Why is it called the "Inland Basins" Region?

Inland from the mountains, the Earth's crust was buckled (downwarped) into a series of depressions called "basins" (Figure 2.26). Basins are naturally great places to preserve thick sediment layers because they are lower areas that easily collect sediment and commonly continue to subside from the weight of the sediment. There are two major basins in the Inland Basins region separated by the Cincinnati Arch and its branches: the Appalachian and Illinois Basins. Other smaller basins existed throughout the region at various times through geologic history that were also important areas of deposition, including the Black Warrior Basin of northern Alabama and Mississippi (at the southern tip of the Appalachian Basin).

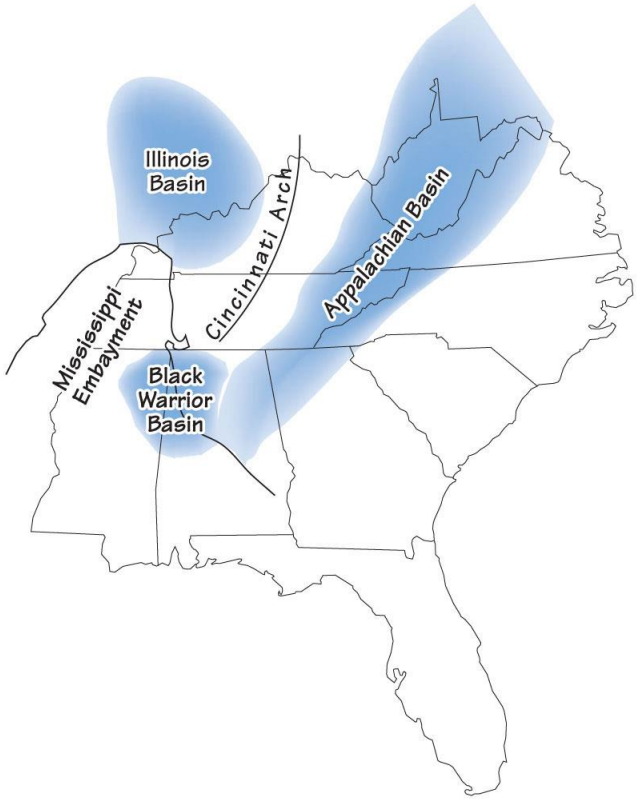
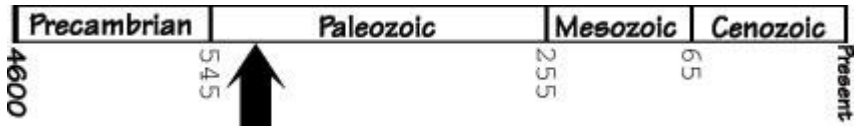


Figure 2.26: In the Southeast, the Illinois, Appalachian and Black Warrior Basins have all been important areas of deposition.

Cambrian - Ordovician Rocks



Following the Precambrian mountain building event, a period of erosion gradually wore down the Grenville Mountains. Globally, sea level began to rise in the early Cambrian until by late Cambrian most of North America was covered with a shallow ocean. The sea widened westward depositing sand and mud near shore and mostly organically derived carbonates like limestone and dolostone in the deeper water. Sea level remained high through the Ordovician, resulting in deposition of limestone and dolostone, which are common in warm, shallow, sediment-starved seas. These widespread carbonate rocks, are thousands of feet thick in Kentucky and Tennessee.

Later in the Ordovician as sea level dropped, the carbonates were exposed to intense erosion and many layers of sediment were removed. The eroded layers represent "missing time," also known as an unconformity. A large, regional unconformity occurs at the top of the Ordovician Knox Group. Several hundred meters of sediment may have been eroded away in some places where the unconformity formed.

