspidistra- Cast Iron Plant

CRETACEOUS FLORA

Cercidiphyllum

Lauraceae (like Laurus and Sassafras)



Araliaceae: Aralia

Ginkgophyta: Ginkgo

Betulaceae: Alnus - the birches, alders, hazels, hornbeams and hop-hornbeams

Cornaceae (the dogwood family)

CRETACEOUS FLORA

Fagaceae- Many species of oak, chestnut, and beech

Witch-hazel: Hamamelis

Salicaceae: Malpighiales - willow, violet, Poinsettia and coca plant

Liquidambar- sweetgum Gum, redgum, satin-walnut, or American storax

Magnoliaceae: Magnolia

Salicaceae or the willow family

BEFORE IMPACT | CRETACEOUS FLORA | 85 MILLION YEARS AGO

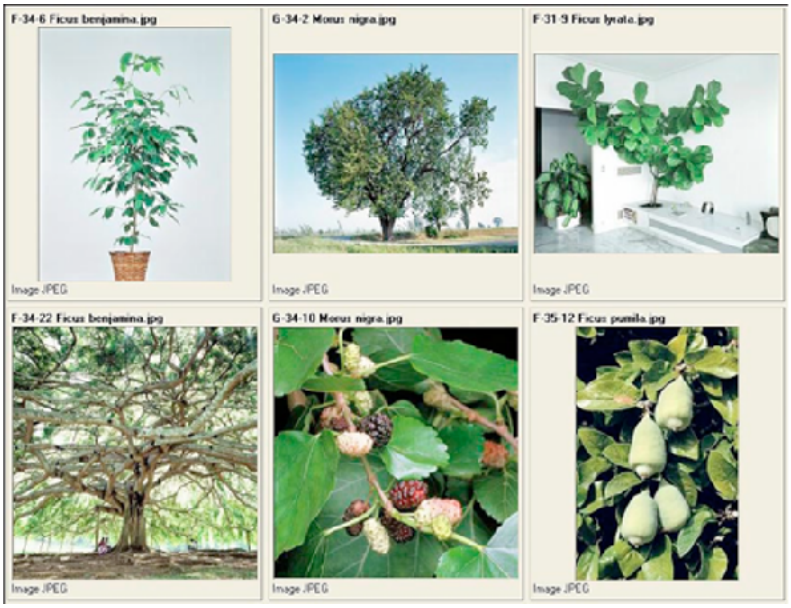
CRETACEOUS FLORA

Nothofagus- the southern beeches

Conifers: Pinus (Pines)

Salicaceae: Populus - poplar aspen, and cottonwood.

Long Leaf Pine



Moraceae: Ficus - often called the mulberry family or fig family

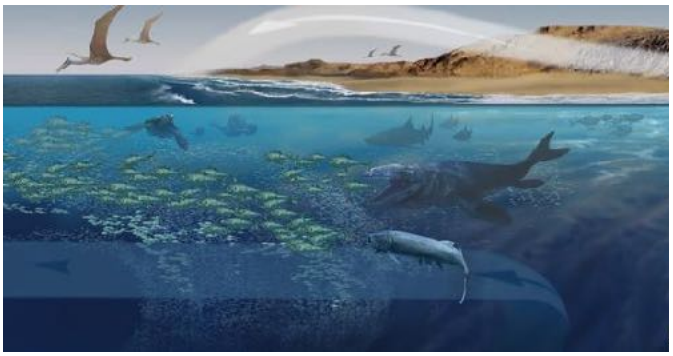
Cypress

45 Karen Carr
Digital Painting
24” h x 41” w
Geologic Period: Cretaceous
Cretaceous Marine Environment
Pictured: Mosasaur, Pleisiosaur, Hesperornis, Protostega, belemnites, nautiloids, crabs, starfish and Xiphactinus

About this image:
One of Karen's most popular works, "Cretaceous Marine Environment" shows a host of Cretaceous underwater life, including a mosasaur hunting ammonites. Also featured are a long-necked Pleisiosaur, a loon-like Hesperornis and the turtle Protostega.

Displayed at The Sam Noble Oklahoma Museum of Natural History, "Cretaceous Undersea Environment" also gives a hint of the tremendous variety of life that existed but that rarely attracts the attention of Hollywood cinema: schools of belemnites and nautiloids, seafloor-dwelling crabs and starfish, and Xiphactinus, a Cretaceous fish somewhat resembling today's tarpon.

Karen's Ancient Life Series for The Sam Noble Oklahoma Museum of Natural History was selected in juried competition to appear in the Communication Arts annual illustration issue. A juried panel from among thousands of entries worldwide selects images.



Karen Carr
Digital Painting
30” h x 56” w
Geologic Period: Cretaceous
Angolan Oceanic Upwelling Community
Pictured: Cretaceous mosasaurs, sharks, ammonites, pterosaurs, fish and other animals from the South Atlantic, off the coast of what is now Angola.

About this image:
The underlying mechanisms driving the incredible marine productivity seen today in Angola were established early in the geological history of the coastal areas. Driven by coastal winds, currents from the ocean floor call upwellings brought cold nutrient-rich water to the surface, feeding plankton that is the foundation of the food chain. As it is today, the upwelling areas in the ancient sea were full of shellfish, sea urchins, snails, crabs and small fish, providing nutrition for larger fish and animals. High in the ancient food chain were the reigning predators of the time, the mosasaurs and plesiosaurs.

Hope Brannon

Geologic Period: Cretaceous

Time Capsule: Cretaceous Period Marine Environment, 2015

Oil on Shaped Canvas

Pictured: Cretaceous mosasaurs, ammonites, fish, ocean flora, corals and other marine animals from Alabama

About this image:
"Cretaceous Marine Environment" shows a host of Cretaceous underwater life, including a mosasaur and its baby swimming among a variety of ammonites near a shallow coastal shelf. Also featured are corals, crinoids and ocean flora.

Karen Carr

Digital Painting

Geologic Period: Cretaceous

Marine Environment: Paleo Angola Sea

Pictured: Mosasaur, Sea Turtle and Ammonites

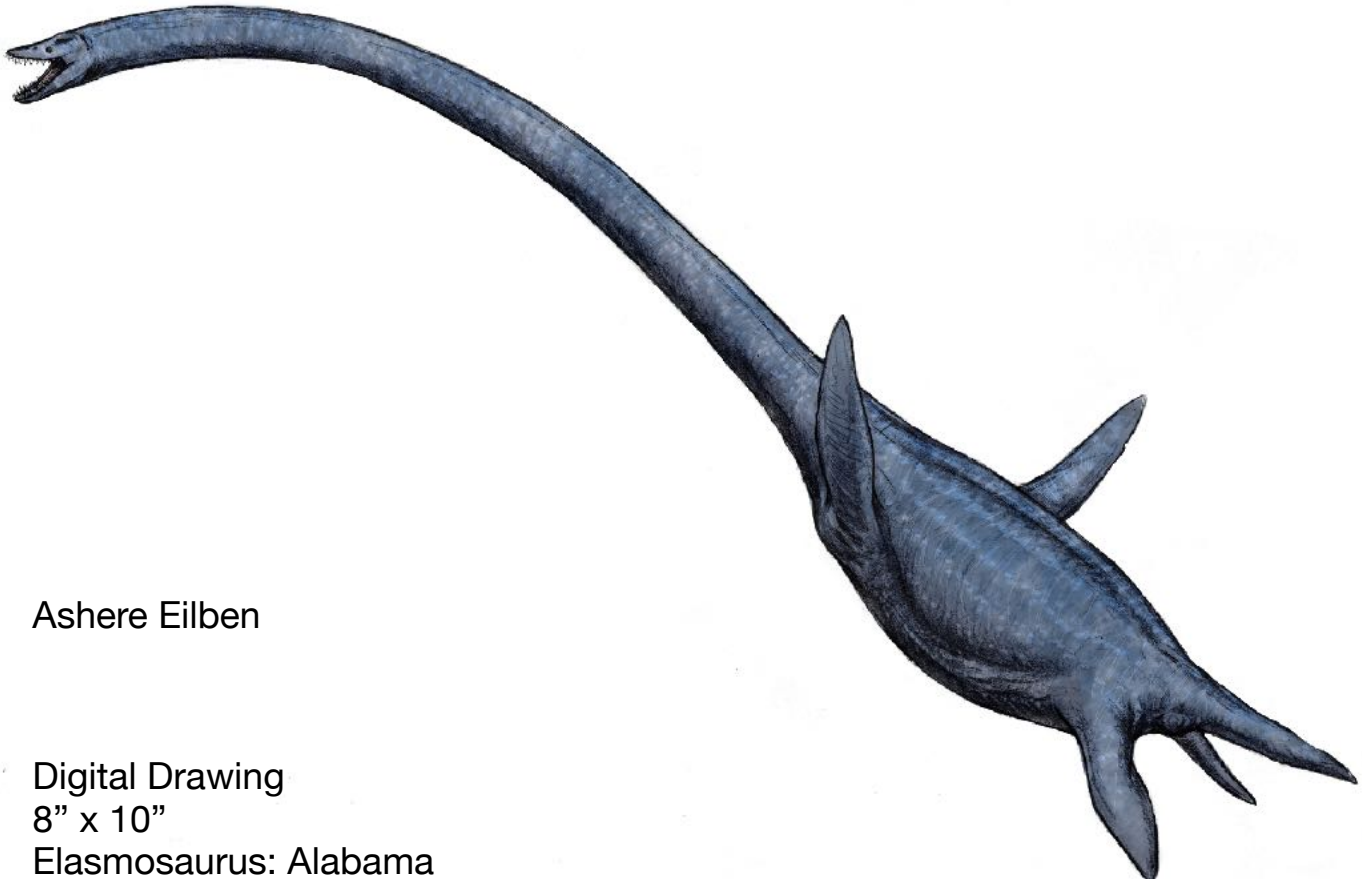
Karen Carr

Digital Painting

Geologic Period: Cretaceous

Mesozoic Marine Environment

Pictured: Cretoxyrhina, Ischyrhiza mira, Xiphactinus, Protostega, Helioceras, Volutomorphia muatabilis wade, Neithea quincostatus sowerby, Euspira, Inoceramus, Dakotacancer overanus, pycodonts, Exogyra costata



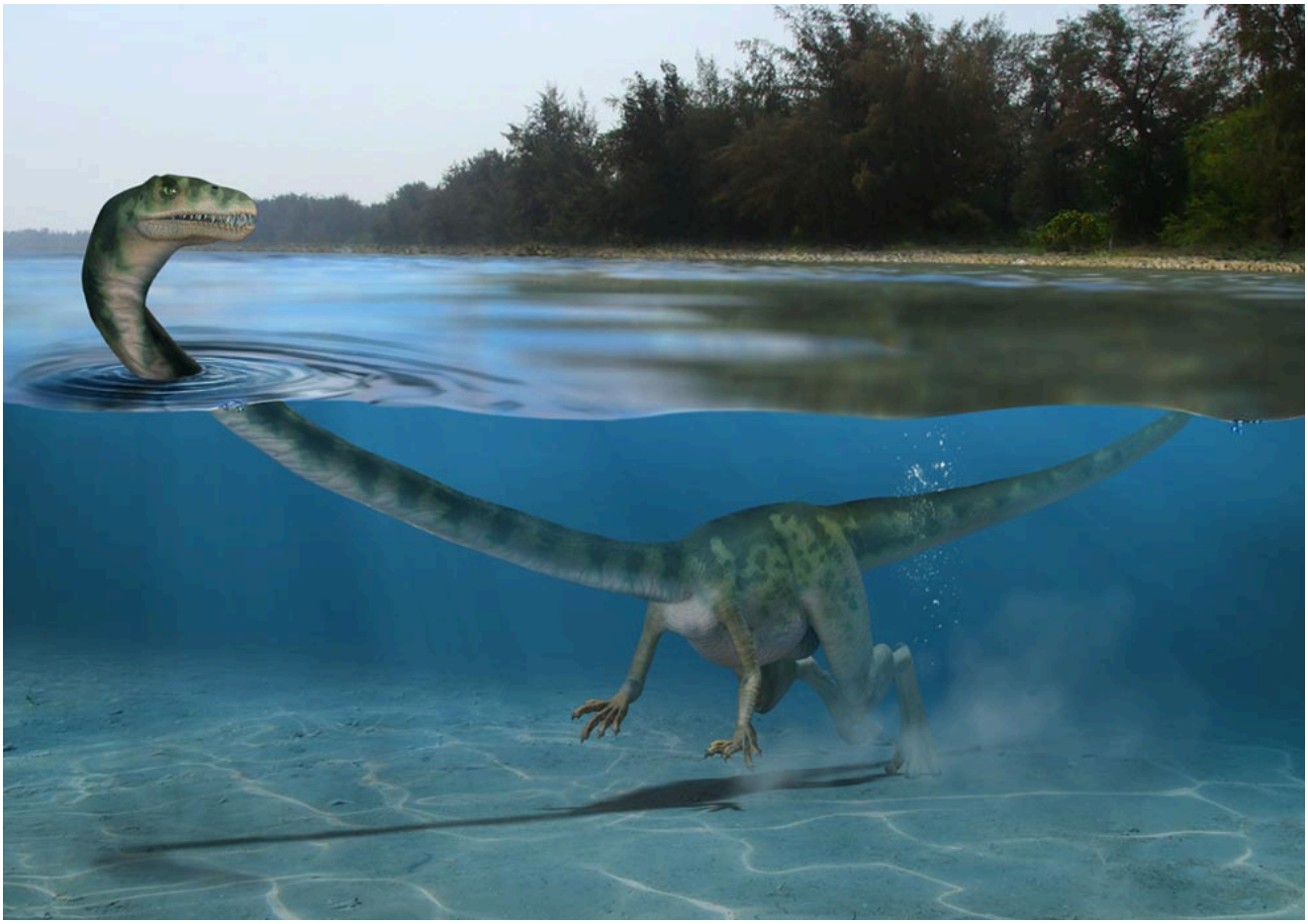
Ashere Eilben

Digital Drawing
8” x 10”
Elasmosaurus: Alabama

About this Image:
Elasmosaurus was about 46 ft. in length and weighed over 2.2 short tons, making it among the largest plesiosaurs. Like most plesiosaurs, Elasmosaurus was incapable of raising anything more than its head above the water as it is commonly depicted in art and media. The weight of its long neck placed the center of gravity behind the front flippers. Thus Elasmosaurus could only have raised its head and neck above the water if in shallow water, where it could rest its body on the bottom.

Elasmosaurus was a slow swimmer and may have stalked schools of fish. The long neck would allow Elasmosaurus to conceal itself below the school of fish. It then would have moved its head slowly and approached its prey from below. The eyes of the animal could have had stereoscopic vision, which would help it find small prey. Hunting from below would also have helped by silhouetting the prey in the sunlight while concealing Elasmosaurus in the dark waters below. Elasmosaurus probably ate small bony fish, belemnites (similar to squid), and ammonites (mollusks). It swallowed small stones to aid its digestion. Elasmosaurus is believed to have lived mostly in open oceans. The paddles of Elasmosaurus and other plesiosaurs are so rigid and specialized for swimming that they could not have come on land to lay eggs. Thus it most likely gave live birth to its young like modern sea snakes.

Elasmosaurs (elas-mo-sau-rus) belong to the family Elasmosauridae, a classification of extinct marine reptiles that belong to the order Plesiosauria. The name "plesiosaur" means "near-lizard" in reference to the fact that these animals were taxonomically close to living reptiles. Elasmosaurs have the longest necks of all plesiosaurs discovered thus far. By the late Cretaceous, the animals had reached what would be their peak length of 14 meters (46 feet) and weighed more than two tons. Their long necks were comprised of anywhere between 32 and 76 cervical (neck) vertebrae. These marine reptiles probably could lift their heads only slightly above water to breath, as their necks were too long and heavy to raise very high outside the water. Elasmosaurs preyed primarily on fish and prehistoric cephalopods (a class that includes present-day squids and octopuses) such as belemnites and ammonites. Scientists believe that elasmosaurs were relatively slow-moving ambush predators that used their long necks and thin, pointed teeth to catch their prey.

