THE GREAT SMOKY MOUNTAINS
THEIR GEOLOGY AND NATURAL HISTORY

By Philip B. King, Geologist, U. S. Geological Survey
and
Arthur Stupka, Naturalist, National Park Service

THE SETTING OF THE MOUNTAINS

The Great Smoky Mountains lie in eastern Tennessee and western North Carolina, between the cities of Knoxville on the west and Asheville on the east (see index map, fig. 1). The mountains are a segment of the divide that forms the boundary between the two states, and are a part of the Appalachian Highlands—the long belt of elevated country that extends through the Southeastern States from Virginia to Georgia. Until about 1830 the mountains were poorly accessible from centers of population, harbored a mountaineer culture, served as a refuge for wildlife, and retained many areas of virgin forest.

A mist or haze rises at times from the dense vegetation of the mountain valleys, and obscures even the lofty peaks of the range; from this "smokiness", no doubt, the name Great Smoky Mountains is derived. On its northern, or Tennessee, side the range projects in ramparts and massive bastions above much lower foothills and forms the skyline on the south when viewed from Maryville, Sevierville, Newport, and elsewhere in the Tennessee Valley. On the southern, or North Carolina, side the mountain front is poorly defined, and innumerable sharp-crested spurs branch out from the main divide. Thus, from this direction the full sweep of the range is not visible, except from lofty overlooks in the Blue Ridge farther southeast.

Many streams in the Appalachian Highlands originate in western North Carolina, east of the higher mountains, and flow in a curious fashion westward through the mountain barrier to join the Tennessee River, a part of the Mississippi River drainage. The valleys of two of these, the Pigeon and Little Tennessee Rivers, terminate the Great Smoky Mountains on the east and west, respectively (fig. 1), and separate them from other ranges of the Appalachian Highlands. Two others, the Little Pigeon River and the Little River, drain only the northern slopes of the Great Smoky Mountains.

The Great Smoky Mountains include some of the highest land east of the Mississippi River. For 36 miles the main divide stands more than 5,000 feet above sea level, and sixteen of the peaks rise to altitudes greater than 6,000 feet, culminating in Clingmans Dome at 6,643 feet. The altitudes of the higher peaks exceed those of Mount Washington in New England (6,288 feet) and are only a little lower than Mount Mitchell (6,684 feet), farther east in North Carolina, Mount Le Conte, on a spur that projects from the main range into lower country, stands more than a mile above the town of Gatlinburg, 6 miles away (fig. 5), forming one of the highest and steepest slopes in the eastern states.

GREAT SMOKY MOUNTAINS NATIONAL PARK

This mountain wilderness has been set apart for the American people as Great Smoky Mountains National Park. Establishment of the park was authorized by an act of Congress of May 22, 1926, and land was acquired gradually by the states of Tennessee and North Carolina, with Federal aid in addition to a contribution by John D. Rockefeller, Jr., through the Laura Spelman Rockefeller Memorial. The park is 54 miles long, and its greatest width is 19 miles (fig. 1). It comprises an area of about 500,000 acres, or about 780 square miles.

THE GEOLOGICAL STORY

The visitor to the Great Smoky Mountains sees at first the predominant forest and the shaded undergrowth, and is not immediately aware that the soils of the forest conceal a solid core of native rock. Later he notices here and there rocky cliffs and crests, and the great boulders, or "graybacks", that are strewn over the mountain sides and choke each rushing torrent. He may then perceive that the rock formations, although masked by soil and vegetation, have determined the basic features of the landscape.

Many visitors ask: Are the Great Smoky Mountains the oldest mountains in the United States? The geologist is nonplused by the question, for he is aware of the ceaseless changes that take place on the face of the earth through the ravages of geologic time. Does the question ask whether the rocks that compose the mountains are the oldest? Does it refer to the folding and disturbance that one sees in the layers, which were undoubtedly created during a former time of mountain making? Or does it refer to the peaks, ridges, and valleys that we see today? The geologist therefore does not answer the question directly, but tells the story of the region in the following terms:

Rock making.—The first chapter in the geological story deals with rock making, and the part of the chapter that is written largest in the Great Smoky Mountains tells of the creation of the Ocoee Series. This series, a great mass of rocks 20,000 feet or more thick, forms most of the core of the Great Smoky Mountains, and projects as cliffs and ledges on the mountain sides. The creation of the series took place at a time now remote, before the beginning of the Cambrian Period of the Paleozoic Era 600 million years ago, and later than 900 million years ago. This was before life was abundant on the earth, and the Ocoee Series, so far as known, contains no fossil remains of plants or animals.

