

## Appendix 4

### Calculation of Appalachian Erosion

The Appalachian Mountains of eastern North America form a zone 100 to 310 miles (160 to 500 km) wide starting from Newfoundland, southeast Canada, and running 1,500 miles (2,400 km) southwestward to central Alabama. The Appalachian Mountains include the Blue Ridge Mountains and the Valley and Ridge Province. The highest mountains are



*Figure A4.1. Grandfather Mountain in the southern Blue Ridge Mountains at 5,946 feet (1,818 m) msl as seen from the Blue Ridge Parkway at 4,150 feet (1,265 m) msl.*

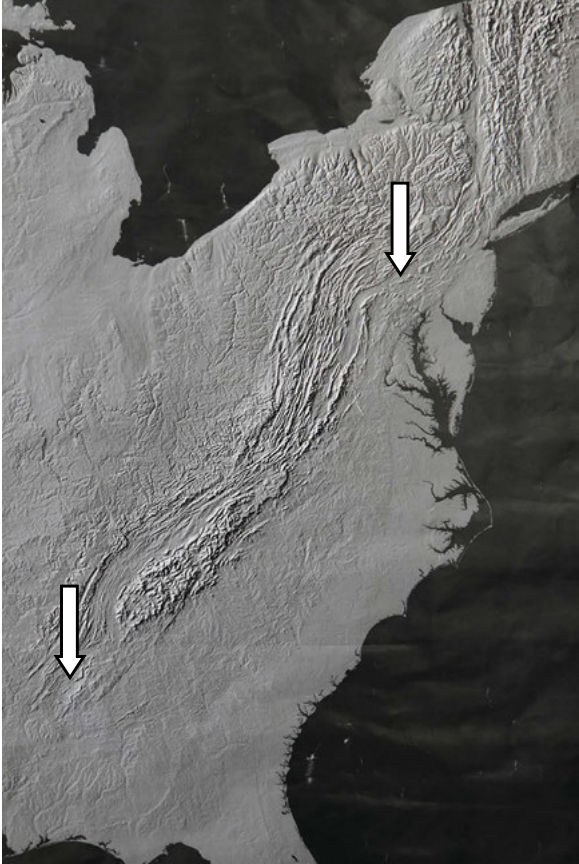
in western North Carolina with Mount Mitchell rising to 6,672 feet (2,034 m) msl, the highest point east of the Mississippi River. Grandfather Mountain is another important high point in the Blue Ridge Mountains at 5,946 feet (1,818 m) msl (Figure A4.1). The Appalachians not only refer to the mountains, but also to several regions associated with the mountains,<sup>1,2</sup> which are northwest and southeast of the Appalachian Mountains. All these regions are divided up into provinces of similar geomorphology.

#### **General Geomorphology of the Appalachians**

Based on geomorphology, the Appalachians or Appalachian Highlands can be subdivided into provinces of similar geomorphology. The Blue Ridge Province is the backbone

<sup>1</sup> Fenneman, N.M., 1938. *Physiography of Eastern United States*, McGraw-Hill Book Company, Inc, New York, NY.

<sup>2</sup> Thornbury, W.D., 1965. *Regional Geomorphology of the United States*, John Wiley & Sons, New York, NY.



*Figure A4.2. The distinctive geomorphology of the Appalachian Mountains (the Blue Ridge and Valley and Ridge Provinces) as seen from space (from "Landforms of the Conterminous United States," U.S. Geological Survey Miscellaneous Investigations Series Map I-2206).*

of the Appalachian Mountains and represents the highest points. The Valley and Ridge Province is just west of the Blue Ridge Province. The Valley and Ridge Province first accumulated thousands of feet of sediments in a deep basin, which then uplifted, buckled into folds and faults, and then the top was eroded. These two provinces appear from space as one large elongated landform (Figure A4.2). Farther west is the Appalachian Plateaus Province, which includes the Allegheny Plateau in the north and the Cumberland Plateau in the south. West of the Appalachian Plateaus Province is the Interior Low Plateaus Province. East of the Blue Ridge Mountains is the Piedmont Province.

Besides the main provinces, there are two other geomorphic features of special interest. The first is the Blue Ridge Escarpment of the southern Appalachians, which is about 310 miles (500 km) long and averages 1,000 to 1,640 feet (300 to 500 m) high (see Appendix 5). A second major geomorphic feature is the Great Valley between the mountainous Blue Ridge and the Valley and Ridge Provinces. The Great Valley can be considered the first westward valley of the Valley and Ridge Province, although it is much wider than any other in that province. It extends the *total length* of the Appalachian Mountains and is quite conspicuous, shown by arrows on its northern and southern end on Figure A4.2. It extends from the St Lawrence Lowland to Alabama.