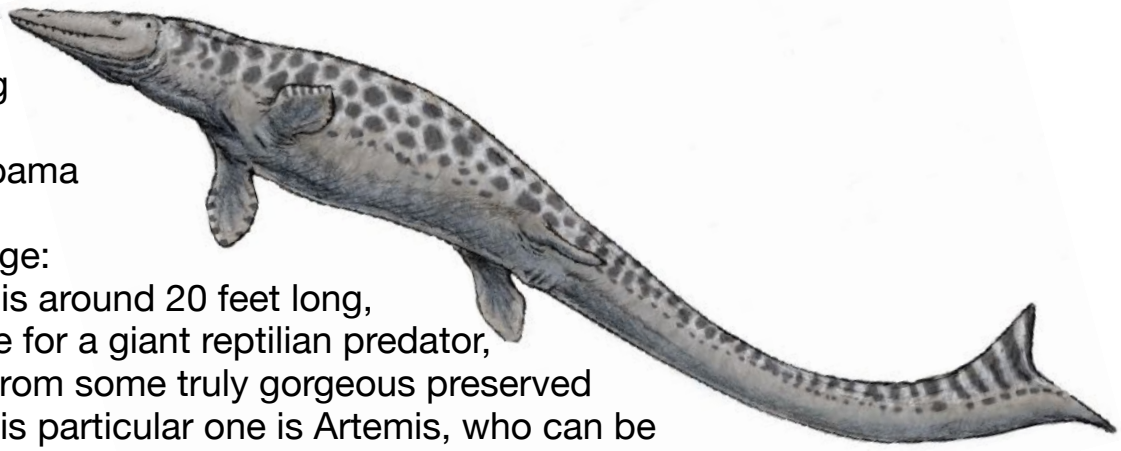


Jon Hughes

Digital Painting

Elasmosaurus

Note: This creature gives a new meaning to the term “rubber-necking”.



Ashere Eilben

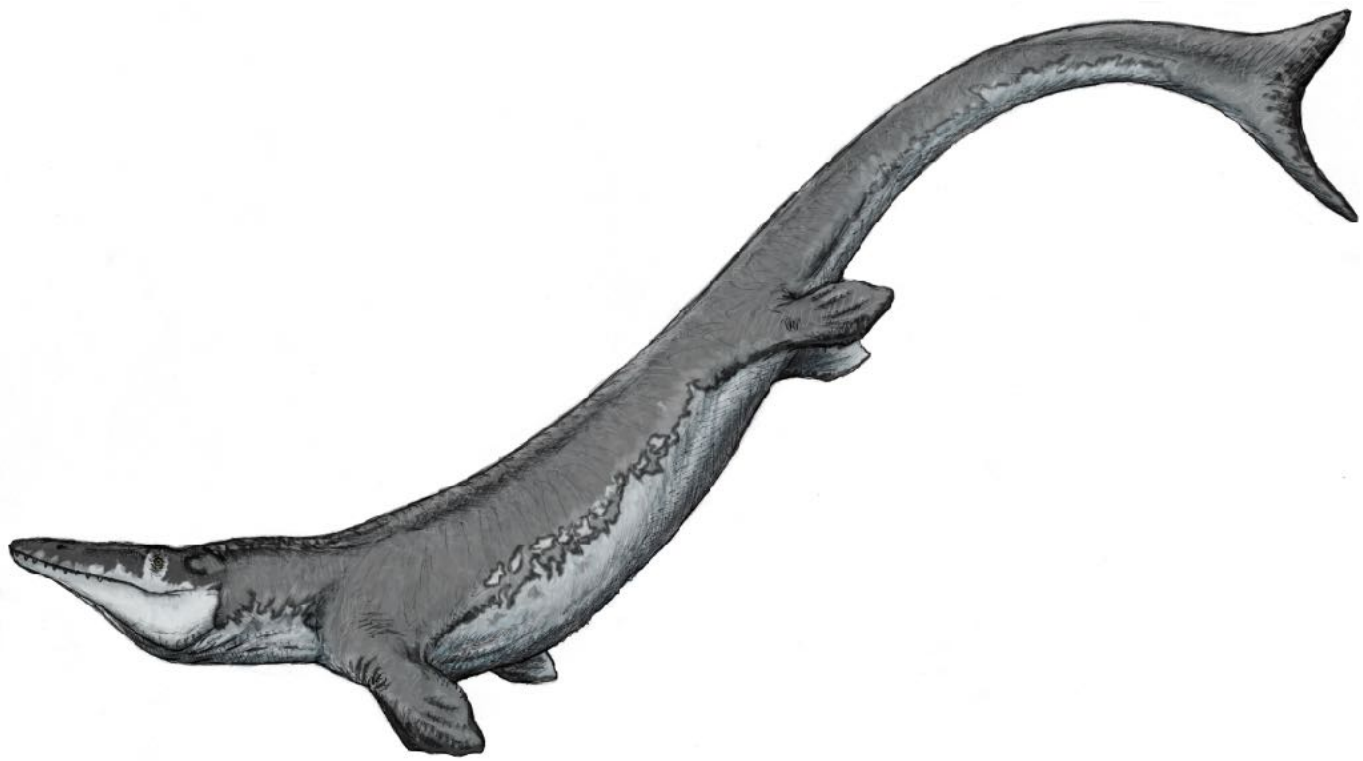
Digital Drawing
8” x 10”
Clidastes: Alabama

About this Image:
This Clidastes is around 20 feet long, somewhat cute for a giant reptilian predator, and is known from some truly gorgeous preserved specimens. This particular one is Artemis, who can be seen in the Alabama Museum of Natural History. It was discovered, originally, in Alabama, but has since been recovered from many other areas that were once near-shore environments of the Western Interior Seaway.

Clidastes was the smallest of the mosasaurs. Adults reached lengths of about 12 or more feet. The relative length of the body compared to the length of the tail is much longer in Clidastes than in other mosasaurs. It also had more teeth. A recent paper (1999) by Sheldon and Bell suggests that Clidastes was a primitive form and much closer to the terrestrial species that re-entered the oceans in the middle Cretaceous. They probably fed on small fish and squid, and were in turn preyed upon by larger mosasaurs such as Tylosaurus. Clidastes becomes the most commonly found mosasaur in the upper chalk, and possibly is an indication that the Western Interior Seaway was becoming narrower and shallower by that time.

It was allied with the genus Mosasaurus, which as discoveries proved, had a slender, eel-like body and tail and not only the anterior paddles previously known, but posterior limbs also. With a mouth resembling a boa constrictor, this monarch of the cretaceous seas could bolt with ease the largest of his coeval reptiles and fishes.”

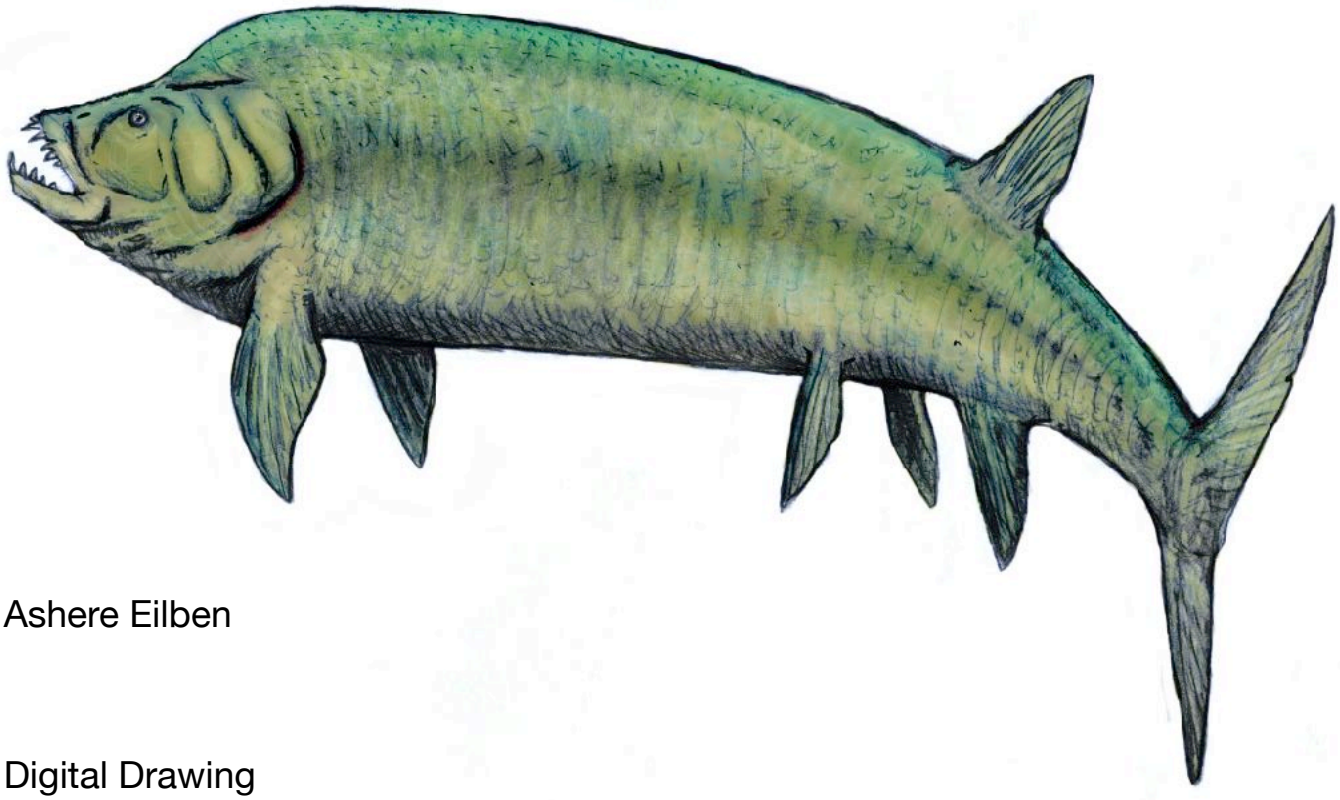
Mosasaurs: *(moe-sa-sawrs)* Alabama is among the best places in the world to find mosasaur fossils. Mosasaurs are marine reptiles that lived during the time of the dinosaurs. Many species of mosasaur once swam in Alabama’s ancient sea. Paleontologists are able to differentiate between these species by their different sizes and slightly different skull and skeletal structures. A few of these species of mosasaurs could grow to enormous sizes, some exceeding 50 feet! Mosasaurs were at the top of the food chain and preyed on smaller individuals of other species, including ammonites, fishes, birds and even smaller mosasaurs. Mosasaurs had to surface periodically to breathe. Instead of an "up and down" movement their tail like whales and porpoises, mosasaurs used a sinuous, undulating movement of their tails to propel themselves rapidly through the water. This movement would have been much like that of a swimming alligator or snake. Mosasaurs could flex their lower jaws allowed it to swallow prey in one piece (much like modern-day snakes). Mosasaurs gave live birth to their young and may have even provided them some form of parental protection.



Ashere Eilben

Digital Drawing
8” x 10”
Tylosaurus propython: Alabama

About this Image:
Tylosaurus was a mosasaur, a large, predatory marine lizard closely related to modern monitor lizards and to snakes. Along with plesiosaurs, sharks, fish, and other genera of mosasaurs, it was a dominant predator of the Western Interior Seaway during the Late Cretaceous. Tylosaurus was among the largest of all the mosasaurs (along with Hainosaurus and Mosasaurus hoffmannii), reaching maximum lengths of more than 49 feet. A distinguishing characteristic of Tylosaurus is its elongated, cylindrical premaxilla (snout) from which it takes its name and which may have been used to ram and stun prey and also in intraspecific combat. Stomach contents associated with specimens of Tylosaurus indicate that this ferocious mosasaur had a varied diet, including fish, sharks, smaller mosasaurs, plesiosaurs, and flightless diving birds such as Hesperornis. In some paleoenvironments, Tylosaurus seems to have preferred shallow, near - shore waters (as with the Eutaw Formation and Mooreville Chalk Formation of Alabama), while favoring deeper water farther out from shore in other environments (as with the Niobrara Chalk of the western U.S.).

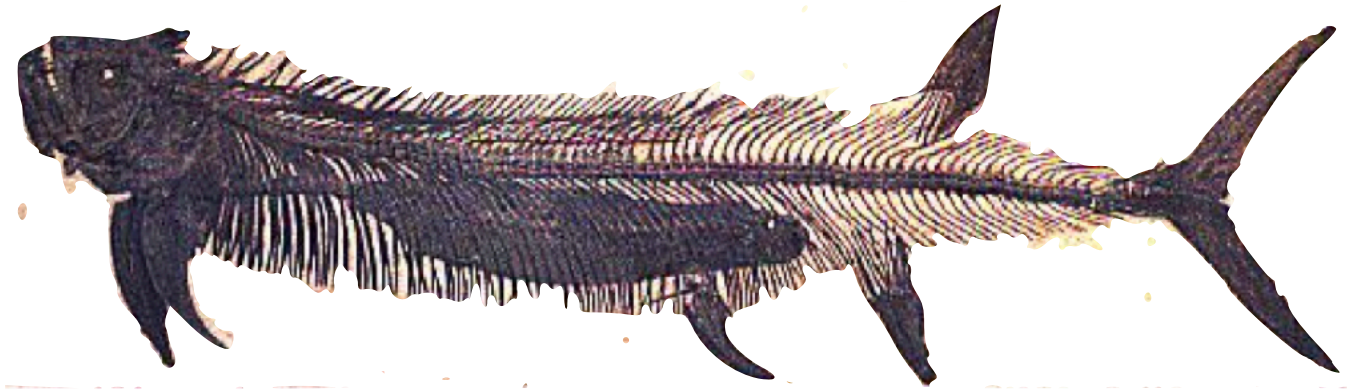


Ashere Eilben

Digital Drawing
8” x 10”
Xiphactinus audax: Alabama

About this Image:
Xiphactinus was a fast, strong swimmer and may have leapt from waters to dislodge parasites from its skin. It is also possible that there were lots of little fish that swarmed around it, nibbling on parasites, much the same as they do today for larger fish. It was one of the largest bony fish of the Late Cretaceous and is considered one of the fiercest creatures in the sea. A powerful tail and wing-like pectoral fins shot the 17-foot-long monster through the surface waters of the ocean. Unlucky fish and unsuspecting seabirds were snared inside Xiphactinus's upturned jaw, which was lined with giant, fanglike teeth, giving it an expression akin to that of a bulldog. A 13-foot-long Xiphactinus could open its jaw wide enough to swallow six-foot-long fish whole, but it itself was occasionally prey to the shark Cretoxyrhina. It trolled an ancient ocean called the Western Interior Seaway, which covered much of central North America during the Cretaceous. Though long extinct, if alive today the bony fish would look like a giant, fanged tarpon. One Xiphactinus on display at a museum in Kansas has a complete, well-preserved fish inside it. Scientists believe the struggling prey ruptured an organ of its captor as it was swallowed, killing the larger fish.