Despite the early origin of the Ocoee Series, one can find in it no indications of the fires and cataclysms that one might suppose were dominant at such primitive times of earth history. Instead, the processes that created the series would probably not seem strange today, for it consists of sedimentary rocks that were originally spread out as mud, sand, and fine gravel on the bottom of a body of water. Nothing like the present Great Smoky Mountains existed at the time, but primitive hills and mountains must have projected to the southeast or northeast, for broken fragments of the rocks that composed them are embedded in the rocks of the Ocoee Series. The unit marked "graywacke and conglomerate" on section B – B' (fig. 2) contains innumerable pebbles of quartz and feldspar. These pebbles were derived from the breaking apart of individual crystals of an ancient granite mass, by exposure to sunshine, rain and air, on hillsides and mountain slopes, after which they were washed by streams to the body of water in which the Ocoee Series was accumulating. The conglomerate of the Ocoee Series now has much the appearance of granite and is composed of granitic materials, but these materials have been broken up, transported, reconstituted as layers of gravel, and consolidated once more into the firm rocks we see today.

The ancient granites which were eroded to form the graywackes and conglomerates of the Ocoee Series lay farther southeast and northeast, and can be observed in places in this part of the Appalachian Highlands today. An example of these rocks, a layered (or gneissic) granite, occurs in the southeastern part of the Great Smoky Mountains, in the vicinity of Ravens Fork. Part of these granites may have solidified from a molten condition 1,000 million years ago, but other parts may have been formed at this time by transformation of still older rocks, which were soaked by hot solutions emanating from the molten bodies, and were thereby recrystallized and replaced by new material.

The Paleozoic Era, which succeeded the time of creation of the Ocoee Series, was likewise a time of formation of sedimentary rocks, but these rocks are now mainly preserved northwest of the Great Smoky Mountains, in the Tennessee Valley. Rocks formed during Paleozoic time do, however, extend into the Great Smoky Mountains in a few places. Chilhowee Mountain, a narrow ridge that lies between the Great Smoky Mountains and the Tennessee Valley (fig. 1) is formed of sandstones and other rocks of the Chilhowee Group that were laid down during the Cambrian Period, or first division of Paleozoic time. In Cades Cove and Whiteoak Sink within the park, and in adjacent Tuckaleechee and Wear Coves (fig. 1) are limestones that were laid down during the Ordovician, or second period of Paleozoic time. In contrast to the lifeless aspect of the rocks of the Ocoee Series, these later, or Paleozoic, rocks contain fossil remains that indicate the existence during the time of sea-living invertebrate animals. Many of the sandstone beds of the Chilhowee Group contain *Scolithus*, or vertical tubes probably bored by worms; these are the oldest indications of life in eastern Tennessee. The Ordovician limestones in Cades Cove contain remains of other invertebrate animals—brachiopods, trilobites, and gastropods.

Within the Ocoee Series itself, other rocks have been introduced at later times. In the stream beds or the soil of the mountains one frequently sees blocks of white, milky quartz, locally known as "flint rock". In the ledges from which the quartz has broken, it lies in veins that have filled fractures and crevices in the sedimentary rocks of the Ocoee Series. As the quartz is less susceptible to erosion than the rocks into which it was introduced, it has remained long after the enclosing material was destroyed by the weather. Penetrating the rocks of the Ocoee Series in much the same manner as the veins are long, narrow bodies of diorite, an igneous rock, or one that entered while in a hot and molten condition. Diorite is common along Hazel and Eagle Creeks in the southwestern part of the mountains. The copper deposits that were formerly mined there (fig. 1) may have been carried in by hot solutions that seeped out from these originally molten dioritic bodies. The vein quartz and the diorite were formed long after the accumulation of the sedimentary rocks of the Ocoee Series, and after the Cambrian and Ordovician Periods, during the time of mountain building that constitutes the next chapter in the history of the Great Smoky Mountains.

