Mountain Building Part IV: *the formation of Pangea and the Appalachian Mountains*

Pangea, *meaning 'all Earth,' formed over 250 million years ago and lasted for almost 100 million years. All of the Earth's continents were literally joined as one to form a giant super-continent.*

The **Appalachian Mountains** *that we see today are merely the worn down remnants of the Appalachians created millions of years ago. At one time the Appalachians were probably as tall as the modern Himalayas which formed from the collision of the Indian and Asian plates.*

The roots of today's ***Appalachian Mountains*** formed more than 1 billion years ago when the Grenville Mountains were created. The Taconic and Acadian mountain building events successively squeezed and added new land to the margin of North America, each partly shaping the continent. Approximately 250-300 million years ago, in the Pennsylvanian and Permian periods, the final mountain-building event occurred as proto-Africa (already joined to other continents as Gondwana) collided with North America to create the central and southern Appalachians *(Figure 1.23, 1.24)*. Sediment from the Iapetus ocean basin and the continental shelf and slope of North America, was pushed upwards and squeezed along with the crust. This mountain building event is known as the Alleghanian Orogeny. Although the Acadian orogeny initially shaped the northern Appalachian Mountains, the Alleghanian orogeny gave the final squeeze to the margin of the continent to form today's Appalachian Mountains.

Similar to the Taconic and Acadian mountain building events, the Alleghanian event deformed, uplifted,

Figure 1.23: Permian: 255 million years ago. Shaded areas represent land that was above water. Figure by J. Houghton, after C. Scotese, *Paleomap Project*, 2000.

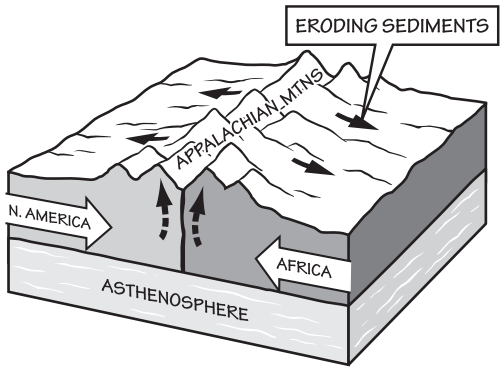
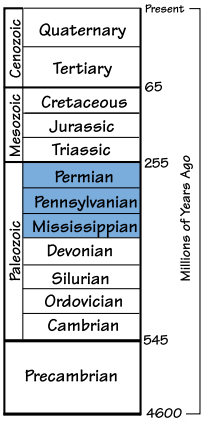


Figure 1.24: A Permian cross-section showing the collision of North America and Africa (part of Gondwana). Further north, Baltica also collided with the margin of North America.

Why are the Appalachians still here?

Although the Appalachian Mountains were formed over 250 million years ago, they are still around today. The forces of erosion and weathering have worn down the Appalachians over time; periodic uplift of the range, however, has prevented them from completely eroding away.



Appalachians vs. Himalayas

Though the Appalachian Mountains do not look as tall and rugged as the Himalayas of India, the Appalachians formed through esentially the same geologic processes. The collision of the Indian and Asian plates that is taking place today is raising the Himalaya Mountains, similar to the collision over 250 million years ago between Africa and North America created the Appalachian Mountains.

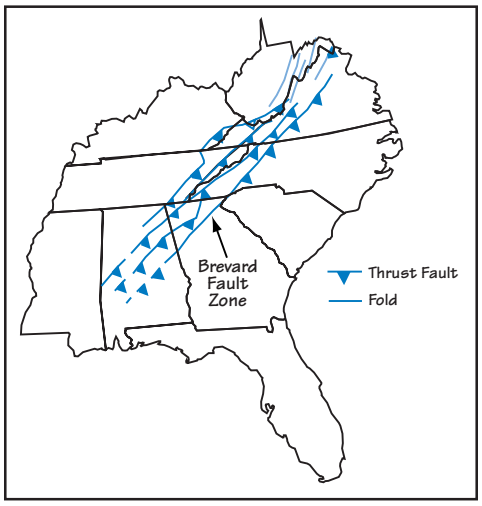


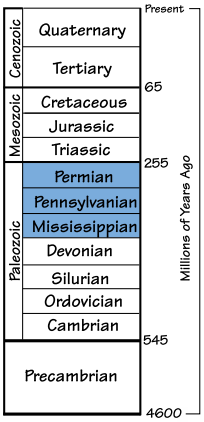
Figure 1.25: Major thrust faults of the Southeast. The Brevard Fault Zone divides the Blue Ridge from the Piedmont. Folds (rather than thrusts) are common in West Virginia, northern Virginia and further north in the

folded, faulted, intruded and compressed the crust of the eastern margin of North America. The Appalachian Mountain chain extends from Alabama to Canada. The rocks affected include the sediment deposited in the inland ocean throughout the Paleozoic Era as well as the Iapetus and Avalon Rocks that had been added to North America from the Ordovician through the Devonian. The inland ocean that existed west of the Taconic and Acadian Mountains gradually began to recede as the ***Appalachian basin*** was filled with sediment from the eroding Appalachian Mountains. The collision caused the rocks along the eastern margin to compress westward like a collapsing telescope. Slices of crust were thrust westward along faults such as the Brevard Fault Zone that runs along the eastern edge of the Blue Ridge *(Figure 1.25)*. The compression of the crust during the Alleghanian mountain building event caused the crust to ***shorten*** by almost 200 kilometers (124 miles). The South American portion of Gondwana had also collided with North America by the early Pennsylvanian, forming the Ouachita Mountains of Arkansas and Texas *(Figure 1.26)*. The Ouachitas extended into Mississippi, but are now buried beneath younger sediments.