Xiphactinus: (zai-fact-in-us) Xiphactinus was the largest bony fish in the Late Cretaceous, sometimes reaching a lengths up to eighteen feet. They are sometimes compared to the modern tarpon though no real evidence exists to support this relationship. They became extinct at the end of the Cretaceous Period. These huge fish, along with mosasaurs, were ferocious predators. Xiphactinus means “sword-ray” and was named from a piece of a front (pectoral) fin. It is equipped with fang teeth, some over two inches long, and had jaws like a huge piranha. Xiphactinus had a voracious appetite and often ate fish whole and head first. Greed sometimes got the best of them and some died with a meal inside. The world famous “Fish within a Fish,” collected by George F. Sternberg in 1952 and on display at the Sternberg Museum of Natural History in Hays, Kansas has a classic example of this; the fourteen-foot Xiphactinus swallowed a six foot Gillicus fish and died as a result of its gluttony. Although they were fierce predators they were eaten by large mososaurs and sharks.



Xiphactinus, “Fish within a Fish,” collected by George F. Sternberg, 1952, Sternberg Museum of Natural History, Hays, Kansas

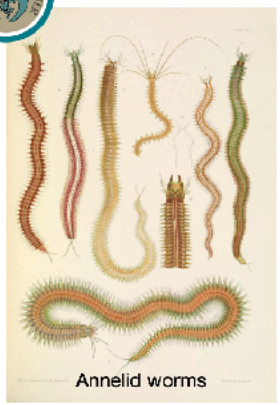
Asher Elbein,
Protosphyraena

Protosphyraena (pro-to-s-fy-ray-nah) is a fossil genus of swordfish-like marine fish, that thrived worldwide during the Upper Cretaceous Period (Coniacian-Maastrichtian). Though fossil remains of this taxon have been found in both Europe and Asia, it is perhaps best known from Late Cretaceous deposits in Kansas and Alabama. *Protosphyraena* was a large fish, averaging 2–3 metres (6.56-9.84 feet) in length. *Protosphyraena* shared the Cretaceous oceans with marine reptiles, such as mosasaurs and plesiosaurs, as well as with many other species of extinct predatory fish. The name *Protosphyraena* is a combination of the Greek word protos ("early") plus Sphyraena, the genus name for barracuda, as paleontologists initially mistook *Protosphyraena* for an ancestral barracuda. Recent research shows that the genus *Protosphyraena* is not at all related to true swordfish-family Xiphiidae, but belongs to the extinct

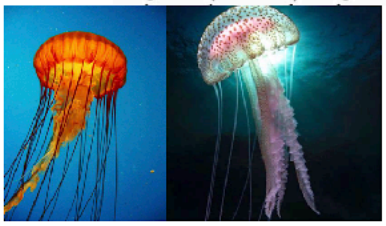
CRETACEOUS LIFE: MARINE INVERTEBRATES

Ammonites (closed and open coiled, candy canes, and particularly weird forms), microfossils, annelid worms, jellyfish, belemnites (squid pens), brachiopods (lamp shells), corals, crustaceans (crabs, lobsters, and shrimp), echinoderms (urchins, sand dollars, starfish, brittle stars, and crinoids), gastropods (sea snails, conchs, and limpets), nautiloids (ancestors of the modern Nautilus) and pelecypods (clams, oysters, scallops, and rudistids).

Cretaceous Invertebrates


Annelid worms

RIGHT; Types of Jellyfish


Jellyfish


Corals


Belemnites (squid pens)


Ammonites (closed and open coiled, candy canes, and particularly weird forms)


Nautiloids (ancestors of the modern Nautilus)

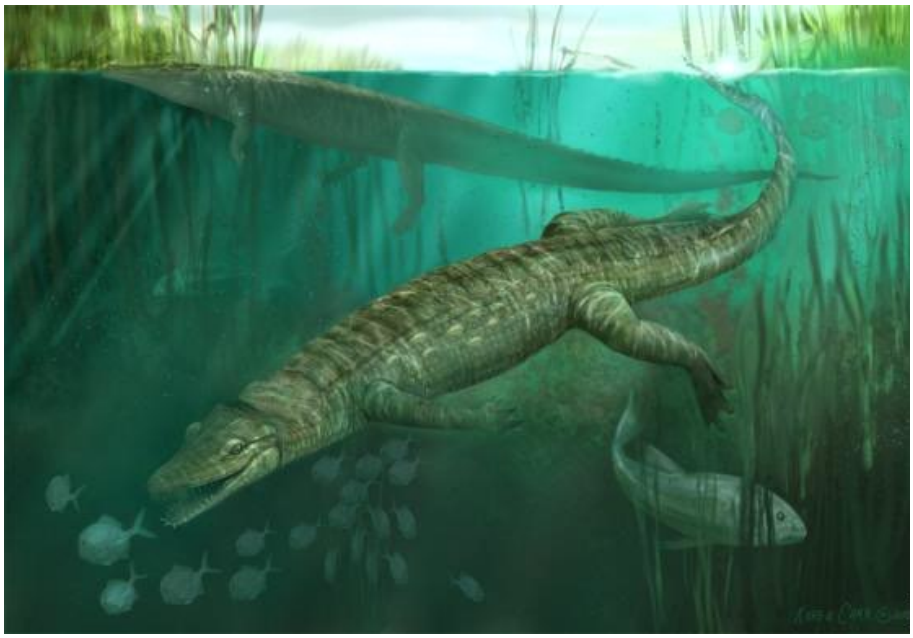

Crustaceans (crabs, lobsters, and shrimp)


Gastropods-sea snails((left), conchs (middle), and limpets (right)

urchins | sand dollars | starfish | brittle stars | crinoids


Brachiopods (lamp shells)


Pelecypods (clams, oysters, scallops, and rudistids)



Karen Carr

Digital Painting
24” h x 36” w

Geologic Period:
Cretaceous

Pachycheilosuchus
Pictured:
Pachycheilosuchus and freshwater fish

Karen Carr

Digital Painting

36” w x 24” h

Geologic Period:
Cretaceous
Pictured:
Aetodactylus halli,
a newly described
toothed pterosaur

Did you know?
This rare pterosaur --
literally a winged lizard --
is also one of the youngest members in the world of the pterosaur family Ornithocheiridae, according to paleontologist Timothy S. Myers, who identified and named Aetodactylus halli. The newly identified reptile is only the second ornithocheirid ever documented in North America, says Myers, a postdoctoral fellow in the Huffington Department of Earth Sciences at Southern Methodist University in Dallas.

Karen Carr

Digital Painting

120” w x 33.5” h

Geologic Period: Cretaceous

Texas Cretaceous Coastal Landscape
Pictured: Tenontosaurus, Hypsilophondont, Deinonychus, Titanosaur, Glyptops, Goniopholidid crocodile, Semiontid fish

About this image:
Towering dinosaurs, rare fossils and virtual paleo-habitats are just a few of the features that make the T. Boone Pickens Life Then and Now Hall a must-go destination for dinosaur lovers, fossil collectors or just about anyone who has ever wondered what life was like when dinosaurs roamed the Earth.

Inside the 11,000-square-foot exhibition space within the Perot Museum of Nature and Science, discover awe-inspiring fossil finds like the infamous predator Tyrannosaurus rex or the plant-eating Alamosaurus. Also discover how plants and animals adapted to changing conditions over the millennia — and you’ll have the chance to introduce beneficial adaptations of your own as you create a virtual animal to do battle in our video game challenge

Karen's Ancient Life Series for The Sam Noble Oklahoma Museum of Natural History was selected in juried competition to appear in the Communication Arts annual illustration issue. A juried panel from among thousands of entries worldwide selects images.

Karen Carr

Digital Painting

72” w x 23” h

Geologic Period: Cretaceous

Cretaceous Coastal Environment
Pictured: Deinonychus, Tenontosaurs, Ornithodesmus and Gobiconodon

About this image:
Part of Karen's Ancient Life Series for The Sam Noble Oklahoma Museum of Natural History, "Cretaceous Coastal Environment" shows a pack of hunting Deinonychus stalking a herd of Tenontosaurs. Overhead, Ornithodesmus sail on coastal breezes.

Although the focus of this mural is clearly on the dinosaurs and the flying pterosaurs, look also for Gobiconodon, a primitive mammal from a group of animals called Amphilestids. Small and somewhat resembling an opossum, Gobiconodon is known from fossils found both in Mongolia and the western United States.

Karen's mural is also richly illustrated with plants of the Cretaceous Period, including magnolia, cycads, tree ferns and water lilies.

Karen's Ancient Life Series for The Sam Noble Oklahoma Museum of Natural History was selected in juried competition to appear in the Communication Arts annual illustration issue. A juried panel from among thousands of entries worldwide selects images.

Karen Carr

Digital Painting
30” h x 46.5” w
Geologic Period: Cretaceous
Dinosaur Society Hadrosaur
Pictured: Hadrosaur

About this image:
Karen was lucky enough to be on hand when bones for this animal were being recovered near D/FW Airport—and unlucky enough to break one of the creature's ribs when helping to take it out of the ground!

Karen Carr

Digital Painting
36” w x 25.5” h
Geologic Period:
Cretaceous Citipati
Pictured: Citipati, an oviraptor

About this image:
Fossil specimens of Citipati found in Mongolia provide a fascinating look into the lives of ancient animals: Several fossil individuals have been found preserved as they sat on their nests, brooding their eggs. This evidence of nesting is one of the many links connecting modern birds with dinosaurs.

Did you know?
Although the family name for Citipati, Oviraptoridae, means "egg thief," it is possible oviraptors have had a bad rap, at least in part: Early finds of oviraptor fossils were near fossilized eggs, and the 'raptors were thought to be egg thieves. It is possible they were, but it is also possible the eggs they were found near were their own.

Karen Carr

Digital Painting
24” w x 10” h

Geologic Period: Cretaceous

Dinosaur Hunt pages 4 and 5
Pictured: Juvenile Acrocanthosaurus

About this image:
Karen's book, "Dinosaur Hunt," is a fascinating illustrated glimpse into the lives of ancient animals, and features one of the most famous predator-prey confrontations from the Cretaceous.

"Dinosaur Hunt" recounts the confrontation between Acrocanthosaurus and Pleurocoelus along a Cretaceous shoreline more than 65 million years ago. The fossilized footprints from this confrontation are preserved to this day, and can be seen at Dinosaur Valley State Park, in Glen Rose, Texas.

"The intriguing perspectives add drama and immediacy, and the author pushes the limits of the digital media providing impressive detail, for example, the play of light on the mottled textured skin of the giants. This will be a crowd pleaser." — Kirkus Reviews

Karen Carr

Digital Painting

15” w x 12” h

Geologic Period: Cretaceous

Feathered Deinonychus
Pictured: A feathered Deinonychus, whose name means "terrible claw."

About this image:
Deinonychus have been included in many of Karen's murals and are among her favorite animals to paint: They're fierce-looking, sleek and always popular with kids. In the years Karen has been painting, the understanding of Deinonychus has increased, and Karen now shows the animals feathered... but if you look through her web site, you will find other, earlier versions representing the "featherless" reconstruction!

Did you know?
Deinonychus remains are often found close to those of the herbivorous Tenontosaurs, suggesting there was a close predator-prey relationship between these two Cretaceous animals.

Notes:
This image appears in the new Dino Store at the American Museum of Natural History.

Karen Carr

Digital Painting
60” w x 23” h
Geologic Period: Cretaceous
Didelphodon: Egg Thief
Pictured: Didelphodon vorax

About this image:
Didelphodons were possum-sized mammals of the late Cretaceous, with special teeth for crushing and grinding. Their heavy build may indicate they lived in underground burrows, like modern foxes or badgers.

Notes:
This image appears in the Dino Store at the American Museum of Natural History

Karen Carr

Digital Painting

15” w x 7.5

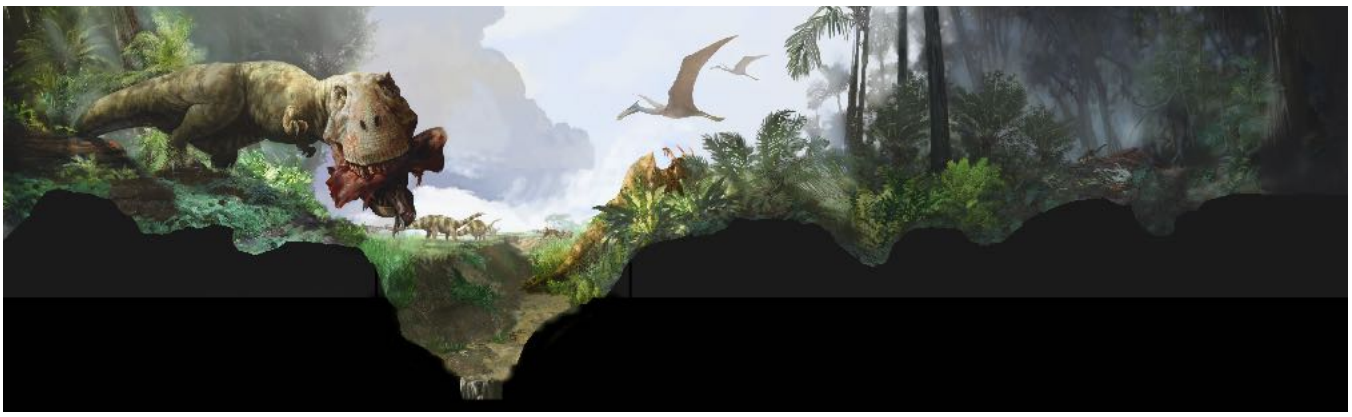
Geologic Period: Cretaceous

Angolatitan
Pictured: Angolatitans and pterosaurus

About this image:
Angola's first dinosaur was discovered in 2005, about 35 miles north of Luanda. This new species of sauropod, named Angolatitan adamastor, is one f the few occurrences of its kind in sub-Saharan Africa in the Late Cretaceous.

Did you know?
Does the site of a large herbivore tracking across a dry desert surprise you? Today, African elephants occupy the same area in much the same climate, so which the desert conditions may have been harsh, Angolatitan found ways to survive then as the elephants do now.

Notes:
Angolatitan was about 40 feet long, and lived 90 million years ago.



Karen Carr

Digital Painting
24” w x 7.5” h
Geologic Period: Cretaceous
Big Bend T. Rex portrait
alternate detail

Pictured:
Tyrannosaurus Rex, Quetzalcoatlus and Pleurocoelus

Notes:
Tyrannosaurus Rex's six-inch teeth have been described as looking like "lethal bananas" because of their size and curved shape. But while Rex was undoubtedly fierce, carrion and scavenging may have supplied some of his -— or her -— diet.

Karen's "Big Bend T. Rex" captures a moment in the Cretaceous Period of what is now far west Texas, in the area known as Big Bend. In addition to Rex, Karen's mural includes Quetzalcoatlus, the giant aviators of the Cretaceous skies, and herds of Pleurocoelus, appearing both as a grazing herd in the background as a T. Rex main course in the foreground.

Karen Carr

Digital Painting
24” w x 10”h
Geologic Period: Cretaceous
Dinosaur Hunt pages 36 and 37
Pictured: Acrocanthosaurus and Acrocanthosaurus eggs in next

About this image:
Karen's book, "Dinosaur Hunt," is a fascinating illustrated glimpse into the lives of ancient animals, and features one of the most famous predator-prey confrontations from the Cretaceous.

"Dinosaur Hunt" recounts the confrontation between Acrocanthosaurus and Pleurocoelus along a Cretaceous shoreline more than 65 million years ago. The fossilized footprints from this confrontation are preserved to this day, and can be seen at Dinosaur Valley State Park, in Glen Rose, Texas.

