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The Physiography of North Carolina

by

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The main outlines of the physiography of North Carolina developed over 200 million years ago. Major earth movements created a line of fold mountains oriented NE-SW which were the forerunners of the present Appalachians. In the succeeding centuries these mountains were weathered and eroded into two distinct regions,the Blue Ridge Mountains and the Piedmont Plateau. The eroded material was carried away by rivers and deposited at the edge of the Piedmont, eventually being consolidated to form the Coastal Plain. (Fig. 1).At present, therefore, 3 physiographic regions can be distinguished, the rounded Blue Ridge Mountains to the west, the gently rolling Piedmont in the center, and the almost flat Coastal Plain in the east. (Fig. 2).

Blue Ridge Mountains

The Blue Ridge Mountains are a series of interlinked ridges occupying the western section of the state. Locally the term Blue Ridge is applied only to the easternmost range and the escarpment overlooking the Piedmont, other ridges having distinctive names. However, the whole of western North Carolina has a similar topography and geologic history, so that the term Blue Ridge is usually applied to the whole region. The region is in fact a single ridge in Virginia, but it increases in width and complexity southwards, being over 125 km wide in the Asheville area.

During the paleozoic era marine sediments accumulated above precambrian granite and gneiss. About 250 million years ago a thrust from the

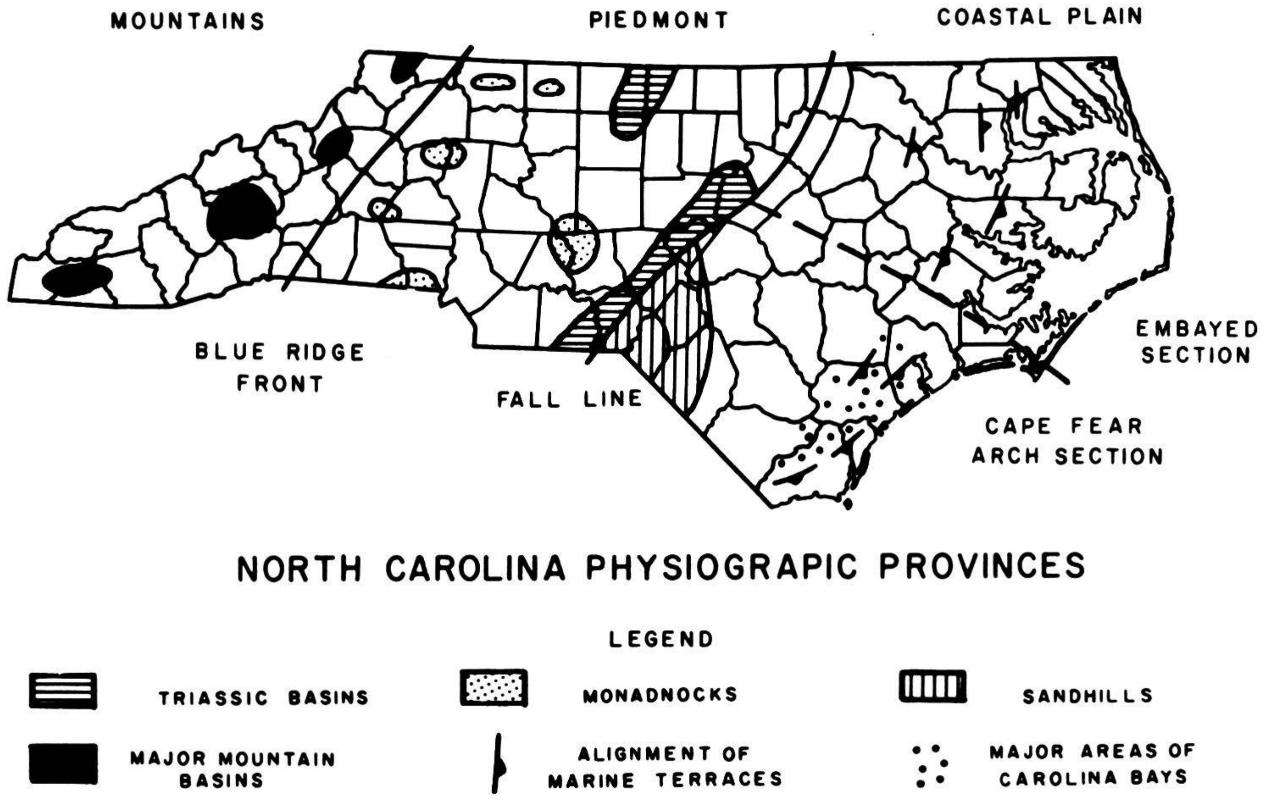

Fig. 1. The major physiographic regions of North Carolina

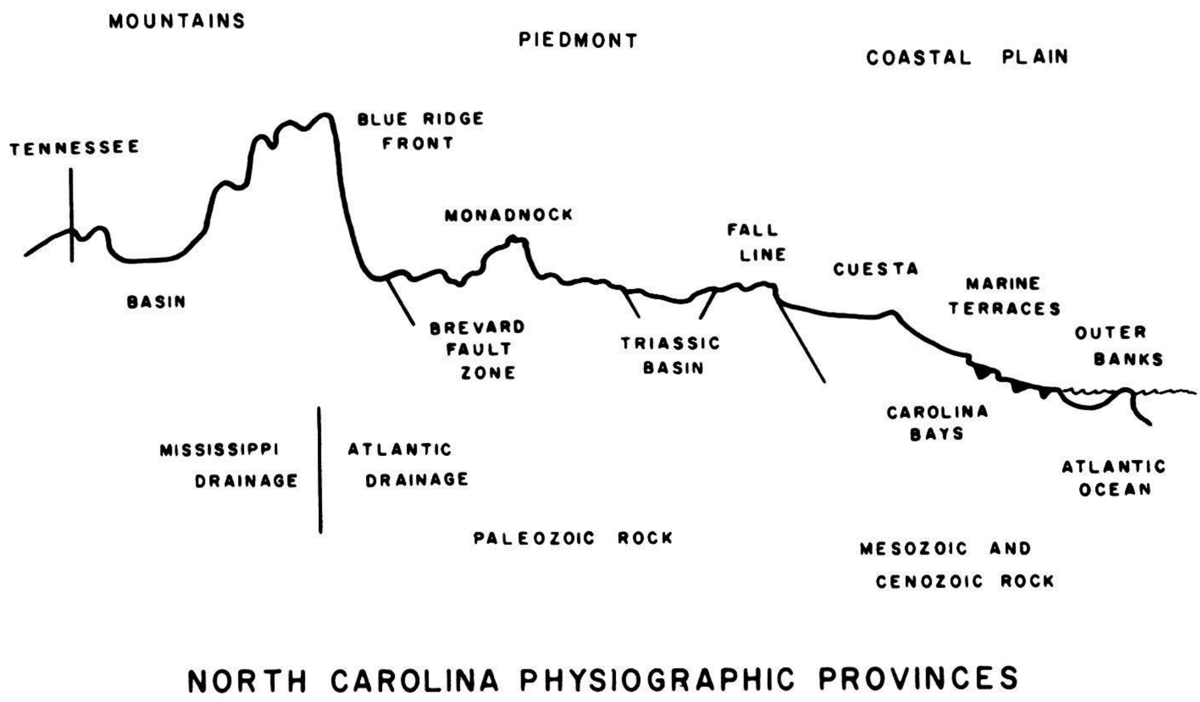

Fig. 2. Schematic cross section through North Carolina.

southeast uplifted the region to produce a series of NE-SW oriented mountains, with overfolding and shear thrusts towards the northwest. Contemporaneous volcanic activity helped to create the present mixture of igneous, sedimentary and metamorphic rocks. Since this time of major uplift the region has been continuously above sea level and erosion has been the dominant process. A complete fluvial erosion cycle removed the fold mountains and produced a peneplain. Later epeirogenic movements elevated the land and a second erosion cycle began. It is still unclear whether this cycle was also completed and a third started, but the present landscape is certainly derived from the erosion of a pre-existing peneplain. This present erosion cycle is not very far advanced and lithology controls the topography. The more resistant rocks form the higher land. Since the rock strata have the NE-SW trend established by the folding of the late paleozoic, the high land forms ridges with the same orientation.