Mountain building.—The mountain building took place in the later part of the Paleozoic Era, or about 200 million years ago. During this time powerful movements compressed the crust of the earth in the southern Appalachian region, so that places originally far apart to the northwest or southeast were brought nearer to each other. The sedimentary rocks subjected to the compression were disturbed and changed, and were upheaved into lofty mountain ranges, some of which lay on the site of the present Great Smoky Mountains. These mountains are the first of which there is record in the area; hitherto, it seems to have been low country.

One may observe in figure 5 that the flanks of Mount Le Conte are marked by lines sloping to the right (south). These are lines of stratification that were the surfaces over which successive layers of the Ocoee sediments were spread during the time of rock making. The layers are shown more completely in section B – B', figure 2, a geologic section as worked out by the geologist. While the Ocoee Series was being formed the layers were nearly horizontal; their present slope is a result of later tilting. Elsewhere in the Great Smoky Mountains the effects of even greater disturbance are visible. At Newfound Gap (fig. 1) the layers are turned on end, and at other places they are wrinkled into innumerable small folds and contortions. While the rocks of the Ocoee Series were being disturbed, they were also being transformed by heat and pressure. Along the Little River between Townsend and Elkmont (fig. 1) the slates are no longer composed of clay as they were when first deposited, but are made up largely of flakes of mica, formed by recrystallization (metamorphism) of the original clay constituents. The slaty rocks at many places in the southeast part of the mountains contain small crystals of garnet, likewise formed by recrystallization of the clay.

The mountain-making movements of later Paleozoic time are nowhere more strikingly exemplified than in Cades, Tuckaleechee, and Wear Coves (fig. 1). A view of one of these coves, or flat mountain valleys, is shown in figure 3. Each cove is underlain by Ordovician limestones and associated shales like those in the Tennessee Valley to the northwest, and is surrounded by rocks of the Ocoee Series, which project as ridges and mountains, and which overlie the limestones. These relations are illustrated by section A – A' (fig. 2), in which the Ordovician limestones and shales of Wear Cove are shown to be connected northwestward, beneath the Ocoee Series, with similar rocks in the Tennessee Valley northwest of Chilhowee Mountain.

The Ordovician limestones and shales are younger than the rocks of the Ocoee Series, and originally must have been laid down above it. The abnormal, or reversed, relations have been caused by the development of a great overthrust fault, designated as the "Great Smoky fault" on section A – A'. This originated first as a gently dipping fracture, which cut diagonally through the Ocoee and Paleozoic rocks. Compression of the crust caused the rocks of the Ocoee Series to slide northwestward along the surface of this fracture, until they extended as a sheet or plate many miles over the Ordovician and other Paleozoic rocks. The present coves and their surroundings were thereby covered by the mass of rocks of the Ocoee Series.

During the succeeding time of mountain carving, erosion cut through the overthrust sheet in the cove areas, thereby creating "windows" through which one may look at the overridden Ordovician beneath. Limestone is soluble and poorly resistant to erosion under present climatic conditions of the region, and the windows have therefore been enlarged into the level-floored coves, or valleys, that we now see.

Only the total results of the time of mountain making are now visible, and from these one might conclude that an abrupt catastrophe had then overwhelmed the southern Appalachian region. However, different aspects of the mountain making, such as the metamorphism, folding, and overthrusting, seem to succeed each other rather than to have taken place simultaneously, and the mountains that seeped out from these originally molten dioritic bodies. The vein quartz and the diorite were formed long after the accumulation of the sedimentary rocks of the Ocoee Series, and after the Cambrian and Ordovician Periods, during the time of mountain building that constitutes the next chapter in the history of the Great Smoky Mountains.

Mountain carving.—The next chapter in the history of the Great Smoky Mountains was one of mountain carving, during which the mountains were gradually shaped into their present forms. After the end of the mountain building of Paleozoic time, the crust of the earth became quiet. Nothing comparable to the Paleozoic crustal disturbance took place again in the region. Subsequent history has been one of erosion, by which weathering processes and stream action wore down the mountain ranges of Paleozoic time from their once lofty heights. If the time of mountain building was long, that of mountain carving was still longer, for it embraced the Mesozoic and Cenozoic Eras of geologic time, or about 225 million years.