"The intriguing perspectives add drama and immediacy, and the author pushes the limits of the digital media providing impressive detail, for example, the play of light on the mottled textured skin of the giants. This will be a crowd pleaser." — Kirkus Reviews

Karen Carr

Digital Painting

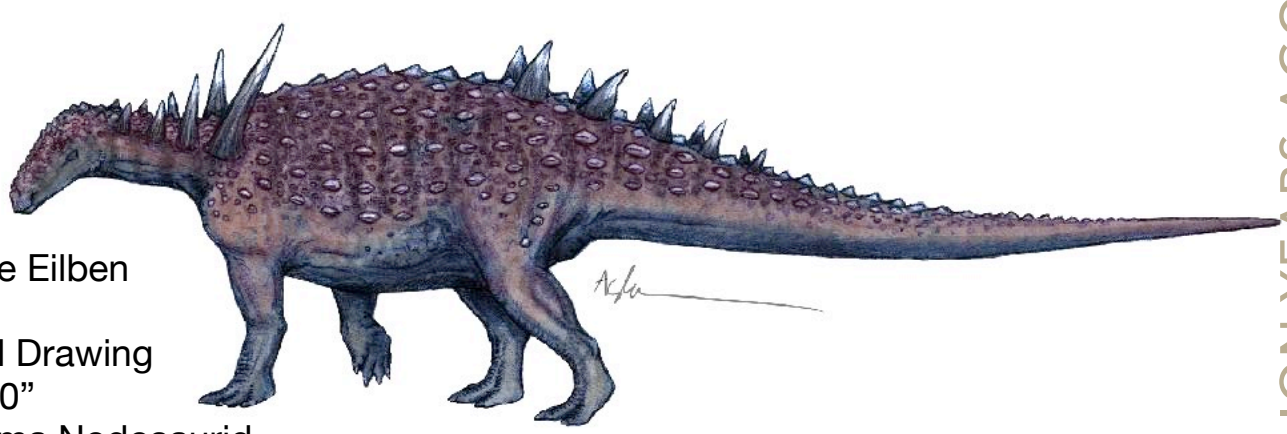
Geologic Period: Cretaceous

Dinosaur Island

Pictured:

About this image:
Dinosaurs make science exciting. They show us how the earth has changed over eons. Our current period of geologic time, the Cenozoic era, has lasted a mere 66 million years — nearly 100 million years shorter than the Mesozoic reign of the dinosaurs. Lone Star Dinosaurs tells the history of these gigantic reptiles in Texas and the accounts of people who found their fossilized remains.

Lone Star Dinosaurs was Karen's first collaboration with Dr. Louis Jacobs of Southern Methodist University, the Saurus Institute and the Institute for the Study of Earth and Man.



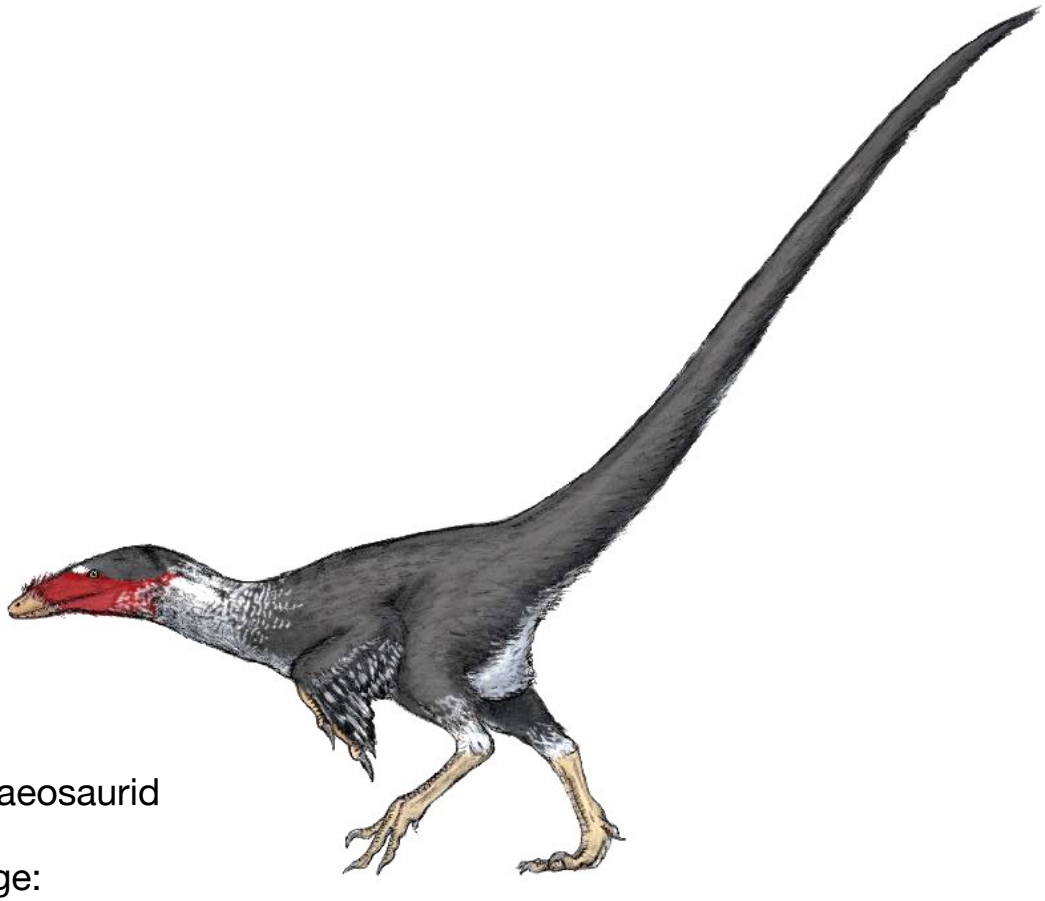
Ashere Eilben

Digital Drawing
8” x 10”
Alabama Nodosaurid

About this Image:
Nodosaur fossils are reasonably common in Alabama marine deposits, often where carcasses washed out to sea and were scavenged by sharks.

Nodosauridae represents a group that traditionally includes Nodosaurus, Edmontonia, and Sauropelta. The nodosauridae had longer snouts than their akylosaurid cousins. They did not sport the archetypal 'clubs' at the ends of their tails, but rather, their most pronounced physical features were their spikes. Nodosaurids had very muscular shoulders, and a specialized knob of bone on each shoulder blade called the acromial process. It served as an attachment site for the muscles that held up their large parascapular spines. These spines would be used for self-defense against predators. They had wide, flaring hips and thick limbs. Most nodosaurid finds are from North America. They had smaller, narrow beaks than the ankylosaurids, which likely allowed them to be very selective over what plant matter they grazed on. They sported a very small brain size in proportion to their body, second only to the Saurischian sauropods. They were also very slow moving, largely because of the extreme weight of their armored skin. Their top speed was likely less than 10km/hour.

Nodosaurs: *(no-do-sawrs)* Nodosaurs are known for the individual pieces of bony armor are called “scutes” or “spines,” in most species are modified into side and shoulder spikes and armor plates. Some species even have fused "skin armor" onto their skulls. Unlike their close relatives the ankylosaurs, nodosaurs did not have a tail club, but made up for this with heavier and more extensive armor and side spikes. Nodosaurs were herbivores. Their tank-like build prevented them from feeding much higher than about 2 feet off the ground, so they likely feed on things such as ferns, which formed the ground cover during the Mesozoic (there was no grass then). This means that *Lophorhothon* (duck-bill dinosaurs) and nodosaurs could graze side by side without competing for the same food resources. Imagine some of the mixed herds of zebras and gazelles on the plains of Africa congregating for mutual defense and you can form a mental picture of the same thing happening during the Late Cretaceous in Alabama. Individual nodosaur bones are occasionally found in Alabama, and unfortunately the only set of associated remains are incomplete and from a very young animal, making identification difficult. Nodosaurs have the somewhat dubious distinction of having the second smallest brain weight to body weight ratio of any dinosaur - only sauropods had a smaller brain.



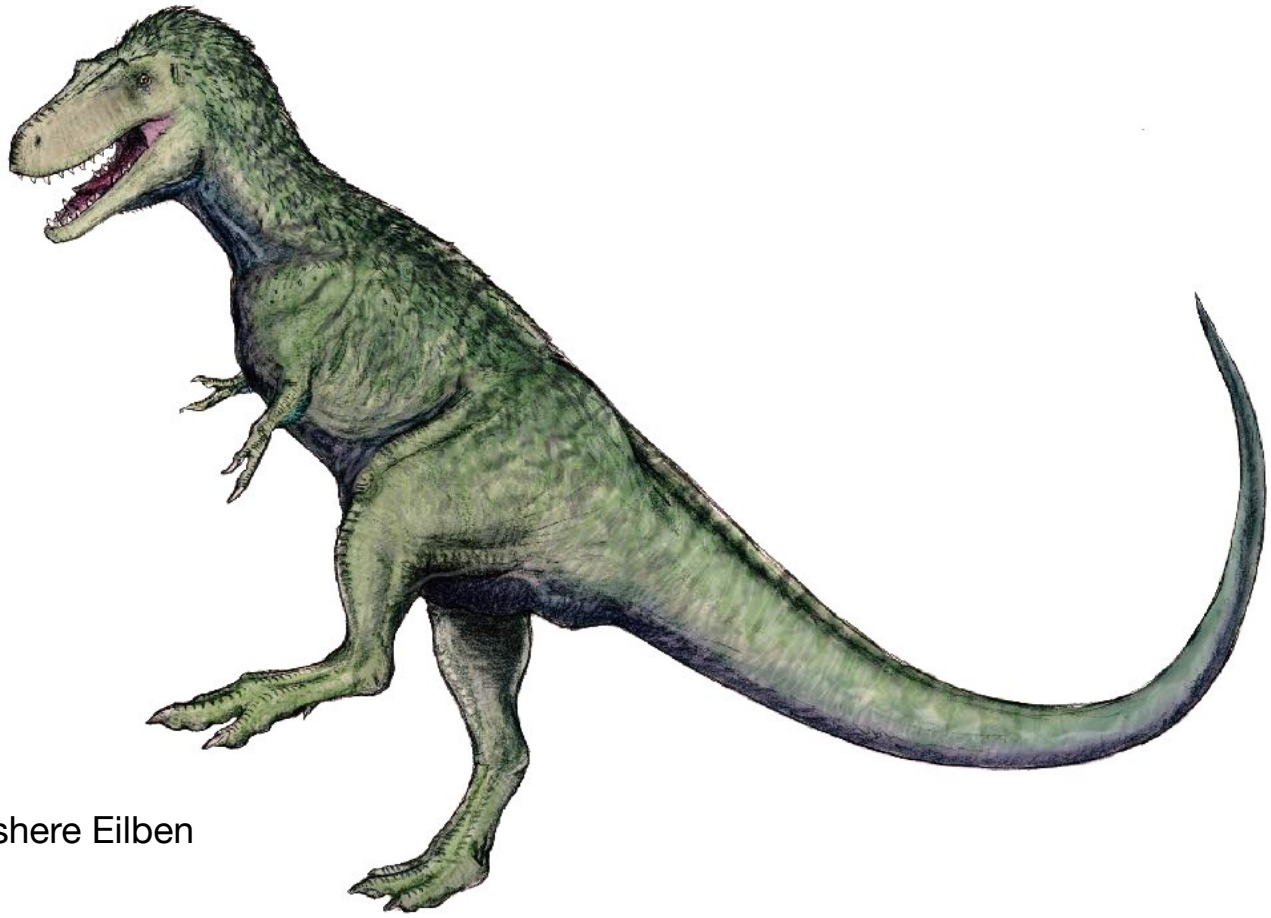
Ashere Eilben

Digital Drawing
8” x 10”
Alabama Dromaeosaurid

About this Image:
This little fellow is known only from some teeth, a tiny sickle claw, and some feather imprints. The coloration is loosely based around the Caracara, or Mexican eagle.

Dromaeosaurs constitute a small clade of theropod dinosaurs which exhibit some highly derived characteristics that they all share, especially modifications of the forelimb allowing for a flexible seizing function (which is thought to have been modified to create the bird "flight stroke".) According to current thinking, birds are hypothesized to have shared a common ancestor with the dromaeosaurs sometime in the Jurassic period; Dromaeosauridae is thus termed the sister group of the clade Aves (which includes all birds.) It may even be that the ancestry of birds lies within this group, which would make them dromaeosaurs too, but this is not at all established.

Dromaeosaurs: *(drome-e-oh-sawrs)* Dromaeosauridae is the family of theropods that include *Deinonychus* - the villains of the Jurassic Park movie (even though they incorrectly called them *Velociraptor*, presumably because they thought the name was more cool; and they made them too big). The discovery of Deinonychus in the late 1960's is widely credited as the launching point of our present understanding that dinosaurs were not slow, lumbering, dumb brutes. Obviously built for speed and sporting an enlarged, retractable, switch-blade killing claw on their hind feet, there was no way this animal fit the old ideas. Dromaeosaurs are the specific group of theropods thought to be most closely related to birds, sharing with them over 100 skeletal characters, and chemically identified remains of feathers. Dromaeosaurs are known from Alabama, but the remains have been too incomplete to be assigned to a species.



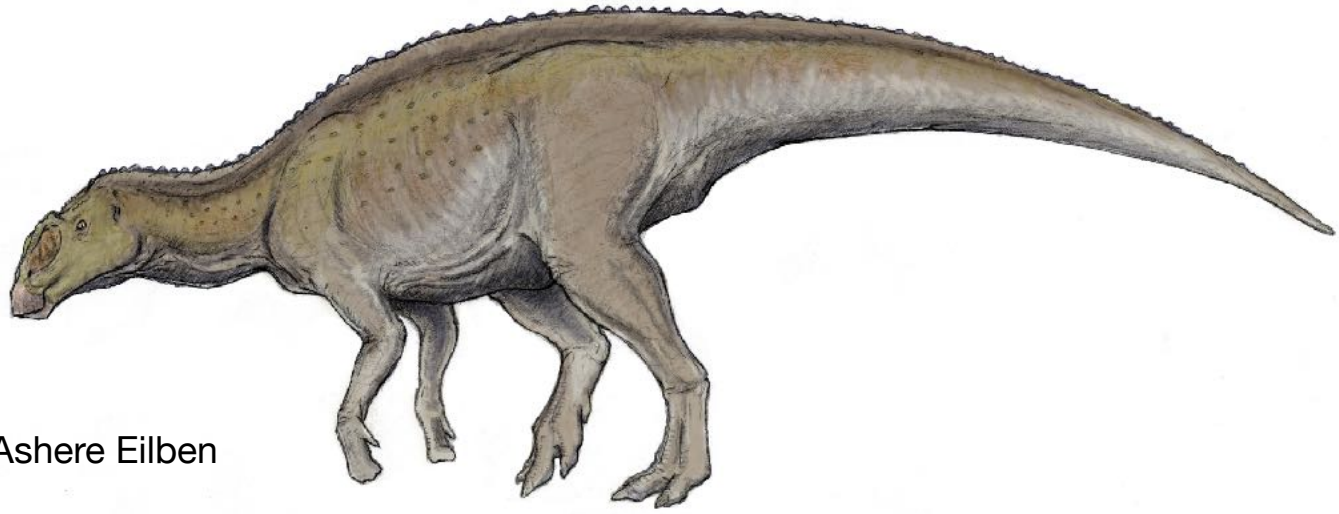
Ashere Eilben

Digital Drawing
8” x 10”
Appalachiosaurus montgomeriensis: Alabama

About this Image:
The name of this dinosaur "appalachian dinosaur from Montgomery" - an allusion to the fact that it comes from the Late Cretaceous Appalachia division of North America, and was found in the Demopolis Formation in Montgomery County, Alabama in the 1980’s. It was not formally described and named until 2005. Appalachiosaurus is closely related to the Tyrannosauridae, the family of theropods (meat-eating dinosaurs) to which Tyrannosaurus rex belongs. There are hints that early tyrannosaurs in various parts of the world did not have the tiny, two-fingered arms of the later tyrannosaurs like T. rex, Albertosaurus, Daspletosaurus, etc., but rather had the more typical theropod build of a large arm and three fingers. Because of the separation of Appalachia, Appalachiosaurus had evolved from a primitive tyrannosaur stock and still retained a large arm. In fact, although T. rex was fully twice the body size of Appalachiosaurus, it had an arm one-half the size of an Appalachiosaurus arm. While the tiny arms of T. rex have given rise to a debate about whether it was an active hunter or a scavenger, there seems little doubt that Appalachiosaurus was a capable hunter. Pronounced: ap-a-lay-chi-o-sawr-us munt-gum-er-e-in-sis

Appalachiosaurus montgomeriensis: *(ap-a-lay-chi-o-sawr-us munt-gum-er-e-in-sis)* The name of this dinosaur "appalachian dinosaur from Montgomery" - an allusion to the fact that it comes from the Late Cretaceous Appalachia division of North America, and was found in Montgomery County, Alabama. Appalachiosaurus is closely related to the Tyrannosauridae, the family of theropods (meat-eating dinosaurs) to which *Tyrannosaurus rex* belongs. There are hints that early tyrannosaurs in various parts of the world did not have the tiny, two-fingered arms of the later tyrannosaurs like *T. rex, Albertosaurus, Daspletosaurus,* etc., but rather had the more typical theropod build of a large arm and three fingers. Because of the separation of Appalachia, Appalachiosaurus had evolved from a primitive tyrannosaur stock and still retained a large arm. In fact, although T. rex was fully twice the body size of Appalachiosaurus, it had an arm 1/2 the size of an Appalachiosaurus arm. While the tiny arms of T. rex have given rise to a debate about whether it was an active hunter or a scavenger, there seems little doubt that *Appalachiosaurus* was a capable hunter. Like other tyrannosaurs, *Appalachiosaurus* teeth have strong serrations - notching like the teeth along the cutting edge of a handsaw. Experiments have shown that these serrations trap meat fibers and it is likely that *Appalachiosaurus* had a nasty fauna of microbes growing in its saliva. A bite from a tyrannosaur could probably induce massive infection. A well-tested mathematical formula allows paleontologists to determine the speed of an extinct animal from a set of preserved footprints - a trackway. A medium-sized theropod like *Appalachiosaurus* was probably capable of running 25 miles an hour. That's olympic class sprinter speed, and because theropods seem to have had the same flow-through "turbo lung" design as birds, they likely had great endurance to go with that speed.