### Amount of Erosion Based on Offshore Sediments

Besides a crude estimate for the amount of erosion that is based on coal rank (see Chapter 8), there is another method for estimating erosion from the Appalachians. This method estimates the amount of sediments and sedimentary rocks offshore, which mainly eroded from the Appalachians.<sup>3</sup> The continental margin of the eastern United States starts on the coastal plain at the “Fall Line,” a small topographical expression between the eroded Piedmont to the west and the Coastal Plain Province to the east. The height and the topographical expression of the Fall Line vary. The major rivers that transverse the Fall Line form either waterfalls or a series of rapids. The coastal plain blends into the continental margin, beginning with the nearly flat continental shelf, then to the continental slope, ending with the continental rise. The sedimentary rocks from the Fall Line to the continental rise represent a seaward prograding and thickening wedge of sedimentary rock (see Figure 7.3)<sup>4,5</sup>

The sediments that accumulated along the coastal plain and continental margin very likely originated from the Appalachians. The uplift of the continents and the sinking of the ocean basins caused the erosion and sedimentation.<sup>6</sup> Poag and Sevon state: “The primary forcing mechanisms considered have been tectonic and isostatic uplift and subsidence...”<sup>7</sup> Tectonic uplift of the eastern United States is believed to have caused the erosion, while the total amount of subsidence off the coast along the continental margin is believed to be 8.7 miles (14 km)!<sup>6,8</sup> Isostatic uplift is a secondary tectonic force caused by the removal of rock, which in turn causes uplifting. Conversely, the addition of sediments causes an area to isostatically subside.

Abundant measurements of the sedimentary rocks along the eastern margin of the United States are available. Using this data, a calculation of the amount of rock for each geologic period from the Jurassic to the Quaternary was performed by C. Wylie Poag and colleagues.<sup>6</sup> The amount of sedimentary rocks per period depends upon assumptions about index fossils, so I did not use this detailed information. I am interested only in the volume of sediments and sedimentary rocks in order to estimate the erosion of the Appalachians. The total volume of non-carbonate and non-“evaporite” sedimentary rocks is 335,000 mi<sup>3</sup> (1.377 million km<sup>3</sup>) over an area of about 122,000 mi<sup>2</sup> (500,000 km<sup>2</sup>) between latitudes 36° and 42° N and longitudes 39° 30' and 78° W off of the East Coast of the U.S. This gives an average depth of 1.7 miles (2.7 km), and if the carbonates and evaporites are included, it probably would be around 1.9 miles (3 km) or more.

<sup>3</sup> Oard, M.J., 2011. Origin of Appalachian geomorphology Part I: erosion by retreating Floodwater and the formation of the continental margin. *Creation Research Society Quarterly* 48(1):33–48.

<sup>4</sup> Klitgord, K.D., D.R. Hutchinson, and H. Schouten, 1988. U.S. Atlantic continental margin; structural and tectonic framework. In, Sheridan, R.E. and J.A. Grow (editors), *The Geology of North America, Volume I-2: The Atlantic Continental Margin: U.S.*, Geological Society of America, Boulder, CO, pp. 19–55.

<sup>5</sup> Poag, C.W. and P.C. Valentine, 1988. Mesozoic and Cenozoic stratigraphy of the United States Atlantic continental shelf and slope. In, Sheridan, R.E. and J.A. Grow (editors), *The Geology of North America, Volume I-2: The Atlantic Continental Margin: U.S.*, Geological Society of America, Boulder, CO, pp. 67–85.

<sup>6</sup> Poag, C.W. and W.D. Sevon. 1989. A record of Appalachian denudation in postrift Mesozoic and Cenozoic sedimentary deposits of the U.S. middle Atlantic continental margin. *Geomorphology* 2:119–157.

<sup>7</sup> Poag and Sevon, Ref. 6, p. 119.

<sup>8</sup> Poag, C.W. 1992. U.S. middle Atlantic continental rise: provenance, dispersal, and deposition of Jurassic to Quaternary sediments. In, Poag, C.W. and P.C. de Graciansky (editors), *Geological Evolution of Atlantic Continental Rises*, Van Nostrand Reinhold, New York, NY, pp. 100–156.

The central Appalachians, including the Blue Ridge, Valley and Ridge, and Piedmont Provinces, cover an area of around 123,000 mi<sup>3</sup> (315,000 km<sup>2</sup>) between the above latitudes.<sup>9</sup> Based on the total volume offshore, assuming that the sediments originated from these provinces, results in an average erosion of 2.7 miles (4.37 km). However, it is likely that the sediments offshore were mostly eroded from east of the Appalachian divide, and so the area of erosion could be reduced by around 30%. So, erosion from the remaining 70% of the area east of the divide would be in the neighborhood of 3.8 miles (6 km). Pazzaglia and Gardner estimate an average erosion of about 4.4 miles (7 km).<sup>10</sup> These estimates are close to the amount of erosion derived from coal studies, which is around 2.5 to 4.1 miles (4 to 6.5 km). It is clear that the offshore sedimentary rocks are close to the amount of erosion estimated for the Appalachians.

It is difficult to estimate the amount of erosion west of the Appalachian divide. Part of this area includes the southern Valley and Ridge Province where there is coal at the surface. So presumably the erosion of the Valley and Ridge Province west of the Appalachian divide was similar to the 2.5 to 4.1 miles (4 to 6.5 km) of erosion east of the divide. The amount of erosion of the Appalachian Plateaus Province is unknown. Regardless, eroded debris west of the continental divide would have been transported west and then south into the Gulf of Mexico.

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<sup>9</sup> Poag, Ref. 8, p. 101.

<sup>10</sup> Pazzaglia, F.J. and T.W. Gardner. 2000. Late Cenozoic landscape evolution of the US Atlantic passive margin: insights into a North American Great Escarpment. In, Summerfield, M.A. (editor), *Geomorphology and Global Tectonics*, John Wiley & Sons, New York, NY, pp. 283–302.