Because of the great length of time during which mountain carving went on, one might suppose that forces of erosion would long ago have worn the Great Smoky Mountains and southern Appalachian Highlands down to a plain, sloping gently toward the sea. The Great Smoky Mountains are still rugged today, partly because their rocks have resisted removal more than those roundabout, and hence have been worn down more slowly. Also, the whole region has been worn down nearly to a plain several times, but each period of leveling was interrupted by a period when the processes of erosion became active once more, and the streams began to cut into the plain toward lower levels. These revivals of stream activity may have been caused by broad, gentle upwarps that raised the southern Appalachian Highlands above the base level of the sea.

When one stands on some vantage point on the summits of the Great Smoky Mountains, as on Cliff Top, on Mount Le Conte (fig. 4), one sees at first only a tangled confusion of peaks and ridges. Later, one observes that each ridge is separated from the next by a vast gulf, or valley, whose bottom is followed by a mountain torrent a thousand feet or more below. The present ridges and mountains are not caused by upheaval, but by erosion during the time of mountain carving, whereby the valleys have been cut out of the same rock formations as those that still project above them. The landscape of the Great Smoky Mountains is therefore more aptly characterized as being made up of valleys cut between the ridges than of ridges rising between the valleys.

The ridge summits of the Great Smoky Mountains vary in height from place to place by hundreds of feet, yet the crests in each neighborhood rise to more or less the same height. If, in the mind's eye, one can see each deep intervening valley in the view shown in figure 4 filled to the level of the adjacent ridge tops, a hilly or rolling landscape would come into view, with here and there a higher summit projecting above the rest. Whether such a surface ever existed is perhaps conjectural, but if it did it represents the earliest recorded pause in the long chapter of doorcutting.

Remnants of another plain, formed at a later time, are visible at a much lower altitude in the foothills along the north side of the Great Smoky Mountains. As seen in figure 5, the top of each foothill ridge stands at nearly the same height as the others, although the intervening valleys are cut to depths of hundreds of feet below them. These ridges seem to have been formed during a second pause in downcutting, which was again interrupted by the carving of the present stream valleys.

Ice ages of Pleistocene time.—A later chapter in the history of the Great Smoky Mountains has to do with the ice ages of Pleistocene time. The Pleistocene Epoch, with its succession of ice ages and intervening times of more moderate climates, endured for nearly three million years and lingered until about 10,000 years ago. It is thus a mere yesterday when compared with the geologic history already set forth; yet while it endured it imparted to North America an aspect very different from that before or afterward. Broad ice caps buried the northern part of the continent, just as they still bury Greenland and Antarctica in the far north and south, and their edges spread southward as far as the Ohio River. Because of these nearby frigid ice caps, the land farther south had a more rigorous climate than now.

The Great Smoky Mountains were well south of the region of the ice sheets, and seem never to have possessed any glaciers. The time of mountain carving just described was largely completed in the Tertiary Period immediately preceding the ice ages. The gross features of the mountains were therefore much the same during the ice ages as at present, but during that time they were modified in many details.

Some of the steep mountain valleys well up toward the summits are covered by angular boulders of great size, which have been broken from rock ledges higher on the slope. None of these boulders seem to be breaking down or sliding or rolling down the slope today, for they are overgrown by forest, and are decayed and lichen covered. Farther down, near the bases of the mountains, the floors of many of the valleys are studded with other boulders, some as much as 30 feet in diameter and miles from their source, which the streams now flowing there seem unable to move. One may infer that these various boulder deposits are relics of a former time, and were produced by processes no longer at work in the region.

These processes may have been at work during the Pleistocene. The accumulations of angular boulders on the higher slopes resemble those now forming in alpine and subarctic environments above timber line. All the mountains of the Southeastern States are below timber line today, and timber line appears only farther north, as on Mount Washington in New England. During the ice ages, however, those ridges of the Great Smoky Mountains above 4,000 or 5,000 feet may have been bare of forest, a land of snow fields and naked rock. Projecting rocks were then being split by frost action, and were falling and sliding into the boulder fields below. Boulders accumulated in the valleys to such an extent that they could not be removed by streams, although they were urged forward slowly by the freezing, thawing, and heaving of the water-soaked clays that enclosed them.

