

Plateau Geology

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Obed Watershed Community Association

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Appalachian Plateau: The Appalachian Plateau extends from New York to central Alabama. The TN portion, called the Cumberland Plateau, covers 4,300 square miles, 10% of the state area. At the KY-VA state lines, the Cumberland Plateau is its widest at 55 miles and narrowest, 38 miles wide, at the Alabama line. Its eastern escarpment is steep while the western escarpment is ragged and deeply incised by the Cumberland, Duck, and Elk tributaries.

Cumberland Plateau Rocks

Era	Period	Years Before Present	TN Life Forms
Paleozoic	Pennsylvanian	285 million	Age of the Forest
	Mississippian	325 million	Age of Crinoids
	Devonian	350 million	Insects, amphibians, reptiles Mass extinction
	Silurian	410 million	First land plants
	Ordovician	430 million	Mass extinction
	Cambrian	500 million	Great diversity of life. First vertebrates - backbones.
Precambrian	Late Proterozoic	1 billion	All life marine Multicellular life - algae, jellyfish No fossil record - soft-bodied.
	Early Proterozoic	2.5 billion	Present level of oxygen reached - result of photosynthesis. Nucleated cells.
	Archean	3.5 billion	Bacterial life arises
	Hadean	4.5 billion	Earth forms

Note: Dinosaurs lived dinosaurs 75 millions years ago. The earliest human ancestors arose 5 million years ago.

Precambrian Era

Plate Tectonics: Major segments or plates of the earth crust move over the earth's mantle, sometimes moving apart or passing each other and at other times crashing into or sliding under each other. The maximum rate of plate movement is about 6 inches a year, or a mile every 10,000 years

TN Topography: Geologic history during the Proterozoic period is highly speculative. The current consensus is that during the Late Proterozoic, a megacontinent named Gondinia existed, consisting of proto-Antarctica, North America, Australia, and fragments of South America. Later Gondinia split into proto-North America (Laurentia) and proto-Africa (Gondwana). The breakup produced smaller fragments which included the Blue Ridge fragment. The valley between proto-North America and the Blue Ridge filled with sedimentary material and volcanics. During this era, TN may have been a shallow continental shelf. Geologists assume that there must have been land areas nearby to supply the great amount of erosional debris making up the rocks of this period.

The Basement Complex. These rocks are the oldest rocks underlying TN and are either from cooled lava or from sediment. Heat and pressure over millions of years have metamorphosed these rocks.

TN Life: Most rocks of this era contain no fossils as Proterozoic life was soft-bodied, such as algae and jellyfish. The seas were low in calcium carbonate and so corals, shells, or bones could not develop.

Paleozoic Era

Cambrian Period

Life Forms: The Cambrian Era saw an explosion of life with the advent of shells. It is sometimes called the Age of Trilobites. The oldest fossils come from this time.

Rocks: An increasing number of life forms extracted calcium carbonates from sea water, meaning that when they died, their bodies went to the bottom and ultimately formed layers of limestone. Other rocks from this period include sandstone, siltstone, and shale.

TN Topography: Geologists believe that the sediments that formed rocks in TN eroded from a landmass located to the west of the area. Shallow seas to the east were supplied with sediment from eroding mountains to the west, developing a broad continental shelf environment where large sequences of limestone, shaly limestone, and dolostone formed.

Ordovician Period

Rocks: Ordovician rocks are present in the subsurface beneath the Cumberland Plateau and Highland Rim, with outcrops in the Sequatchie Valley. The period is marked by the deposition of thick sequences of carbonates and shale.

TN Topography: East TN consisted of intertidal flats, and Middle TN was covered by a shallow sea.

Life Forms: All life lived in the ocean. Corals appear as fossils here, indicating a marine environment during this period. Globally, a mass extinction occurred during the Ordovician period, likely due to the cooling of the oceans.

Silurian Period

TN Topography: East TN was a coastal region to a westward advancing sea that covered much of Middle TN and further west.

Life Forms: The first land plants appear.

Devonian Period

TN Topography: During this period, this spot was a marine environment. A sea covered much of the east central US, covering all of TN west of the Smokies. Deposited into the sea was rotted organic matter mixed with mud.

Life Forms: The first vertebrates (animals with backbones) appear. This period has been called the Age of Fishes. At the end of this period was another mass extinction.

Rocks: Local rocks formed from this period are called Chattanooga Shale and occur throughout the Cumberland Plateau. These rocks contain oil from the organic matter laid down with the mud. During the 1970s, some thought was given to extracting the oil from the shale at a rate of 15 gallons of oil per ton of shale.

Mississippian Period

TN Topography: During this time, TN was again covered by a shallow sea.

Rocks: Mississippian rocks underlie the entire plateau and much of the state, from the Smokies to Nashville. Three major rocks comprise this period: Maury Shale from greenish-grey mud, the Fort Payne Formation from a silty-lime sediment, and the Pennington shale.

Life Forms: This was the Age of Crinoids, animals which produced circular fossils that we today call Indian money.