Missing time in the Inland Basins

One of the most prominent sections of "missing time" in North America is the Ordovician Knox unconformity. There are other examples of unconformities in the Inland Basins Region, as well. Where are the rocks representing the Triassic, Jurassic, Cretaceous and Tertiary periods in the Inland Basin? The absence of rocks deposited during certain time periods in regions of a geologic map does not mean that there were no rocks forming during that time. It may mean, however, that very little sediment was deposited, that the sediment was eroded away, or that the rocks are buried beneath the surface. There is no single place on Earth that has a complete sequence of rocks from the Precambrian to the Quaternary. Erosion and weathering over time have removed many meters (and in some cases kilometers) of rock from the surface of the Southeast.

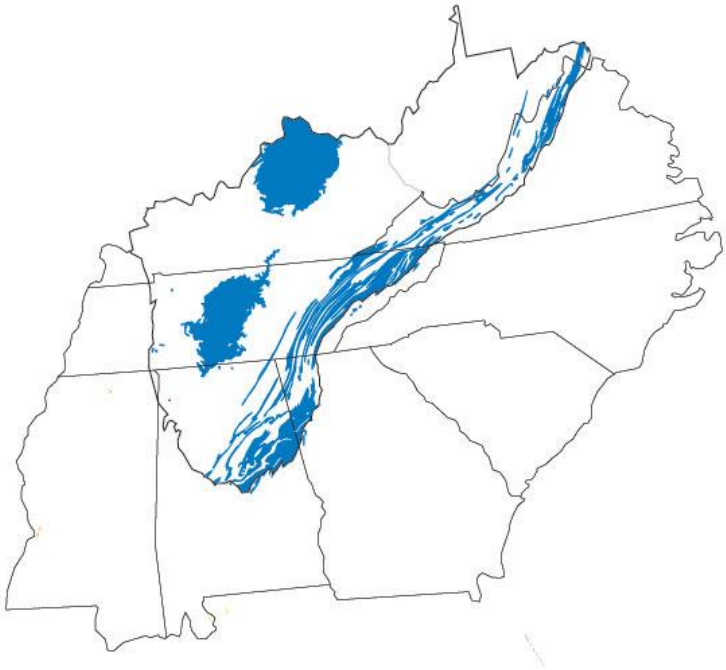
Toward the latter half of the Ordovician, the Iapetus Rocks (including the Taconic volcanic islands, Piedmont Terrane, and associated marine sediment) collided with the margin of North America, forming the Taconic Mountains. The Appalachian Basin, formed as a result of the plate collisions, was submerged under an inland ocean. Reefs developed along the shallow margins of the Appalachian Basin in parts of Tennessee resulting in the formation of very coarsely crystalline limestone that is now referred to as Tennessee "marble." It is marble only in the sense that it polishes to an attractive dimension stone that is architecturally sound and pleasing. Buildings in the National Capitol using Tennessee marble include the National Museum, the National Art Gallery, the Taft Memorial, the Capitol Building, and the Lincoln Memorial. Layers of bentonite clay, altered volcanic ash, from volcanic activity during the collision were deposited in the inland ocean and were preserved within the limestone and shale formations in the Inland Basins region. A deltaic wedge of sediment formed on either side of the Taconic Mountains as they eroded. Close to the highlands, conglomerate formed. Streams brought sandy, muddy sediment to floodplains, lakes, estuaries, beaches, and into the inland ocean to form sandstone, siltstone and shale. Sediment from the Taconic highlands spread as far south as northern Alabama and as far west as central Tennessee, but was concentrated mainly in Virginia and West Virginia. Further away from the highlands, carbonate rocks continued to form, along with sandstone and shale.

Cambrian and Ordovician rocks are exposed in the Valley and Ridge section of the Inland Basin, and along the Cincinnati Arch in Kentucky and Tennessee (Figure 2.27). These rocks are exposed because of folds, faults and erosion in the region—otherwise they would have remained buried beneath younger sediment!