Carl Albrecht-Buehler



Ashere Eilben

Digital Drawing
8” x 10”
Lophorhothon atopus: Alabama

About this Image:
The first discovery was a young Lophorhothon atopus, 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.

Lophorhothon Family Hadrosaurs were herbivorous dinosaurs that ranged from 24 to 35 feet long. They were largely bipedal, but their front limbs were sturdy enough to allow for some four-legged walking, standing, and feeding. Most hadrosaur skulls feature flattened, duck-like mouths developed from wide, toothless upper and lower front jawbones. Hadrosaurs had long rows of grinding rear teeth that the animals used to process vegetation. Hadrosaur skulls also usually display a variety of odd crests, formed by their nasal and upper jawbones. The more primitive hadrosaurine subfamily, of which Lophorhothon is a member, often developed a "Roman-nose" shape formed by a high, narrow nasal ridge.

Duck-billed Dinosaur**:** Two species of duck-billed dinosaurs have been discovered in Alabama, *Lophorhothon atopis* and *Eotrachodon orientalis*. Duck-billed dinosaurs, named for their “duck-like” snouts, are the most common dinosaur found in Alabama. These dinosaurs could grow up to 35 feet in length and lived in vast herds like modern American bison. Duck-billed dinosaurs were herbivores and possessed a mouth lined with banks of hundreds of baseball-diamond-shaped teeth, each with a strong, sharp ridge running down the center. These teeth formed a compound file or rasp-like chewing surface, allowing the animal to thoroughly grind up even tough plant material. Like all dinosaurs, they replaced teeth throughout its life.

Ashere Eilben

Digital Drawing
8” x 10”
Pteranodon: Alabama

About this Image:
Pteranodons were flying reptiles (pterosaurs) that were about 6 feet long, had a 25-33 foot wingspread, and weighed about 35 pounds; its standing height was about 6 feet. This wingspan is longer than any known bird. Pteranodons had hollow bones, were lightly built, had almost no tail, and small bodies; they may have had fur. They had large brains and good eyesight. Some pteranodons had long, lightweight, bony crests on their heads that may have acted as a rudder or stabilizer when flying, or may have been a sexual characteristic. They had no teeth. A leathery membrane covered Pteranodon wings. This thin but tough membrane stretched between its body, the top of its legs and its elongated fourth fingers, forming the structure of the wing. Claws protruded from the other fingers.

Pteranodons were reptiles, but not dinosaurs. Pteranodons lived during the late Cretaceous period about 85-75 million years ago. Although they had no teeth, Pteranodons were carnivores. They ate fish (which they caught at the surface of the oceans), mollusks, crabs, insects, and scavenged dead animals on land. They may have hunted like modern-day pelicans, scooping fish out of the water and swallowing them whole.

Pteranodon: (tuh-ran-uh-don)The order Pterosauria includes almost 200 species of flying reptiles that co-existed with the dinosaurs from the Upper Triassic to the end of the Cretaceous Period (228 to 66 million years ago). Pterosaurs have been discovered across the world on every continent, even Antarctica. Their ability to cover vast distances, and a lack of competition for niches by other animal species. Many people believe pterosaurs were dinosaurs, but they are actually just a closely related group of reptiles. The name "pterosaur" is Latin and translates to "winged lizard"; they were so named for this most notable feature of the order. Of the various species of Pterosaur, only specimens of the genus Pteranodon have been uncovered in Alabama. The name Pteranodon means "winged and toothless" because, unlike many early pterosaurs, these animals had toothless beaks most likely used for catching fish. This genus includes some of the largest members of Pterosauria, with wingspans reaching 18 to 24 feet in males, although females commonly stretched only around 12 feet on average.

Jon Hughes

Digital Painting
23”h x 30.5”w
Edmontosaurus

About this Image:
Edmontosaurus and other duck-billed dinosaurs, or hadrosaurs, were very common in the northern hemisphere during the Late Cretaceous Period. Some species of duck-billed dinosaurs moved about in herds numbering hundreds or thousands of individuals. Edmontosaurus means "Edmonton Lizard" named for the Edmonton Rock Formation in Edmonton, Alberta, Canada. When first discovered, hadrosaurs were thought to be water dwellers. Later study showed that while the body is built for land, the broad tail enabled these animals to move very easily through water. The paddle-like hands of Edmontosaurus support this observation. The snout of Edmontosaurus ended in a large, broad beak suitable for cropping vegetation. Up to 2,000 tightly packed teeth at the back of the jaws were used for chewing and grinding tough plant material. This herbivore (plant-eater) probably ate low-lying plants like cycads, conifers, and ginkgos. Edmontosaurus would have been a common prey animal for T. rex. It was 42 ft. long, 10 ft. tall at the hips and weighed 3-3.5 tons.

Jon Hughes

Digital Painting

23” h x 38” h

Cretaceous Environment

About this Image:
During the Late Cretaceous, the climate was one of the warmest in Earth’s history. This was a result of a variety of factors including:

1) The continents were in different positions so that a world-spanning equatorial ocean current distributed warm ocean water even as far north and south as the poles.
2) Atmospheric carbon dioxide was approximately 4 to 6 times modern levels.
3) Increased area covered by oceans (melted ice caps). Water retains heat from the Sun more efficiently than land.

The combination of these and other factors resulted in a climate so warm that there were no glaciers or ice caps anywhere on Earth, and all of that ice volume was added to the oceans as water. This resulted in the second highest sea level in all of Earth's history, and flooded about 1/3 of the present day land surface with shallow seas. In North America, the Western Interior Seaway extended from the Gulf of Mexico to the Arctic Ocean. This divided North America into a western half, known as Cordillera, and an eastern half, known as Appalachia. However Appalachia was completely isolated from other dinosaur populations, so the Late Cretaceous dinosaurs that lived in what is now the Eastern U.S. are unique, having evolved in isolation for some 30 million years.

Jon Hughes

Digital Painting

23”h x 30.5”w

Diabloceratops

About this Image:
Although Diabloceratops has only recently been announced to the general public, this horned dinosaur has been familiar to paleontologists since 2002, when a near-intact skull was discovered in southern Utah. Eight years of analysis and preparation yielded what may (or may not) be a ceratopsian "missing link." Diabloceratops seems to have evolved from the smaller horned dinosaurs of the early Cretaceous period, yet it predated more advanced genera like Centrosaurus and Triceratops by millions of years. As you might expect given its evolutionary position, the massive head of Diabloceratops was ornamented in a unique way: it lacked a horn on its snout, but had a medium-sized, Centrosaurus-like frill with two sharp horns jutting up from either side. It's possible that Diabloceratops' frill was covered with a thin layer of skin that changed color during mating season. Diabloceratops (Greek for "devil horned face") is pronounced dee-AB-low-SEH-rah-tops. It inhabited the woodlands of North America during the late Cretaceous (85 million years ago.) It was about 20 - 25 feet long and weighed one to two tons. This giant was a plant eater. Distinguishing characteristics included: no horn on snout and a medium-sized frill with two long horns on top.

Jon Hughes

Digital Painting

40” w x 18” h

Tyrannosaurus

About this Image:
Tyrannosaurus rex was one of the largest meat-eating dinosaurs that ever lived. Tyrannosaurus means "tyrant lizard." Everything about this ferocious predator, from its thick, heavy skull to its 4-foot-long jaw, was designed for maximum bone-crushing action. Fossil evidence shows that Tyrannosaurus was about 40 feet long and about 15 to 20 feet tall. Its strong thighs and long, powerful tail helped it move quickly, and its massive 5-foot-long skull could bore into prey. T. rex's serrated, conical teeth were most likely used to pierce and grip flesh, which it then ripped away with its brawny neck muscles. Its two-fingered forearms could probably seize prey, but they were too short to reach its mouth.

Scientists believe this powerful predator could eat up to 500 pounds of meat in one bite. Fossils of T. rex prey, including Triceratops and Edmontosaurus, suggest T. rex crushed and broke bones as it ate, and broken bones have been found in its dung. Tyrannosaurus rex lived in forested river valleys in North America during the late Cretaceous period. It became extinct about 65 million years ago in the Cretaceous-Tertiary mass extinction.

CRETACEOUS ALABAMA IMPACT

WETUMPKA METEOR'S IMPACT EVENTS

84.4 million yeas ago the Wetumpka meteor impact occurred about 10-15 miles offshore in water about 100 feet deep. The rim of the crater is made of hard, crystalline rocks, and the interior area is composed of softer, sedimentary materials. There is also an area of highly disturbed sediments outside the crater's rim on the southern side of the crater that were washed into place by the catastrophic resurgence of sea water forced away from the area by the impact.

BEFORE IMPACT

At the time of impact: 84.4 million years ago… The southern half of future Alabama was covered by a warm, shallow ocean. Teeming with a variety of aquatic life, that part of the shallow seaway was full of invertebrates such as exogyrine oysters, inoceramids, and ammonites, while monstrous creatures such as marine reptiles inhabited the water, and dinosaurs lived on nearby land. About 40 to 60% of the forests appear to have been composed of flowering plant species, with the remainder composed of ferns and allied plants, including tree ferns, and the Gymnosperms, the group to which conifers belong.

METEOR APPROACH

Meteor type: It is thought that this meteor originated as an asteroid before interacting with the Earth.

Meteor enters Earth's atmosphere: A very large rock-type meteor (1,200 feet diameter) had intersected Earth's orbit.

Outer layer of meteor burns: Traveling approximately 43,000 miles per hour, the meteor creates what we would think of as a sonic boom and heats up, creating a tail of fire and a blinding light.

CONTACT AND COMPRESSION

Impact: After burning through the atmosphere, the meteor makes impact offshore in a southern part of the shallow (about 100 feet deep) sea of North America's Western Interior Seaway. The blast created as part of the impact would go about 2,000 feet deep into bedrock.

Shattered rocks and earth: Shock wave travels into earth. Asteroid is vaporized.

EXCAVATION AND IMPACT EFFECTS

Explosion and blast with ejecta: Some rocks went into low Earth orbit. The meteor impact created an explosion equivalent to 2.6 billion tons of TNT, and equivalent to the energy of 175,000 times the nuclear bomb at Hiroshima in 1945.

Flashfires: Flash fires begin along the shore and reach out more than 31 miles from the crater causing injury and destruction of life.

Falling rocks: After the explosion, rocks would have fallen back down in a thirteen-mile radius.

Earthquake: Explosion causes a 9.0 earthquake.

Wind blast - stronger than hurricane force: Wind from the explosion affects more than a fifty-mile radius.

MODIFICATION

Complex crater forms: As the rocks fall back to Earth, the crater forms a bowl with sides about 1,200 feet high and a diameter of 4.7 miles wide. Interestingly Wetumpka Impact Crater has no central uplift.

Tsunami: Tsunami backwash hits the crater rim and shoreline. Part of the southern rim collapses and is washed away.

AFTERMATH

All life in the area is destroyed, later a part of the rim slides into the crater. It is thought that the total area affected was 830 to 3840 square miles and included parts of Alabama and Georgia (current names).

CHANGES OVER TIME

Crater becomes an island in the shallow sea: An ecosystem developed on the island. The crater was in the sea for more than 20 million years.

Modification as sea recedes: About 64 million years later, the sea continues receding, the predecessor of the Coosa River forms, and rocks from the crater creation are left 13 miles away.

Coosa River flows over the crater: According to Dr. King, "It is thought that about 5.3 million to 2.58 million years ago, what would become the Coosa River flowed over a land surface that was above the crater rim. At that time, the crater itself was completely buried in sediment, and the ancient Coosa River (or its predecessor river) was flowing directly across the area, which was essentially flat land that sloped ever so slightly to the south. The only remains today of that flat plain with the river are the small patches of river gravel on the tops of the highest hills in the area."

Coosa River changes course: Sea continues to recede and the crater continues to erode. Coosa River begins to flow along the northwest rim of the crater.

"HOW FAST DID ALL THIS HAPPEN?"

0.00 SECOND
Forward shock wave begins travel into Earth and the reverse shock wave begins travel back into asteroid.

0.02 SECOND
Asteroid reaches depth of 1,000 feet into the ground. *Did not "see" the water! That is, the 100 feet of water where it hit made no difference to the incoming object.*

0.02 SECOND
Shock wave reaches back end of the asteroid and it is vaporized yielding about 2,600 megatons of energy (175,000 times the energy of the Hiroshima bomb).

0.02 SECOND
Flashfires reach a radius of over 31 MILES; total fire area probably was more than 3,000 square miles. (For example, Montgomery is in the area of total destruction).

0.02 SECOND
First ejecta material leaves the crater at 159,000 miles per hour.

0.60 SECOND
First ejecta material reaches outer space (goes into low orbit around earth).

2.00 SECONDS
Shock wave reaches out to 25 miles, flattening everything in its path. Total flattened area probably was more than 2,000 square miles. Middle part of Alabama is flattened; dinosaurs and most other living things in the area are killed.

2.00 SECONDS
Tsunami wave reaches height of 39-128 feet high and extends out to a distance of several miles from the crater.

11.5 SECONDS
Crater opens (crater is created).

26.0 SECONDS
Central rebound area reaches its maximum height of 200 feet.

IN LESS THAN 30 SECONDS
Crater Rim was raised to its final height and position; then the southern part collapses, and debris flows back into the crater.