Pennsylvanian Period

Rocks: Rocks from this period are dominated by sandstone and shale and are up to 4,000 feet in thickness. These rocks are the last rocks found in TN. Any rocks that might have overlaid these rocks have been eroded away.

TN Topography: During the Pennsylvanian Period, much of what is now East and Middle TN up through Kentucky, and indeed much of the east central North American continent, switched back and forth from being beach barriers and shallow marine to lagoons and coastal swamps where mud and organic matter collected. As the shoreline migrated, the relatively narrow beach area, together with tidal deltas, became extensive covers of sand which advanced over the mud formed in the lagoonal swamp areas. Short Mountain, twenty miles west of the escarpment, is capped with sandstone.

Life Forms: This was the Age of the Forest. The present extent of the coal fields and whatever has been eroded away mark the former extent of the swamp environment.

Coal: TN was tropical with the warmth and precipitation to support a profuse growth of swamps and forests. The biomass fell into the swamps to form peat that, which with the pressure of more layers of sand and swamp on top, compacted into lignite and then coal. Coal and shale seams are interbedded with the sandstone.

Late Paleozoic Mountain Building

Allegheny Orogeny: The last mountain building activity that affected the region of the Southern Appalachia occurred 250 million years ago, toward the end of the Pennsylvanian Period, the end of the Paleozoic Era. The proto-continent of North America, Africa, and South America collided to form the megacontinent, Pangea.

Collision with Oceanic Plate: The movement of the oceanic plate toward the edge of the North American continental plate caused a down warping of the sediments resulting in the great folding and thrust faults now seen in the Appalachian Mountains, Valley and Ridge and the deformed parts of the Plateau, the most western extent of the collision's force. This collision affected an area 300 miles wide and 1000 miles long. The present topography of this area results from the rocks being uplifted, tilted, or folded. From Alabama to Pennsylvania, sediments that had been collecting along the eastern edge of North America for millions of years buckled and fractured into the high range of mountains we call the Appalachian Mountains.

Cumberland Plateau Overthrust Fault: The Cumberland Plateau marks the western most deformation in TN during the Allegheny Orogeny. Large-scale breaks in the rock layers reduced stress, and great rock masses moved along those breaks for as much as 10 miles. Much of the top surface of the plateau has been thrust upward and to the northwest along faults. The entire group of faults that together form the boundary of the displaced part of the plateau is called the Cumberland Plateau Overthrust fault. It is not a single, simple break, but a complex interwoven system of faults. The western side of the Plateau was not affected.

Eastern Escarpment Along the eastern edge, rocks folded, broke, or both. Some rock layers even stand vertically in towering crags and pinnacles. Where the escarpment is armored with sloping sandstone layers, erosion slowed. The shape of the eastern escarpment is controlled by the direction of the rock folding.

Sequatchie Valley: Rocks from the southeast were pushed up and over rocks to the northwest along a 180-mile break on the west side of the present Sequatchie Valley. The movement totaled thousands of feet. The enormous overriding block was folded into an arch that eventually fractured and eroded away to form the valley. The arch is still visible in the Crab Orchard Mountains.

Post-Paleozoic

Above Water: Since the Permian Era which followed the Paleozoic, most of the eastern interior of the North American continent remained above sea level, never being inundated to the present time. Once the land rose above sea-level, rock formation came to an end and the long and continuing period of erosion began. For the past 135 million years, TN has no rock record of its past.

Plateau Topography: Today, only on the Cumberland Plateau area does the caprock still protect the underlying Mississippian limestones from a relatively rapid dissolution. The present topography of TN and the Plateau has been formed by the constant lowering of the surface by erosion, a process that on the Plateau involves slope retreat

on beds of different resistance. Pennsylvanian sandstone was removed by erosion from the central part of the Nashville Dome 100 million years ago and the underlying Mississippian limestones were exposed. A process of slope-retreat by limestone dissolution then began, forming an escarpment and initiating a retreat in all directions away from the dome. The dissolution of the underlying limestones is primarily responsible for the steep slope angles along the Highland Rim and the Cumberland Plateau escarpment.

Relief map of TN showing the relationship of major geologic structures to physiographic units. From Robert Miller, *The Geologic History of TN* (TN Division of Geology, 1974.)

Resources: Edward T. Luther, *Our Restless Earth* (UT Press, 1977); Russ Manning, *The Historic Cumberland Plateau* (UT Press, 1999); Robert Miller, *The Geologic History of TN* (TN Division of Geology, 1974); Harry Moore, *A Geologic Trip Across TN by I-40* (UT Press, 1996.)

The Obed Community Association has as its purpose community appreciation and volunteer involvement in ongoing research of the natural and cultural heritage of the Obed River watershed within Cumberland County. Louise Gorenflo, OWCA director, produced this fact sheet. Those wanting to join this membership organization or more information may contact OWCA at 484-2633 or at 185 Hood Drive, Crossville, TN 38555.