What makes the patterns of rocks that we see on the geologic map? For example, the Ordovician rocks of the Inland Basins region are found in long thin ribbons as well as a circular pattern. The patterns are caused by the underlying structure of the rocks. The "underlying structure" refers to the way layers of rock have been folded and then sliced at the surface by erosion. The long thin ribbons of Ordovician rock are in the Valley and Ridge region where the rocks were compressed into tight, elongated folds along the linear Blue Ridge during the Paleozoic mountain building events. The circular to oval patterns of Ordovician rocks in Kentucky and Tennessee are the result of exposure

on circular domes along an upward buckling called the Cincinnati Arch. Rock above the arch has been uplifted and eroded, exposing the older Ordovician rock (Figure 2.28).

Figure 2.27: Cambrian and Ordovician rocks exposed in the Inland Basins region.



Rock Patterns

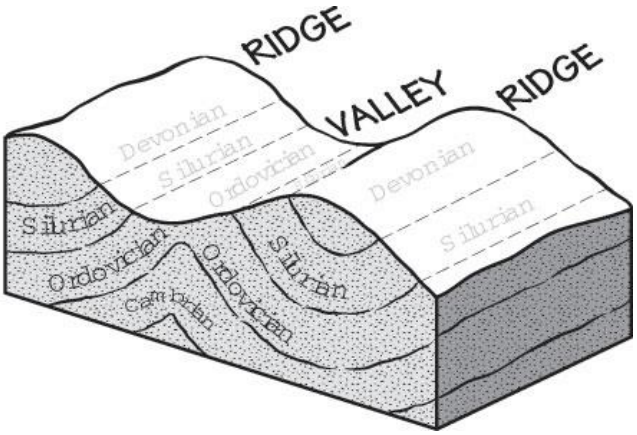
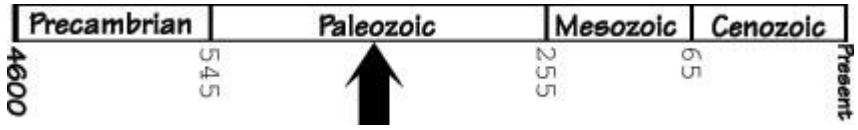


Figure 2.28

Silurian - Devonian Rocks



Silurian rocks are exposed mainly in the Valley and Ridge, and Interior Lowlands section of the Inland Basins region (Figure 2.29). These rocks record the continuing story of the Paleozoic inland ocean and the after-effects of the Taconic mountain building event. Sedimentary rocks were still forming in response to rising and falling sea level in the Inland Basins region. Sea level rose and fell

across North America many times during the Paleozoic, in part because the convergence of tectonic plates continued to buckle the inland basins, deepening the ocean, and in part because sea level itself is continually changing. With shifting sea level, the types of sediment deposited in a given area varied as well. Erosion of the Taconic Mountains continued to provide sediment to the inland ocean, forming sandstone and shale. Further out from the eroded sediment of the Taconic Mountains, carbonate rocks were again forming (mainly in Kentucky).

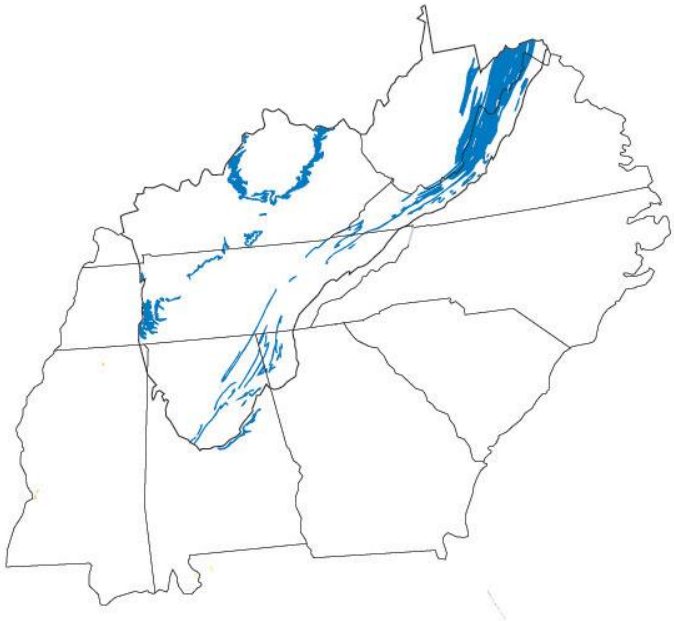


Figure 2.29: Silurian and Devonian rocks of the Inland Basins region.