The present physiography, therefore, is an expression of the differential rates of fluvial erosion on the various rock types, not a result of folding. The hills are rounded rather than rugged and tend to have similar summit elevations. Both youthful and mature valleys occur. The former are deep and steep sided, formed where the rivers cut through the rock, and hence oriented NW-SE. The latter occur on the weaker rocks and are much more open and flat-floored and oriented NE-SW. They commonly form basins within the mountains, examples being Asheville, Hendersonville and Linville Basins. In some areas the easily eroded limestones and shales which were in place prior to the folding have been exposed, forming small, oval-shaped, blind valleys, such as the "coves" of the Great Smokies.

The eastern boundary of the Blue Ridge Mountains is a straight, steep escarpment, the Blue Ridge Front, standing at least 300 m above the Piedmont. The origin of the front is debatable, but two processes were probably involved. Initial formation seems to have been the results of fluvial erosion. Most of the drainage of the Blue Ridge is westwards, eventually to the Mississippi, while on the Piedmont streams flow directly to the Atlantic. The shorter, steeper course of the latter creates more vigorous headward erosion and a more rapid lowering of land surface. Hence it can be postulated that the scarp is retreating and that the more vigorous Piedmont streams should capture those of the mountains. The Linville River shows evidence of such capture. It rises on the slopes of Grandfather Mountain and flows for a few miles southwestward in the broad open valley with gradient and elevation typical of the westward flowing streams. It then turns abruptly eastwards, at an elbow of capture, creating a 550 m deep gorge as it falls 400 m in 24 km to the Piedmont. This type of fluvial erosion would be expected to leave remnants of mountain topography on the Piedmont as the westward retreat progressed, and several such outliers do occur. The retreat, however, would be unlikely to produce a straight escarpment. Such linearity may have been produced by the scarp movement over a fault zone. Although no single fault parallels the scarp throughout its length, the Brevard Fault Zone is close to its foot for a great distance, and it is likely that the scarps' present configuration was initiated by this fault series.

Piedmont

The Piedmont region stretches for 200 km east from the Blue Ridge Front. It is a dissected plateau with a gently rolling landscape, local relief averaging 20 m, but with knobs, ridges, and valleys increasing this to 100 m in places. The plateau is highest in the west, about 300 m above sea level, and gradually slopes eastward to be less than 150 m high at the edge of the coastal plain.

The region was formed as part of the Appalachian mountain system and the underlying structures are similar to those of the Blue Ridge. However, the more rapid fluvial erosion by the eastward flowing rivers is responsible for the great difference in topography between the regions. The erosional activity can be divided into two stages. The first culminated in the creation of a peneplain, the Harrisburg surface, about 150 million years ago, and produced the basic plateau topography. Some residual monadnocks, such as King's Mountain and Brushy Mountain, break the surface, giving the outliers with mountain-like character. The second erosional stage, which is still going on, followed a series of differential uplifts of the area. The rivers are eroding into the plateau surface, creating the present landscape.

The present drainage pattern is dendritic, with little structural control, since the rivers were superimposed from the overlying peneplain. Although most valleys are mature and open, lithology frequently controls their detailed configuration, and sections with youthful characteristics are common.

Most of the topography diversity in the Piedmont is attributable to lithological differences, creating different rates of erosion. Of the metamorphic rocks that constitute most of the surface, gneiss has been least eroded, and slate the most. The gneiss uplands, often the monadnocks surviving above the Harrisburg surface, are commonly associated with igneous intrusions, to give both large upland areas, such as the Uwharrie Mountains, and isolated hills, such as Hanging Rock and Pilot Mountain. The slate region occurs at the eastern edge of the Piedmont, the Carolina Slate Belt. Here it forms generally lower ground with low relief, the rivers flowing in wide open valleys. Unmetamorphosed rocks occur in two Triassic Basins, the Danville and Deep River Basins. In these downfaulted troughs easily eroded sandstones, conglomerates and silts predominate, and the resulting topography is relatively flat.