203 SECONDS (IN JUST OVER 3 MINUTES)
Crater ejecta has reached out to a distance of 13 miles from the crater.

FOR THE WETUMPKA CRATER, THIS WAS NOT THE END
Ongoing research indicates that a secondary, "tsunami backwash" washed back into the crater, washing away parts of the southern rim!

IF IT HAPPENED TODAY—
400,000 human casualties!

This is clearly Alabama's greatest natural disaster!

Source: Wetumpka Impact Crater Timeline on Dr. King's website with additional editing by James Lowery for use in presentations. Acquired online March 27, 2003. JRL revision 3-13-2017
•Scientific knowledge evolves over time, in some areas research has updated previous information. Please excuse any discrepancies in facts.

WETUMPKA IMPACT Crater 85 MILLION YEARS AGO

6 Meteor Enters Earth's Atmosphere
Hope Brannon Mixed Media Painting, 2022

Meteor Approach: Wetumpka's imperfect horseshoe-shaped crater rim is thought to be associated with an interior northeast-trending aeromagnetic anomaly. The meteor is presumed to have arrived at average intra-solar system velocity of 20 kilometers per second (44,738 miles per hour). The most impressive phenomenon accompanying a hypervelocity impact such as the Wetumpka impact is the destruction of the projectile.

7 Flash Point Radiation
Hope Brannon Mixed Media Painting, 2022

Flash Point Radiation: A brilliant light flash (including ultraviolet, visible, and infrared) typically accompanies a hypervelocity impact. This would have blinded all surviving animals. This phenomenon is attributed to the ionization of gasses at the instant of impact, as well as the ejection of incandescent molten material. For Wetumpka on a clear day, maximum burn area would have been 7500 square kilometers (or 4,660 square miles), and maximum burn radius would have been 47 kilometers (29.2 miles). For comparative purposes, the area of Montgomery County is approximately 2.1 x 105 hectares (1,304 square miles,) and downtown Wetumpka, AL and the State Capitol building in Montgomery, AL are separated by approximately 18 kilometers (12 miles) along a straight line.

8 Meteor Approaches Ocean
Jerry Armstrong, Acrylic Painting, 2005

Paintings done in 2005 by artist, Jerry Armstrong, depict what might have happened in the Wetumpka area 85 million years ago....

A marine reptile bites a fish in the Gulf of Mexico waters that covered Central Alabama, 85 million years ago as the Wetumpka asteroid streaked through the sky.

9 Meteorite Crashes Into Ocean
Jerry Armstrong, Acrylic Painting, 2005

Paintings done in 2005 by artist, Jerry Armstrong, depict what might have happened in the Wetumpka area 85 million years ago....

A small tyrannosaurid dinosaur is beach-combing on the island shoreline just north of Wetumpka when he witnesses the asteroid or comet impact 15 miles offshore.

10 Meteorite Crashes Into Ocean
Shirley Esco, Acrylic Painting, 2016
Sensing danger, a pteranodon flies away from a large object that crashes into the shallow sea.

11 Excavation Begins
Hope Brannon Mixed Media Painting, 2022
Ground Zero: Area of Impact: Wetumpka's impact is thought to have occurred in about 100 feet of water and 10-15 miles offshore from a barrier-island coastline in a shallow sea; teaming with aquatic Cretaceous life. Dinosaurs and other reptiles roamed and ruled the shoreline, barrier-islands and a tropical-rainforest of cycads, conifers, angiosperms, and other lush vegetation that thrived on future Alabama's low coastal plain.

12 Excavation & Explosion
Hope Brannon Mixed Media Painting, 2022

Destruction of Life: When the meteorite vaporized after surface impact, energy equivalent to 175,000 times the energy of the nuclear bomb at Hiroshima was released and thus opened a 3.3 to 4.2 kilometer (2 to 2.6 mile) diameter transient crater (stage 1: contact and compression, stage 2: excavation) within approximately 11.5 seconds.

13
9.0 Earthquake
Hope Brannon Mixed Media Painting, 2022
Earthquake: The terrestrial surface-wave magnitude of seismic shock-wave (an earthquake) would have been 8.4 to 9.0 on the Richter scale.

14 Blast Wave: Hurricane Force Winds
Hope Brannon Mixed Media Painting, 2022

Hurricane Force Straight Winds: (Force 5 Hurricane winds, as high as 500 mph) On a vegetated plain, both atmospheric peak over-pressure wave and infrared flash-burn combustion due to the impact explosion would have devastated a region estimated to have comprised of 830 to 3840 square miles. At Wetumpka, a ground impact would have set up an atmospheric blast wave that delivered key peak pressure at a maximum radius of 19 to 40 km (11.8 to 24.8 miles). The maximum radius of key peak pressure would have been 96 kilometers (59.7 miles). To put the maximum radii above in perspective, downtown Wetumpka, AL and Auburn, AL are separated by a straight-line distance of 69 kilometers (42.8 miles.) The shock wave would have flattened the middle of today's Alabama and Georgia, killing most animal life.

15 Flash Fires
Hope Brannon Mixed Media Painting, 2022

Flash Fires: Flash fires occur when direct, radiant thermal energy exceeds 109 erg/cm2 on combustible natural materials. These effects would have occurred within the 7500 square kilometers (4,660 square mile) area. The combustible natural materials at Wetumpka were likely tropical-rainforest angiosperms, cycads, conifers, and other lush vegetation thriving on future Alabama's low coastal plain. Subsequent reentry of particles sent into low orbits would have secondarily heated the atmosphere and would have caused additional radiant thermal damage.72 Flash-fires would have disintegrated everything for 3,000+ square miles, including modern-day Auburn, Montgomery, Clanton, and some of Birmingham.

16 Falling Rocks
Hope Brannon Mixed Media Painting, 2022

17 Falling Rocks Into the Sea
Hope Brannon Mixed Media Painting, 2022

Falling Projectiles: A cascade of falling rocks and molten materials were blasted out of the developing crater bowl and were most likely traveling at a high velocity, perhaps disintegrating, perhaps falling back to earth as weapons from the sky.

18 The Crater Begin to Form
Jerry Armstrong, Acrylic Painting, 2005

Paintings done in 2005 by artist, Jerry Armstrong, depict what might have happened in the Wetumpka area 85 million years ago....

After impact, scientists think the rim stood above sea level and excluded sea water, but eventually the weaker southwestern rim collapsed causing a catastrophic flood across the interior.

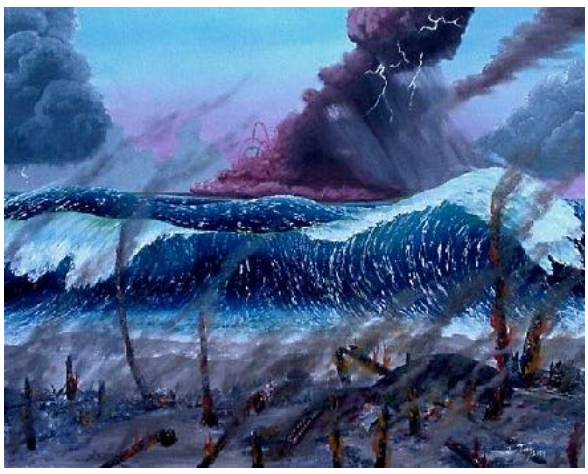
19 Tsunami
Hope Brannon, 2022

Mixed Media Painting

Tsunami: In shallow seawater, this impact would have generated a tsunami-like wave estimated to have been as much as 150 - 239 meters (492 - 784 feet) high at a distance of five asteroid radii (875 meters or .54 miles) from the target center. Sediments outside the southern side of the crater were washed into place by the resurgence of sea water that had been forced away from the area by the impact.[67] The outward surge occurred in 5 - 200 seconds before returning in a matter of minutes.[67] It is thought that the southwest side of the rim collapsed at about 25 seconds.

20 Tsunami Approaches the Forming Crater
Hope Brannon, 2022

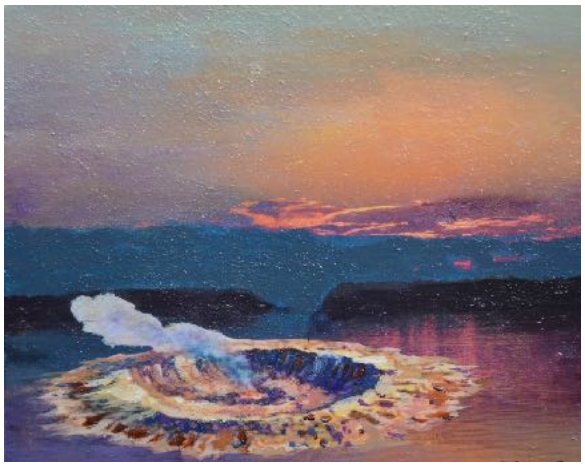
Mixed Media Painting



21 Tsunami Approaches Land
Jerry Armstrong, Acrylic Painting, 2005

Paintings done in 2005 by artist, Jerry Armstrong, depict what might have happened in the Wetumpka area 85 million years ago....

Heat from the blast has set the shoreline woods on fire and now the tsunami wave from impact arrives onshore as the impact crater forms at sea.



22 Crater Forms
Hope Brannon Mixed Media Painting, 2022

Crater Formation, Reshaping the Landscape: The impact's blast effect pulverized rock within a crater cavity that extends over 650 feet deep (beyond the limit of the drilling depth at the time of investigation). Judging from the crater diameter, the Wetumpka asteroid was approximately 1200 feet in diameter and composed mostly of stone.

23 Aftermath
Hope Brannon Mixed Media Painting, 2022

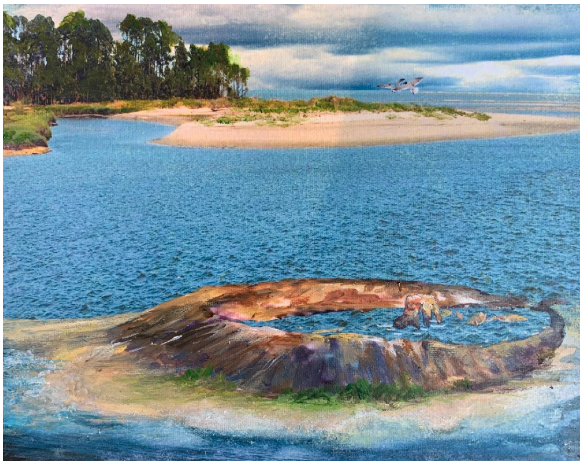
Aftermath Area: In the aftermath of the Wetumpka impact, the devastated area for Wetumpka would have been between 830 to 3840 square miles. To put the disaster area in perspective, Montgomery County, AL comprises an area of approximately 800 square miles.

24 Smoke & Ash-Life Destroyed
Hope Brannon Mixed Media Painting, 2022

Loss of Life: Thousands of living things were decimated by the event: plants, dinosaurs, reptiles, and aquatic life.

25 Final Crater: Southern Rim Collapses
Jerry Armstrong, Acrylic Painting, 2005

After impact, scientists think the rim stood above sea level and excluded sea water, but eventually the weaker southwestern rim collapsed causing a catastrophic flood across the interior.
The Wetumpka Impact Crater (4.7 miles wide - rim to rim) had an estimated original rim height of 210 to 360 meters (688 to 1214 feet) but today, because of erosion, it has a modern height of 87 meters (285 feet) with an apparent depth of 255 to 405 meters (836 to 1328 feet) in the center area. Today, 123 to 273 meters (403.5 to 895.6 feet) of computed apparent depth is now missing.61 Harwell Cemetery Hill crops out at a maximum elevation of 152 meters (498.6 feet) and the highest point, Bald Knob, at 587 feet.



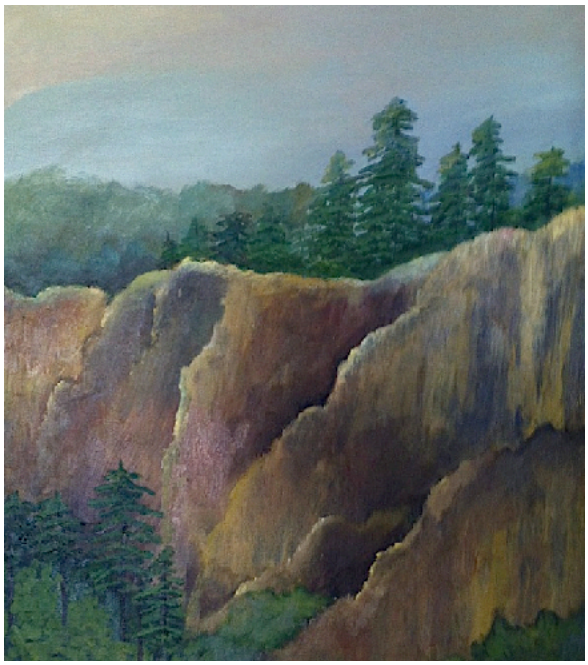
26
Crater Becomes A Terrestrial Island: 20 Million Years Later
Hope Brannon, Mixed Media, 2022

As life begins to return, an ecosystem develops on the crater island. The crater remains in the sea (Gulf of Mexico) for millions of years until the sea level recedes.

27 Coosa River Flows Over the Sediment Filled Crater
(5.33 - 2.58 million years ago) Hope Brannon, Mixed Media Painting
As the sea recedes, the crater, which was eroded and buried in sediment, becomes dry land. When the Coosa River develops, it flows over the buried crater. Today river gravel is found on the highest hills in the area.

28 Eroded Crater Interior Today "The Cliffs":
Barry Chrietzberg, Photograph

All around the semi-circular pattern of hills that make up the remaining rim of the crater, the hard rocks of the Piedmont are bent sharply and point away from the center of the impact. The normally horizontal layers of older Cretaceous surface rocks, also highly deformed, are mixed in and around the crater resulting from the incredible explosion that destroyed all life in a radius of many, many miles.



29 "The Cliffs":
Shirley Esco, Acrylic Painting, 2014

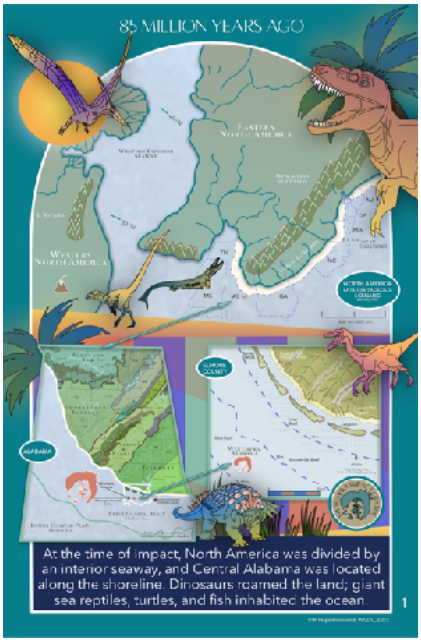
Wetumpka's impact-crater mélange (assorted debris), at least 25 meters (82 feet) thick, was likely formed by mass movement from the transient crater rim commencing after the first 18 to 21 seconds of impact.

85 Million Years Ago: A shallow offshore area of the ancient Gulf of Mexico eventually became the land upon which downtown Wetumpka was built and through which today's Coosa River flows. Our area also was the site of Alabama's greatest natural disaster and the or "bull's eye" of a great explosion caused by the impact of a huge object from outer space.

During the "age of dinosaurs in Alabama," (Late Cretaceous or about 85 million years ago) a meteor the size of a large college football stadium blasted 2,000 feet deep into local bedrock and exploded under the shallow sea. At the time of impact, marine reptiles, fish, and turtles inhabited the sea, and dinosaurs lived on nearby lands.

The meteor impact created a 2.6 billion-ton TNT explosion thousands of times larger than the largest atomic weapon ever developed, thus causing heavy damage and death, affecting both land and sea.