During the late Silurian, as the Appalachian Basin was filled up with sediment, the ocean became relatively shallow. Much of the sediment deposited in the earlier Silurian was eroded when relative sea level fell. The remaining marine sediments exposed to the air were oxidized, resulting in red sedimentary rocks (including sandstone, siltstone, shale and limestone). A thick band of red sedimentary rocks is found in the Inland Basins region, extending from Alabama to New York. Many of these "red beds" are oolitic. In West Virginia (and further north and east), shallow water and poor circulation resulted in rapid evaporation and deposits of evaporite minerals such as salt and gypsum. None of the salt is exposed at the surface in the Southeast.

The thick sequences of eroded Acadian Mountain sediment filling the Appalachian Basin are called the Catskill Delta. The Acadian highlands eroded rapidly, providing huge amounts of sediment to be deposited on the Catskill Delta and into the inland ocean. Although the thickest sequences are in Pennsylvania and New York, Catskill Delta deposits are found through West Virginia and Virginia as well.

Devonian-aged rocks in the Inland Basins region record the onset of the Acadian mountain building event (Figure 2.29). Acadian mountain building deepened the Appalachian Basin by once again buckling the crust downward, similar to the Taconic mountain building event. Also similar to events of the Ordovician period, eroding sediments from the Acadian Mountains produced a westward spreading delta into the inland ocean. Some of the Devonian rocks produced during the Acadian mountain building event are similar to the rocks of the earlier Ordovician period (when similar tectonic events were happening). Conglomerate was formed close to the Acadian highlands, and finer grained sediment spread westward along coasts and into the inland ocean to form sandstone, siltstone and shale. At times, when the amount of sediment being deposited from the highlands

decreased, limestone and dolostone formed as well. One of the differences between the Ordovician and Devonian are widespread black shales. These were deposited as marine mud rich in organic material in deeper waters of the inland seas.

During the Mississippian period, the Inland Basins region was still covered by the inland sea, with sediment being shed into the ocean from the Acadian highlands in the east. The deeper black shale seas were infilled with gray mud, silt, and sand. Gradually through the Mississippian, the amount of sediment coming into the basin declined and carbonate deposits came to be widespread once again. Chert is common in Mississippian carbonates as well as Ordovician and Devonian carbonates because silica (of which chert is made) was abundant. Shells of siliceous sponges, abundant quartz sand and silt, and other sources provided silica. In western Kentucky at the southern end of the Illinois Basin, evaporites were deposited where the water was shallow and circulation restricted. Mississippian rocks dominate the Interior Lowlands section of the Inland Basins region, and are also found in smaller outcrops of the Appalachian Plateau, and Valley and Ridge (Figure 2.30). Toward the end of the Mississippian period sea level fluctuated. Deltas and coastlines advanced and retreated repeatedly, so that at times large parts of the Inland Basins region were coastal environments and land, and at other times were under shallow seas.