The eastern edge of the Piedmont is the Fall Line, where the metamorphosed rocks of the Piedmont dip below the sedimentary cretaceous cover of the Coastal Plain. In many areas this change is expressed as an abrupt change in topography, from the Piedmont hills to the Coastal Plain flats. In particular, the rivers have a series of rapids or waterfalls for a few kilometers. These rapids were originally at the structural boundary, but are now a few kilometers upstreams. In some regions, especially were the Deep River Basin abuts the Coastal Plain, there is no marked topographic change and the rivers may have a 30 km stretch of rapids. The boundary here is distinguished chiefly by the change in soil and vegetation type.

Coastal Plain

The rocks that underly the Coastal Plain were derived from the erosion of the Appalachian Mountains. They were deposited on the paleozic basement as a series of strata dipping gently eastwards. A mixture of on-shore, nearshore and off-shore environments were involved, so that there are several minor, but important, lithological differences. Deposition commenced in the cretaceous near the edge of the Piedmont and continued, with interruptions, throughout the tertiary and quarternary, extending the Coastal Plain eastwards with time.

The whole of the Coastal Plain is less than 150 m above sea level, and over 50 % of the area is below 30 m. Hence the relief is minimal. The land is not uniformly flat, however, since minor earth movements, changes in sea level, and lithological differences have produced numerous microrelief features. The most significant earth movement was an upwarping along a NW-SE axis through Cape Fear, leading to two distinct sections within the region; the Embayed section, from near the line of the Neuse River to the Virginia border, and the Cape Fear Arch, from the Neuse southwards.

The Embayed section has been partially drowned during the post-glacial rise in sea level. This is only the latest in a series of sea level changes, as former marine erosion is indicated by several lines of marine terraces. The highest, 70 m above sea level, is about 100 km inland. The cliffs behind the terraces are only a few feet high and have been subaerially eroded, so that frequently the only indication of their presence is a region of poor drainage and distinct vegetation on the terrace. The most recent terrace, the Pamlico, 10 m above sea level, is well preserved, and this frequently forms a scarp that acts as the inner edge of the coastal swamps, notably the Dismal Swamp. The swamps have been created by the post-glacial sea level rise, which partially drowned the lower portions of most valleys, and left swampy flats on either side of the rivers as far inland as the Fall Line. The rivers themselves are mature and slow flowing, and are usually slightly incised below the general level of the plain, suggesting some fluvial erosion prior to the recent changes. The only other evidence of fluvial erosion on the landscape is the presence of weakly formed cuestas parallel to the coast as lithological difference have been emphasized by the rivers which have developed a roughly trellised pattern.

Along the coast itself are a series of depositional features. The tidal mudflats of the mainland facing the sounds are continuations of the depositional process that has been going on since the cretaceous. It appears that the slow submergence of the land is reducing river gradients, and rapid deposition of silts and clays along the lower water courses and coastline is occurring, extending the land rather faster than it can be drowned. Across the sounds the barrier islands, the Outer Banks, are composed mainly of sand. The sand is transported into the area partly by littoral drift and partly from the offshore ocean floor. How these two effects combine is not fully understood, but they produce a mixture of spits, the cuspate foreland of Cape Hatteras, and the true barrier islands.

The landscape of the Cape Fear Arch section of the Coastal Plain is still basically flat, but different in detail from the Embayed section. This is probably a result of the continued upwarping of the area, so that today it is a region of emergence. The lower reaches of rivers are not drowned, and swamp land is rare. Instead, the river flow in broad , well-defined valleys, even though local relief is only a few metres. Cuestas are present and a trellis drainage pattern can be discerned. Marine terraces, correlated to those farther north, are found, but only close to the shore. Farther inland, abutting the Piedmont, is a major outcrop of cretaceous sandstone, which forms the highest elevations of the Coastal Plain.This produces the Sandhills region, where topography is similar to that of the Piedmont, soil and vegetation marking the transition between the two.