Time after the ice ages.—The final chapter of the geological story is that of the time after the ice ages, or the Holocene Epoch of geological terminology. Geologically this was a time of transition from the ice ages to the present, an insignificant epilogue following the stirring events of earlier times. Biologically, however, it is the time during which the modern plant and animal life developed in the region, as set forth under the succeeding headings.

PLANT LIFE

Tertiary origins and Pleistocene privations.—Perhaps the outstanding feature of the Great Smoky Mountains is its uninterrupted mantle of dense vegetation. The plants that make up this mantle, to a greater extent than in most regions, are deeply rooted in the past, and provide a link with the bygone geologic ages. The plants of North America during the Tertiary Period (a part of the time of "mountain carving" of the geological story) showed great variety and widespread uniformity, but the unfavorable climate of the succeeding ice ages of Pleistocene time eliminated many species of plants in areas farther north and west. Conditions in the southern Appalachian Highlands were in general less disturbed, so that this region harbored much of the Tertiary flora that was elsewhere destroyed. If, by some magic, a botanist familiar with the modern hardwood forests of the Great Smoky Mountains could be transported back in time, he would find himself quite at home in the North American temperate forests of the later Tertiary.

Because more Tertiary plants have survived in the southern Appalachians than elsewhere, the flora is notable for its great variety. Approximately 1,300 species of flowering plants are known, of which 131 represent native trees—a greater number than is to be found in all of Europe. Various botanical surveys made within the park indicate that the nonflowering plants occurring there include about 50 ferns and fern-allies, 330 mosses and liverworts, 230 lichens, and 1,800 fungi.

Although the climate during the ice ages was less disturbed in the southern Appalachian Highlands than elsewhere, and although the highlands were able to harbor the North American Tertiary flora, conditions there were not unchanged, and living things had to endure many privations. Geological evidence indicates that the higher ridges of the Great Smoky Mountains were above timber line during parts of the ice ages, and the climate there was *s.o* severe that few living things could grow. Spruce and fir forests, ordinarily characteristic of Canadian and other northern latitudes, spread southward into the southern Appalachian Highlands during the ice ages, and in the Great Smoky Mountains probably covered the lower slopes, below the timber line.

Spruce and fir forests.—The spruce and fir forests now dominate the mountain slopes of the eastern half of the Great Smoky Mountains from their crests down to altitudes of about 5,000 feet. Two of the species (*Abies fraseri* and *Picea rubens*) are illustrated on the lefthand side of figure 6. The forests are a dark, somber growth that has earned for the ridges which bear them the local name of "black mountains". A few miles west of Clingmans Dome these forests come to an end, and they are absent farther south and southwest in the southern Appalachian Highlands. More than half of the woody plants that grow in these forests are northern species of the so-called Canadian zone, which reaches its southernmost extension in the Great Smoky Mountains. In ascending the Great Smoky Mountains from their northern edges at altitudes of about 1,500 feet, to their crests, at 5,000 feet or more, one encounters a change in vegetation comparable to that which would be seen in traveling a thousand miles to the north.

Grass balds and heath balds.—Although most of the Great Smoky Mountains are forested, small areas on some of the summits are "bald", or bare of trees, and are covered by a growth of grasses and small shrubs. These "balds" do not indicate timber line conditions, for nearby forested summits stand as high or higher. One is tempted to think of them as relics of some former climatic period, now partly engulfed in the prevailing forest, but their true explanation remains elusive. They have certainly been maintained by exposure to the prevailing winds, and to some extent during the last century by the inhabitants of the mountains, who used them as summer pasturage for stock.

Considerably different from the "grass balds" are other open areas on the ridge crests, locally known as "laurel slicks", or technically as "heath balds". From a distance they appear to be a smooth, grassy carpet; they are in reality an almost impenetrable head-high tangle of rhododendron, mountain laurel, and other members of the heath family, some of which are illustrated on figure 7. Probably no individual laurel slick is very old. They seem to have originated from removal of the forest cover by fire, windfall, or landslide, and they are continually being reclaimed by the encroaching forest. They assume their most spectacular appearance in June, when the predominant Catawba rhododendron is covered with its rose-purple blossoms.