The Wetumpka Impact Crater (4.7 miles in diameter) is the only confirmed impact crater in Alabama and one of only about 200 other recognized craters. Its age is based on fossils found in the youngest disturbed deposits in the crater and atomic age-dating of impact-affected crystals. The arc of hills east of the Coosa River and downtown Wetumpka are the eroded remains of the Wetumpka Impact Crater's rim.



1. 85 MILLION YEARS AGO:

At the time of impact, North America was divided by an interior seaway, and Central Alabama was located along the shoreline. Dinosaurs roamed the land; giant sea reptiles, turtles, and fish inhabited the ocean.

Hope Brannon, Digital Painting, 2023

2. WHEN A METEOR HITS THE EARTH:

There are three stages of impact crater formation that occur in the first few minutes:
1 *Contact and Compression*—Energy forces rocks down; some melt or are shocked by intense pressure.
2 *Excavation*—Material is thrown out (ejected) as crater gets larger.
3 *Modification*—Crater is created and center rebounds (rises several hundred feet).
Use these murals to understand how the Wetumpka Impact Crater formed.

Hope Brannon, Digital Painting, 2023

3. METEOR APPROACHES EARTH:

A very large stony meteor (1,200 feet in diameter) approaches Earth from outer space.

Hope Brannon, Digital Painting, 2023

4. METEOR ENTERS ATMOSPHERE:

The meteor enters Earth's atmosphere, traveling approximately 43,000 miles per hour. It heats up, creating a blinding light, a tail of fire, and a sonic boom.

Hope Brannon, Digital Painting, 2023

5. CONTACT AND COMPRESSION:

After burning through the atmosphere, the meteor makes contact (impact) in a shallow sea (100 feet deep). The blast travels about 2,000 feet deep, compressing bedrock and sending shock waves into the Earth. Crater begins forming.

Hope Brannon, Digital Painting, 2023

6. EXCAVATION AND EJECTION OF ROCK DEBRIS:

The explosion which occurs upon impact causes a blast of rock debris to fly from the shallow sea into the atmosphere. Some of the debris reaches low Earth orbit.

Hope Brannon, Digital Painting, 2023

7. EXCAVATION AND EARTHQUAKE:

Excavation results in a 9.0 (Richter scale) earthquake. Flash fires occur along the nearby shore, and rocks begin to fall on land and into the sea.

Hope Brannon, Digital Painting, 2023

8. HURRICANE FORCE WINDS:

Wind blasts more powerful than a violent hurricane extend out in excess of a 15 mile radius and affect the nearby shore.

Hope Brannon, Digital Painting, 2023

9. FALLING ROCKS:

During the first three minutes after the explosion began, ejected rocks fall within a thirteen mile radius causing injury and destruction of life.

Hope Brannon, Digital Painting, 2023

10. MODIFICATION AND TRANS-CRATER SLIDE:

Located within the crater formed by the meteor impact, “The Cliffs” area is composed of layers of rock that slide across the crater floor and collide with the rim during the modification stage. Disturbed and folded layers can be seen in the walls of “The Cliffs” today.

Hope Brannon, Digital Painting, 2023

11. MODIFICATION AND TSUNAMI:

At this point, the crater has sides up to 1,000 feet high except where the south side collapses. A tsunami wave from the impact moves outward and then comes back, bringing sea-floor sediment (chalk) from the south.

Hope Brannon, Digital Painting, 2023

12. LATER THE CRATER BECOMES A TERRESTRIAL ISLAND:

As life begins to return, an ecosystem develops on the crater island. The crater remains in the sea (Gulf of Mexico) for millions of years until the sea level recedes.

Hope Brannon, Digital Painting, 2023

13. CRATER BURIED IN SEDIMENT:

As the sea recedes, the crater, which was eroded and buried in sediment, becomes dry land. When the Coosa River develops, it flows over the buried crater.

Hope Brannon, Digital Painting, 2023

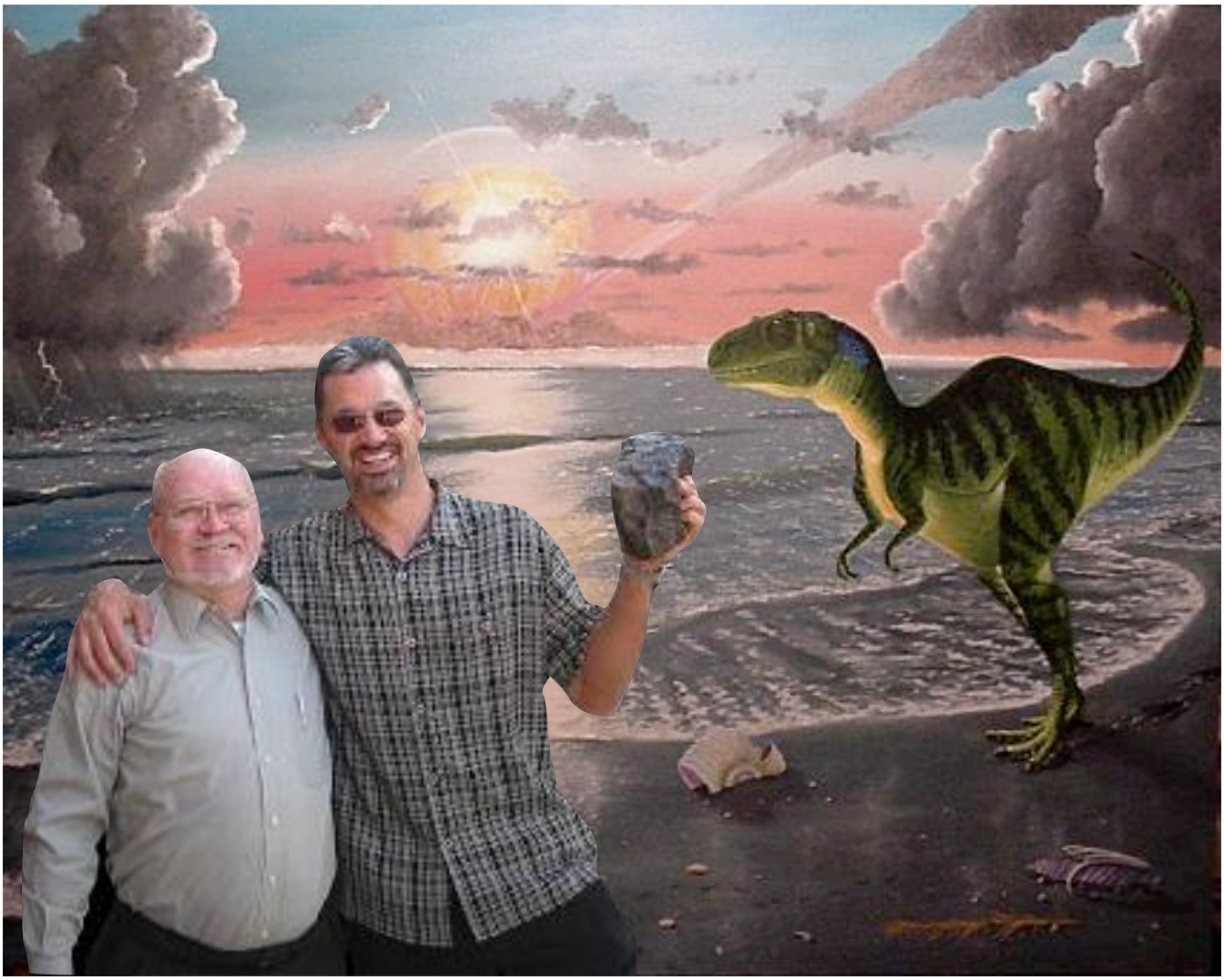
14. WETUMPKA IMPACT CRATER REVEALED:

Over time, the sediment that buries the crater is eroded away. The Coosa River ceases to flow across the crater and changes its course to bend around the crater rim, as seen today. The rocks in the Coosa River are part of the crater rim.

Hope Brannon, Digital Painting, 2023

Jerry Armstrong

Jerry Armstrong is a well known meteorite collector and a cosmic artist whose paintings are highly sought after. He has been an amateur astronomer for decades and discovered a supernova in M51 on April 1, 1994, beating the heavily-funded Berkely search team by 40 minutes with nothing but his telescope, a timely photograph and a deep understanding of that galaxy's typical features. While all of his artwork is absolutely fantastic, it is his meteorite-related paintings that are most catching.



Jerry Armstrong (left) and his buddy Dave (right-holding meteorite)

Hope Brannon

Hope's work includes several thought-provoking series, each incorporating a variety of media, processes, and techniques and each distinctive in its own right. On any given day you might find the smell of melted wax permeating her studio, while she is working on an encaustic painting, or you may see her sitting at a table meticulously cutting paper for one of her works in the "Alternate Endings" series. You might even see Hope in the yard ankle deep in a baby pool as she gains inspiration for her "Waterscapes" series or covered in spackling when working on one of her Chaco Canyon pieces for her "Fossils of Time" series. When not in the act of creating you will most likely find her engrossed in the research of symbols and stories. Her work includes broad symbolism, memories, mythology and the stories of our planet that she finds relevant.

Declining science scholarships, Hope chose to follow her passion for visual art. She attended Huntingdon College and earned her undergraduate degree in fine art form Auburn University at Montgomery. Shortly thereafter, she joined the faculty of a local college preparatory school. Although she intended to teach for only one year, her commitment to teaching art, mushroomed into a 21-year experience. During that time, she obtained a Masters of Education Degree with an emphasis in studio art from Troy University and developed her career as an artist and educator.

Throughout her career as a working artist, she has curated and adjudicated shows such as the Southeast Regional Fine Arts Exhibition at Northwest Florida State College and the nationally acclaimed Scholastic Art Awards, presented workshops and lectures throughout the United States, lead a variety of state art organizations and taught students of all ages, ranging from kindergarten through adults. She has participated in both solo and group exhibitions. Hope has also been honored with national, state, and local awards including: the southeastern purchase award for The Wonders of Alabama Art sponsored by Energen Corporation, Birmingham, Alabama; her work *Internal Compass* was among four works selected for Hudson Alpha's DNA Exhibition in Huntsville, Alabama; she has been included in exhibitions at The Montgomery Museum of Fine Arts in Montgomery, Alabama and selected as the featured artist for The Eastern Shore Art Center in Fairhope, Alabama. Additionally, she has been featured in a number of collections and publications, and has been honored with the opportunity to create commissioned site-specific work for institutions such as; The City of Montgomery's Cramton Bowl, Montgomery, Alabama; Troy University, Troy Alabama; The Confucius Institute, Troy, Alabama; Children's Hospital of Alabama, Birmingham, Alabama,The Women's Pavilion of UAB Hospital in Birmingham, Alabama and Gateway Development Corporation's public art exhibit in Downtown Wetumpka entitled "Wetumpka Impact Crater: Chronological Sequence of Crater Formation.

Although the majority of Hope's creations in her personal work may be abstract and experimental in nature, her love of the landscape is more than apparent in some of her more traditional works. Hope also draws inspiration from her fascination with both physical and social science, the mysteries of our universe and the creatures and cultures that have inhabited our planet.

E-mail: artquest@elmore.rr.com | Web: http://artquest.wixsite.com/phopebrannon

Brooks Barrow

A self-taught stone sculptor, Alabama's Brooks Barrow uses old world techniques and traditional tools to make his modern and minimalist pieces.

The artist: Barrow was born in 1971 and grew up Montgomery, AL and Franklin, TN, and later served in the Marines. While living in Wisconsin, after his military stint, Barrow worked in commercial construction. Unsatisfied, he turned to making art full time.

The company/studio: Brooks Barrow Studio, started in 2009 in Wisconsin. Two years later, the self-taught craftsman moved back to Alabama and set up his shop on a 100-acre pine plantation in Davenport, about 30 miles south of his Montgomery home.

The goods & materials: Functional pieces, such as bowls, and nature-inspired sculpture in stone, mainly limestone and marble, native to Alabama.

> *All of the bowls I make are free form, that is, they are not turned on a lathe. The end product is something more beautiful—almost imperceptibly imperfect with subtle undulations and asymmetry. They are minimalist sculptures each in their own right. Although I use a broad range of stones including granite and slate, my primary interest is working with limestone and marble native to the state of Alabama.*

Process: Hand-tools free-form objects and sculpture from blocks of natural stones using traditional tools and techniques. This process yields subtle asymmetries and produces a softness of line and form not possible with a lathe or other mechanical means, he said. After tooling, each form is either given a tooth chisel finish or is honed and polished to a matte finish sufficient to reveal the color and grain of the natural stone.

Why stone: Because of its permanence, but also the challenges and limitations inherent in the material.

Inspirations:

- Nature and the natural beauty of material itself.
- Sculptures by artists, including Noguchi, Duchamp-Villon and Nevelson.

Fun or unusual requests: Asked to create a sculptural dove for the donor wall at Montgomery Catholic High School in 2019. "It was a challenge to capture all of the details of this bird in flight," he said.

Big break: In 2010, Barrow was selected to participate in a specially curated section of Etsy shops for the "One of the Kind Show" in Chicago. It helped open up his small studio to a much larger audience.

Claim to fame: Commissioned by the City of Montgomery to create a public sculpture on the occasion of Hyundai Motor Manufacturing Alabama's 10-year anniversary in Montgomery, to be on view in Hyundai's visitor center. Barrow sculpted two large stones, one in Alabama marble and the other in Asian black basalt. He positioned them in close proximity and slightly angled to one another, to symbolically reference and link Alabama with South Korea.

Awards/honors: Asked to create pieces for Calvin Klein Home, General Electric and Google.

brooksbarrow.com

Karen Carr

Wildlife and natural history artist Karen Carr has displayed her artwork, in both traditional and electronic media, in publications, zoos, museums and parks across the United States, Japan and Europe. Her most recent works include major illustration projects and publications for the Smithsonian Institution, the Audubon Society, Random House, HarperCollins and others, and she has authored or illustrated more than a half-dozen recent books for young readers.

Born in Fort Worth, Texas, Karen is the daughter of an artist father and a scientist mother, and these two shared influences and careers have shaped Karen's life and work. While at The University of Texas at Austin, Karen studied natural sciences and physics in addition to her studies in art. While there, Karen received a prestigious Ford Foundation scholarship in recognition of her illustration and life-drawing skills. Karen completed her baccalaureate studies with a Bachelor's of Fine Arts degree from North Texas State University. She subsequently took graduate courses in anatomy and business at The University of Texas in Dallas. Originally trained in the classical techniques of illustration and painting, Karen frequently speaks on the transition to a digital world, and on the challenges and benefits this transition poses for artists, clients and viewers. She conducts professional seminars on painting, illustration and digital image creation, and also offers specific programs tailored to the needs of professional groups or classroom instructors.

After Karen graduated, she apprenticed for several years under her father, artist and sculptor Bill Carr. In the years since, Karen has built an international client list that includes some of the most prominent research organizations, scientific publications and museums in the world, including The Audubon Institute; The Field Museum; The Smithsonian Institution; The Royal Tyrrell Museum of Paleontology; the US Marine Corps National Museum, the US Army Infantry Museum; the US Army Museum; Southern Methodist University; Science, Scientific American, Focus and Nature magazines; The Dinosaur Society; and more. Her books and illustrations are published by HarperCollins Publishers, Random House, Barnes & Noble, Scholastic Press and others. Karen and her family live in the mountains of southwestern New Mexico, where they enjoy horseback riding, camping, bird watching and other outdoor activities.