The "Carolina Bays" occur in great abundance on the marine terraces in this section. A "Bay" is an oval or elliptical depression oriented NW-SE, about 10 m deep, anything from 0.5 to 10 km long, and with a sand rim. It is estimated that there are half a million on the coastal plain. They have poor drainage and are frequently peat filled, with evergreen bay trees growing in them. Several theories of their origin have been proposed, but none has satisfactorily accounted for all their features. For example, they are reminiscent of meteorite craters, but it is unlikely that meteorites would fall only on marine terraces. They also resemble some glacial features, but there is no evidence of glacial activity in the area. They could have been formed by marine erosion, but similar features have not been found on other coastal plains. Whatever their origin,they remain a unique feature of the physiography of North Carolina.

Summary

North Carolina is divided into three physiographic provinces, the Blue Ridge, the Piedmont, and the Coastal Plain. The first two have a common geologic history, being formed more than 200 million years ago as a NE-SW oriented chain of fold mountains. Subsequent erosion removed all traces of these mountains, but more recent uplift has allowed renewed erosion. This has re-established the original orientation, but lithological characteristics, rather than the original folds, determine the details of the topography. Rivers in the Blue Ridge province drain westward to the Mississippi, while the Piedmont drainage is directly to the Atlantic. The shorter courses of the latter rivers create more active erosion, and the Piedmont is farther advanced in the current erosional cycle. Consequently the Blue Ridge retains a mountainous character as a series of rounded ridges separated by broad open valleys. The Piedmont, in the contrast, has gently rolling topography. The two provinces are divided by the Blue Ridge Front, a steep escarpment 300 m high which represents the current westward limit of erosion by Piedmont rivers. Material eroded by these rivers has been deposited, since the cretaceous, at the eastern edge of the Piedmont, forming the present Coastal Plain.This province, separated from the Piedmont by the Fall Line, slopes gently to the coast and is a flat area. Changes in rock structure, combined with the effects of post-glacial sea level changes, create some micro-relief features. The northern part has recently been drowned, and contains estuaries, swamps, and the distinctive Barrier Islands. The southern portion was recently uplifted and is generally a well drained area.

Zusammenfassung

North Carolina kann in drei geographische Provinzen eingeteilt werden: Blue Ridge, Piedmont und Coastal Plain. Die ersten beiden haben eine gemeinsame geologische Geschichte, wurden sie doch vor mehr als 200 Millionen Jahren als Nordost-Südwest gerichtete Ketten eines Faltengebirges gebildet. Die darauf folgende Erosion trug diese Berge wieder ab, aber eine spätere Hebung brachte erneute Erosion. Dies führte zur Wiederherstellung der ursprünglichen Richtung der Berge, aber die Topographie im Detail wird mehr durch die Eigenschaften der Gesteine als durch die ursprüngliche Faltung bestimmt. Die Flüsse der Blue Ridge-Provinz entwässern westwärts zum Mississippi, jene des Piedmont direkt in den Atlantik. Die geringere Länge der letzteren führt zu einer intensiveren Erosion, und die Erosion im Piedmont ist deshalb weiter fortgeschritten als in der Blue Ridge-Provinz. Während diese gebirgigen Charakter mit einer Reihe von durch breite offene Täler voneinander getrennten Ketten aufweist, zeigt der Piedmont hügelige Topographie. Die beiden Provinzen werden durch die "Blue Ridge Front" getrennt, einem Steilabfall von 300 m, welcher die Westgrenze der Erosion durch Piedmont-Flüsse bildet.

Das Erosionsmaterial dieser Flüsse wurde seit der Kreidezeit am Ostrand des Piedmont abgelagert und bildet heute die Coastal Plain. Diese Provinz, die vom Piedmont durch die sogenannte "Fall Line" getrennt wird, senkt sich als Ebene allmählich gegen die Küste zu. Unterschiede in der Gesteinsstruktur und die Auswirkungen der nacheiszeitlichen Meeresspiegelschwankungen führten zu Mikrorelief-Ausbildungen. Der nördliche Teil der Coastal Plain hat sich in letzer Zeit gesenkt und enthält Flussmündungen, Sümpfe und eine vorgelagerte Inselkette, die "Barrier Islands". Der südliche Teil wurde dagegen in jüngster Zeit gehoben und entwässert sich im allgemeinen gut.

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