The Appalachian basin formed by the Taconic and Acadian mountain building events as the crust was downwarped as a result of the colliding plates. The basin was then filled with an inland ocean.

Shortening *of the crust refers to a loss of horizontal distance. Seismic studies of eastern North America have shown that the "root" of the thrust, fold and fault structures of the Appalachian Mountains is located 161 kilometers (100 miles) to the east within the Piedmont region.*

Figure 1.26: A reconstruction of the environments and topography of a part of the Southeast in the Pennsylvanian period.



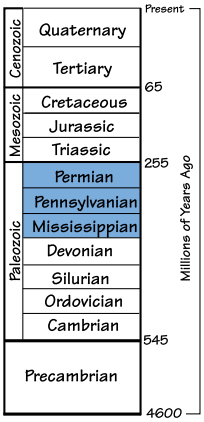
Geologic History

Parts of the West Coast of North America (including Alaska) are also considered to be **exotic terranes**, *sutured on to the coast and repositioned by strike-slip faults (shearing of blocks of crust).*

Due to their origin from far away, 'exotic' places, **exotic terranes** *have distinctly different geologic characteristics than the surrounding rocks.*

Evidence For Pangea

How do we know that Pangea existed 250 million years ago? Fossil evidence and mountain belts provide some of the clues. The Permian-age fossil plant, Glossopteris *had seeds too heavy to be blown across an ocean. Yet* Glossopteris *fossils are found in South America, Africa, Australia, India and Antarctica! The mountain belts along the margins of North America, Africa and Europe line up as well and have similar rock types, indicating that the continents at one time were joined as Pangea. The discovery of* Glossopteris *and the evidence in the rocks helped geologists to formulate the theory of Continental Drift, which, when the processes of continental movement were later discovered, was reformulated under the modern theory of Plate Tectonics.*



Towards the end of the Alleghanian mountain building event, the Tallahassee-Suwanee Terrane was sutured to North America *(Figure 1.27)*. Geologists believe this ***exotic terrane*** was a piece of Africa that collided with North America when most of the continents in the world converged near the end of the Permian Period to form the supercontinent ***Pangea***. What is now Florida was left behind when the continents broke apart millions of years later. The Tallahassee-Suwannee Terrane became Florida's ancient foundation, buried beneath a thick cover of geologically more recent sediment that was eroded from the Appalachian Mountains. It was only about 25 years ago, as an understanding of "***exotic terranes***" evolved with recent research, that geologists realized that the basement rocks of Florida were not merely an underground extension of the Appalachian Mountain rocks. Florida is a good example of an exotic terrane, originating as part of Gondwana and later being attached to North America.

Exotic Terranes of the Southeast

Due to their origin from far away "exotic" places, exotic terranes have distinctly different geologic characteristics than the surrounding rocks. Exotic terranes in the Southeast include:

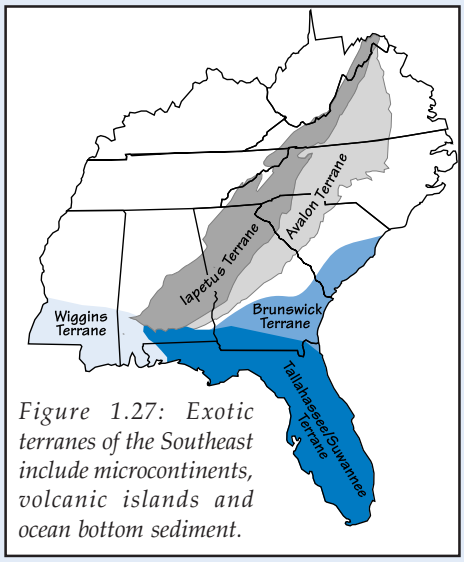


Figure 1.27: Exotic terranes of the Southeast include microcontinents, volcanic islands and ocean bottom sediment.

Iapetus Rocks:
- *Volcanic islands formed at a subduction zone in the Iapetus Ocean*
- *Piedmont terrane*
- *Iapetus Ocean bottom sediment*

Avalon Rocks:
- *Avalon microcontinent (also called the Carolina Terrane in the Southeast)*
- *Ocean bottom sediment surrounding Avalon*
- *Other small fragments of continental crust and volcanic islands*

Tallahassee-Suwanee, Brunswick & Wiggins Terrane:
- *fragments of Gondwana plate*

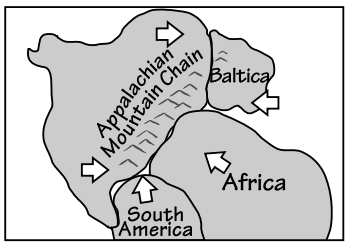


Figure 1.28: Pangea
-Africa collides with North America
-Central and southern Appalachians form
-South America collides with North America
-Pangea assembled: continents form one supercontinent