In addition to the time she spends painting, Karen finds time now and again to serve as a guest speaker, lecturer and instructor to museum groups, professional organizations, schools and universities. She has also presented master classes in art and digital painting at universities in the U.S. Karen has delivered recent presentations for these institutions and groups:

- Smithsonian National Museum of Natural History
- Southern Methodist University
- Guild of Natural Science Illustrators at the College of William & Mary
- and at Montana State University
- New Mexico Highlands University
- University of Texas at Arlington
- University of North Texas
- Dallas Paleontological Society

Karen Carr Studio, Inc.
11 Fleming Tank Road
Silver City, NM 88061
575-388-4505
https://www.karencarr.com

Barry Chrietzberg

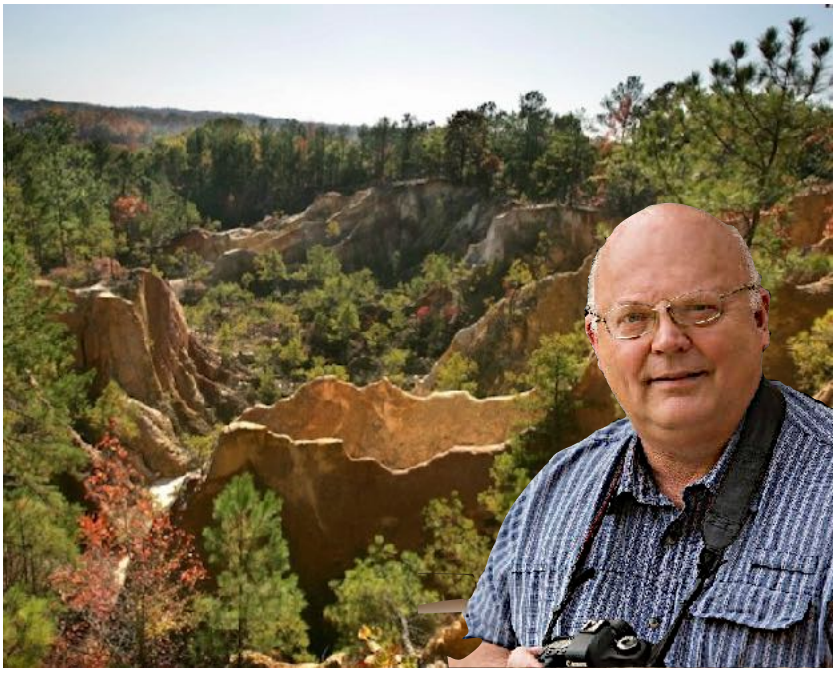
Barry Chrietzberg has spent his whole life documenting events and photographing families and individuals in the Central Alabama area. From portraits, weddings, school photography, sports photography, copy and restoration of old photos, custom picture framing, and video transfers, these are just some of the many services which he provided during his 40+ year career. His photographs grace offices and homes throughout the area.

Chrietzberg Photography studio is located at 502 West Bridge Street in Wetumpka. Barry's wife, Patty works along side Barry in the business. They have 3 daughters who have all grown up in the family business.

Barry was born in Montgomery but went to school in Wetumpka during his high school years. He started working with the Wetumpka Herald before he could even drive. He would ride to the Herald on his motorcycle on Fridays and John Harris (owner of the Herald at that time) would drop him off at local football games and pick him back up in front of the stadium at a pre-arranged time (prior to cell phones). John would then take Barry back to the Herald office where Barry would process film and print photos during the night.

During his career in photography, Barry has worked for television, magazines, and newspapers in addition to the general public. He has a very deep client base that he has developed over the years which includes families, brides and grooms, children, businessmen, politicians, and Hollywood actors and actresses.

When asked what he likes best to photograph, he responds that “he really enjoys photographing at daycares and elementary schools.” His business has evolved and changed over the years but he continues his work to document and pictorially preserve Alabama and Elmore County area’s history, people, and families; present and past.



Barry Chrietzberg
Chrietzberg Photography
502 West Bridge St.
Wetumpka, AL 36092
(334) 567-5381

Ashere Elbein

Asher Elbein is a freelance journalist, fiction writer and artist based in Austin, Texas. He writes print and online features for outlets like The Texas Observer, The Atlantic, Bitter Southerner, Oxford American, and the Smithsonian."

"I like hats, folk music, wandering back roads and wild places, looking for wildlife and listening to people's stories. If you have a good one to tell, please don't hesitate to get in touch."

NATURAL HISTORIES STORIES
I'VE ALWAYS BEEN IN LOVE WITH WILD THINGS.

"As a kid, I spent a lot of time flipping over logs, watching wildlife and going for long rambles in the woods. Every urban creek was a jungle to be explored, every lizard and bird an object of the deepest fascination. When I couldn't be outside, I was reading about distant ecosystems and the men and women who devoted their life to studying them. The natural world is a web of subjects and connections, and I'll never get tired of exploring it."

"The stories in this collection explore a world changing at unprecedented speed. Some are warnings from the burning frontiers, where climate change, habitat destruction, and commerce are taking a heavy toll. Some are tales of adaptation and survival. And some are simple odes to the thrill of discovery."

Read: Appalachia and the Beasts That Roamed It @
https://bittersoutherner.com/the-lost-continent-of-appalachia-and-the-beasts-that-roamed-it

http://www.asherelbein.com

Shirley Esco

Shirley Esco grew up and has lived in the Deatsville area of Elmore County all of her life. She attended and graduated from Holtville High School. As an adult Shirley worked in the banking industry and during this time she attended classes to study Commercial Art at Auburn University Montgomery. After retiring from the banking industry she became a full-time artist and promoter of the arts in Elmore County.

Shirley is well known in the Wetumpka and Elmore County area for her community service, especially to the *Elmore County Art Guild*. She has been a long-time member of the Elmore County Art Guild, serving multiple terms on the Board of Directors as well as President and Vice-President at various times. She has also served numerous terms as the chairperson for the *Elmore County Art Guild Annual Art Show*, and *Sparking the Arts*: Elmore County's annual countywide student art competition which is conducted and sponsored by the Elmore County Art Guild. She also serves as the chairperson for Elmore County Art Guild's *Tallassee Now & Then* competition.

Shirley Esco's work has received numerous awards and can be found in many private and business collections, most notably the *Jackson Hospital Foundation*. Her work can be found at *Gallery One Fine Art* in Montgomery, Alabama. She is also an active member of the *Dixie Art Colony Foundation* Board of Trustees; serving as their Secretary.

In Shirley's words… "Art is an important part of my life. Painting to me, no matter what the medium, is my passion because art is not only food for the eyes, but for the soul. Have you ever stood on the shore soaking up the sunset or admiring the sunlight slant across the grass, or the amber glow of autumn fields. These peaceful moments are never forgotten, and these moments are what I strive to capture when I paint. In fact, my painting style can be considered representational." "Whether it's a reflection in the water or a brewing storm, to me, clouds evoke a quiet, peaceful, and serene calm in the world and… I can sit for hours soaking up the beauty of a peaceful lake or the view of cotton fields by a dirt road."

According to Shirley, she is "continually inspired by the beautiful countryside and lakes of Elmore County." Viewers of her work at *Gallery One Fine Art* often comment that her work conveys serenity. Through her paintings, she tries to "capture the essence of the beauty in the world around us."

Jon Hughes

Initially trained and working as a fine artist, Jon has been illustrating since the mid 1980's, making the shift to digital media in 1998. Specializing in illustration of natural history subjects, he has been writing to accompany his published illustration work since 2007. His work has attracted commissions from many publishers and institutions, and is featured in many books, magazines and exhibition displays worldwide.

Jon started accepting commissions as a commercial illustrator using traditional media, then switched to digital in 1990.

With a keen interest in science, particularly Paleontology, Jon has attracted commissions for a wide range of clients who are looking for realistic reconstructions of extinct animals. His portfolio includes artwork used in over 70 published titles, many images are featured in museum exhibits worldwide.

Jon also started creating art assets for game development companies in 2001, this work now ranges from 2D visualization, texture creation, GUI and in-game graphics, to 3D characters, props and environmental assets, all of which have been featured in published game titles.

https://jfhdigital.com

WETUMPKA IMPACT CRATER Discovery AND VISITOR CENTER

VOLUNTEER! JOIN US!

Wetumpka Gateway Development Corporation, the non-profit group established in 2012, is charged with building Wetumpka Impact Crater Science and Interpretive Centers. In doing so, it is imperative for the group to work with other sectors and utilize the skills of artists, designers, film makers scientists, geologists, writers and educators, fundraisers and publicity, to achieve its goals.

- Chairman: Marilee Tankersley
- Vice-President: Hazel Jones
- Treasurer & Secretary: Dennis Fain
- Members: Kevin Robbins, Kevin Reuter

Wetumpka Impact Crater Commission (WICC) was established in 2003 by separate resolutions of the City of Wetumpka, Elmore County Commission . WICC is responsible for educating about, preserving and promoting the Wetumpka Impact Crater. There are eight members, four appointed by the Wetumpka City Council and four by the Elmore County Commission. They meet six times per year and conduct annual tours & lectures in late winter. The organization hosts & presents numerous other activities.

BOARD OF DIRECTORS:

- Chairman: Kevin Reuter
- Vice-Chair: Marilee Tankersley
- Treasurer: Barbara Jones
- Secretary: Cecelia Ball
- Members: Jim McGhee, James Lowery, Kevin Robbins

OUR MISSION

Interweaving preservation, promotion and education about the Wetumpka impact event, the resulting Crater and Cretaceous life of 85 million years ago; through programs and partnerships that engage, inspire and bring scientific research and knowledge to life.

WETUMPKA IMPACT CRATER Discovery AND VISITOR CENTER

VOLUNTEER!

JOIN US!

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

Art Impact Crater Scientific Community
was established in ____ by

What is this?

WETUMPKA IMPACT CRATER Discovery AND VISITOR CENTER

VOLUNTEER!

JOIN US!

WETUMPKA IMPACT CRATER talks

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

CRATER Cultivators
WETUMPKA IMPACT CRATER GARDEN ASSOCIATION

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

CRATER PERSPECTIVES
WETUMPKA IMPACT CRATER LECTURES

Art Impact: *Where Art & Science Collide*
was established in 2015 by

What is this?

LAND TRUST
WETUMPKA IMPACT CRATER

Wetumpka Impact Crater Land Trust
was established in ? by

What is this?

Educator Advisory Committee

WETUMPKA IMPACT CRATER
Discovery AND VISITOR CENTER

JOIN US!

VOLUNTEER!

ANNUAL MEMBERSHIP: GATEWAY DEVELOPMENT CORPORATION

Name: _____

Is this a Business Membership? _____YES _____NO

If yes, Business Name: _____

Address: _____

City, State, Zip: _____

E-mail: _____

Phone: _____

- ☐ Benefactor $5000 and above
- ☐ Fellow $2500+
- ☐ Sponsor $1000+
- ☐ Patron $500+
- ☐ Advocate $250+
- ☐ Friend $100+
- ☐ Family Membership $50
- ☐ Individual Membership $35

Make checks payable to:
Wetumpka Gateway Development Corporation
Address:
For additional info contact:

VOLUNTEER OPPORTUNITIES

- ☐ Gateway Development Corporation:
  - ☐ Finance
  - ☐ Fundraising
  - ☐ Membership
  - ☐ Public Relations
  - ☐ Event Hospitality
  - ☐ Volunteer Coordinator
- ☐ Discovery Center Guide
- ☐ Annual Crater Tour Guide (late Feb or early March)
- ☐ Art Impact & Art Ed.
- ☐ Crater Scientific Community
- ☐ Crater Talks Programs
- ☐ Crater Perspectives Lectures
- ☐ Crater Cultivators
- ☐ Education Committee
- ☐ Land Trust Development

Alabama Resources

- Alabama Museum of Natural History at The University of Alabama, Tuscaloosa, AL
  - Fossil Hunting Excursions (July): Hale & Green County Sites
  - Museum Field Expedition: Each summer in June and July, field expeditions are led by The University of Alabama Museum of Natural History (ALMNH). Past topics include archaeology, ecology, and paleontology.
  - National Fossil Day: Each October, the ALMNH hosts a Fossil Friday, which is a free event for visitors to see fossils and information about paleontology.
- Anniston Museum of Natural History, Anniston, AL
- Auburn University, Department of Geology (David T. King, Jr. - Professor of Geology: http://webhome.auburn.edu/~kingdat/) Auburn, AL
- Auburn University Biodiversity Center (natural history museum) Auburn, AL
- Cook Museum of Natural Science, Decatur, AL
- Discovering Alabama, Wetumpka Impact Crater, Dr. Doug Phillips (Does not include some of the most recent facts and scientific findings.)
- Geological Survey of Alabama: https://gsa.alabama.gov/
- Jacksonville State University Planetarium, Jacksonville, AL
- McWane Science Center, Birmingham, AL- Has a large-scale Alabama dinosaur and fossil exhibit (in fact, the largest in the state of Alabama.)
- Stephen C. Minkin Paleozoic Footprint Site, (Walker County, near Sumiton, AL)
- University of Alabama Museum's Department of Museum Research and Collections, Tuscaloosa, AL
- University of North Alabama Observatory, Florence, AL
- U.S. Space and Rocket Center, Huntsville, AL
- W.A. Gayle Planetarium, Montgomery, AL
- Wetumpka Impact Crater Commission, Wetumpka, AL

Paleontology & Fossil Groups of Alabama

- Alabama Paleontological Society https://www.alabamapaleosoc.org/
- Birmingham Paleontology Society

Astronomy Groups of Alabama

- Auburn Astronomical Society, Auburn, AL
- Birmingham Astronomical Society, Birmingham, AL,
- Mobile Astronomical Society, Mobile, AL
- Muscle Shoals Astronomical Society, Florence, AL
- Univ of Montevallo Astronomy Club, Montevallo, AL
- Von Braun Astronomical Society, Huntsville, AL

Rock & Mineral Groups of Alabama

- Alabama Mineral and Lapidary Society
- Dothan Gem and Mineral Club
- Huntsville Gem and Mineral Society
- Mobile Rock and Gem Society
- Montgomery Gem and Mineral Society

National Parks of Alabama (Fossils & Rocks)

- Little River Canyon National Preserve, Alabama
- Natchez Trace Parkway, Alabama, Mississippi, and Tennessee
- Russell Cave National Monument, Alabama
- Tuskegee Institute National Historic Site, Alabama

Other Resources

- Cathedral Caverns State Park, Woodville, AL
- Cheaha State Park, Delta, AL
- Desoto Caverns, Childersburg, AL
- Desoto State Park, Fort Payne, AL
- Rickwood Caverns State Park, Warrior, AL
- Tellus Museum, Cartersville, GA
- Mississippi Museum of Natural Science, Jackson, MS

JOIN US!

WETUMPKA IMPACT CRATER Discovery AND VISITOR CENTER

VOLUNTEER!

ANNUAL MEMBERSHIP: GATEWAY DEVELOPMENT CORPORATION

Name: _____

Is this a Business Membership? _____YES _____NO

If yes, Business Name: _____

Address: _____

City, State, Zip: _____

E-mail: _____

Phone: _____

Make checks payable to: Wetumpka Gateway Development Corporation, Address:

- ☐ Benefactor $5000 and above
- ☐ Fellow $2500+
- ☐ Sponsor $1000+
- ☐ Patron $500+
- ☐ Advocate $250+
- ☐ Friend $100+
- ☐ Family Membership $50
- ☐ Individual Membership $35

VOLUNTEER OPPORTUNITIES

- ☐ Gateway Development Corporation:
  - ___ Finance
  - ___ Fundraising
  - ___ Membership
  - ___ Public Relations
  - ___ Event Hospitality
  - ___ Volunteer Coordinator
- ☐ Discovery Center Guide
- ☐ Annual Crater Tour Guide (late Feb or early March)
- ☐ Art Impact & Art Ed.
- ☐ Crater Scientific Community
- ☐ Crater Talks Programs
- ☐ Crater Perspectives Lectures
- ☐ Crater Cultivators
- ☐ Education Committee
- ☐ Land Trust Development

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