Appalachian Mountains were formed. The collisions created a depression called the Black Warrior Basin, into which sediment was deposited from both the uplifting Appalachian and Ouachita Mountains. Fluctuating sea levels of the inland ocean created alternating sequences of marine and non-marine sedimentary rocks, and broad marshy areas along the shorelines of the Appalachian, Illinois and Black Warrior Basins. The Southeast was still located along the equator at this time, and a warm, tropical climate permitted the development of extensive lush vegetation. Large swamps covered the shoreline areas of the inland sea. Plant material in the swamps died and accumulated as thick deposits of peat. The peat was buried by sediment and was compressed. Over time and continued burial, the peat was transformed to layers of coal. Thus, the Pennsylvanian rocks of the Inland Basin region, found in a wide band through the Appalachian Plateaus and in western Kentucky, are repeating sequences of sedimentary rocks that include thick bands of coal (Figure 2.30). The Southeast's coal layers, formed over 300 million years ago, have been an economically vital natural resource of the region.

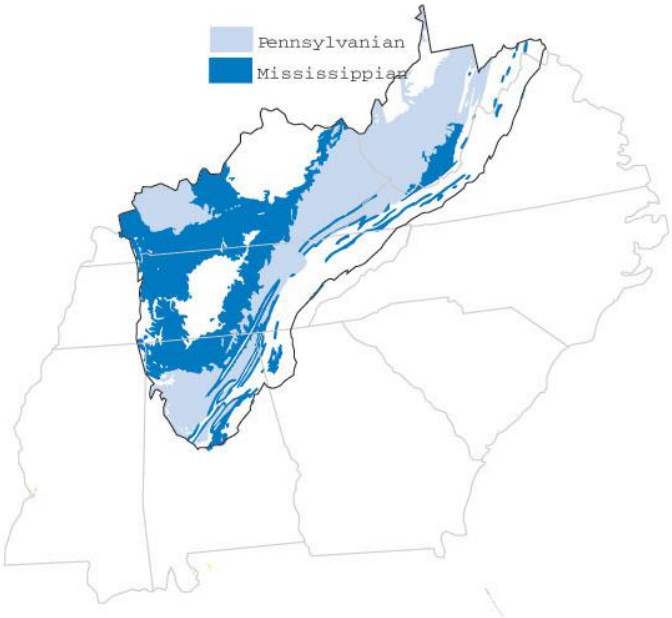


Figure 2.30: Mississippian and Pennsylvanian rocks of the Inland Basins region.

Mississippian - Permian Rocks

In the Mississippian and Pennsylvanian period, Gondwana (Africa, South America, and Australia) and North America were converging into the supercontinent Pangea. The South American crust was shoved over the North American crust when Pangea came together. The Ouachita Mountains of Arkansas and Texas are the structural results of this collision. The Ouachita Mountains also cut across modern day Mississippi at the collision zone, but they are deeply buried. Rather, a deep subduction trench formed where the plates converged and the ocean bottom sediments were squeezed up onto the Gulf Coast margin to form the Ouachita Mountains of Arkansas. As the Iapetus Ocean closed on the adjacent margin where Africa collided with North America, the

By the Permian, the assembly of Pangea was complete. Exposed at the surface in West Virginia are Permian-age sedimentary rocks (Figure 2.31). North America was sutured to Pangea by the collision of Africa with the east coast of North America. The unification of Pangea signaled the closing of the Iapetus Ocean as well as the last time the inland sea invaded eastern North America. This also signaled a major change in the appearance of the Southeast. The area that is now Florida was part of the African continent that became stuck to North America during the construction of Pangea. Later, during the Mesozoic Era, the African continent split away from the Americas and Florida was left behind. Though sea level fluctuated for a time, the inland ocean gradually retreated. With the closing of the Iapetus, the climate in the Southeast became significantly drier as the Southeast was near the center of Pangea. The lush coal swamps of the Pennsylvanian period gradually were replaced by redbeds and lacustrine carbonates, which are typical deposits of drier climates.

Figure 2.31: Permian rocks of the Inland Basins region.

Source: http://geology.teacherfriendlyguide.org/index.php/rocks-se/region-2-inland-basins

Picconi, J. E. 2003. The Teacher-Friendly Guide to the Geology of the Southeastern U.S. Paleontological Research Institution, Ithaca, NY.