Large trees in the Great Smoky Mountains.—Under the influence of the present favorable climate, and free of interference by man, the forest trees of the Great Smoky Mountains attain great size. The table shows some of the maximum circumferences observed, which were compiled from the records of the National Park Service. The dimensions of these virgin trees give some notion of the appearance of the forests over wide areas of the southern Appalachian Highlands before the coming of the white man.

Maximum observed tree sizes in the Great Smoky Mountains

Common name	Scientific name	Circumference
Tulip tree	Liriodendron tulipifera	24 ft.
Canada hemlock	Tsuga canadensis	19 ft. 9 in.
Cucumber tree	Magnolia acuminata	18 ft. 3 in.
Yellow buckeye	Aesculus octandra	15 ft. 11in.
Yellow birch	Betula lutea	14 ft. 1 in.
Red spruce	Picea rubens	14 ft. 1 in.
Mountain silver bell	Halesia monticola	11 ft. 9 in.
Fraser magnolia	Magnolia fraseri	7 ft. 7 in.
Fraser fir (balsam)	Abies fraseri	6 ft. 7 in.
Sourwood	Oxydendrum arboreum	6 ft. 4 in.
Allegheny serviceberry	Amelanchier laevis	6 ft. 2 in.
American mountain ash	Sorbus americana	5 ft. 6 in.
Pin cherry	Prunus pennsylvanica	4 ft. 11in.

Plant life through the seasons.—One best appreciates the vegetation of the Great Smoky Mountains by studying it through the year and seeing the changes with the passing of the seasons. The flowering period is a long one, with sometimes only a month or two separating the late flowers, such as witch hazel, from early bloomers, such as streamside alders. Then, too, certain plants that come into flower in early spring at lower altitudes may be found in bloom 8 to 10 weeks later along the crest of the range.

April and May is the time of greatest blooming of the wild flowers of the forest floor, such as violet, phacelia, and trillium, and of many trees, such as dogwood, serviceberry, and silver bell. Early to middle June marks the height of bloom of the spectacular Catawba rhododendron of the laurel slicks, and late June the blooming of the brilliant flame azaleas of the high grass balds (fig. 7). The Turk's-cap lily, which may attain a height of 7 to 8 feet, reaches its peak of bloom during the second or third week of July. In mid-October, when the year begins to wane, the leaves of the hardwood trees change their color and transform the mountain sides into variegated carpets of reds and yellows. By November most of the hardwood leaves have fallen and the groves are drab and dull, but colors during the succeeding winter months are afforded by the evergreen leaves of the laurel, holly, and various conifers, and by the winter snow, which occasionally falls over the whole area, and may linger for weeks on the north slopes, shaded from the low winter sun.

ANIMAL LIFE

Like the plant life, the animal life of the Great Smoky Mountains is diverse, and many forms have found sanctuary here from the inroads of mankind. It is, however, of less interest than the plant life, for it resembles that in wide areas elsewhere in North America, and hence is not as deeply rooted in the past of its own locality. Within the mountains dwell more than 50 kinds of fur-bearers, 200 birds, 80 reptiles and amphibians, 80 fishes, and a large group of insects and other invertebrates. Although the coming of the white man has hastened the disappearance of certain large mammals, the number of small and medium-sized species has probably changed but little. Black bears may be as prevalent today as when the country was first settled, and they, along with the bobcats, red and gray foxes, ravens, wild turkeys, ruffed grouse, and duck hawks serve to preserve the wilderness character of Great Smoky Mountains National Park.

OTHER PUBLICATIONS

Additional information on the Great Smoky Mountains is contained in the following publications by the U. S. Geological Survey:

King, P. B., Neuman, R. B., and Hadley, J. B., 1968, Geology of the Great Smoky Mountains National Park, Tennessee and North Carolina: U. S. Geological Survey Professional Paper 587, 23 p., map.
McMaster, W. M. and Hubbard, E. F., 1970, Water resources of the Great Smoky Mountains National Park, Tennessee and North Carolina: U. S. Geological Survey Hydrologic Investigations Atlas, HA 420, 2 sheets.

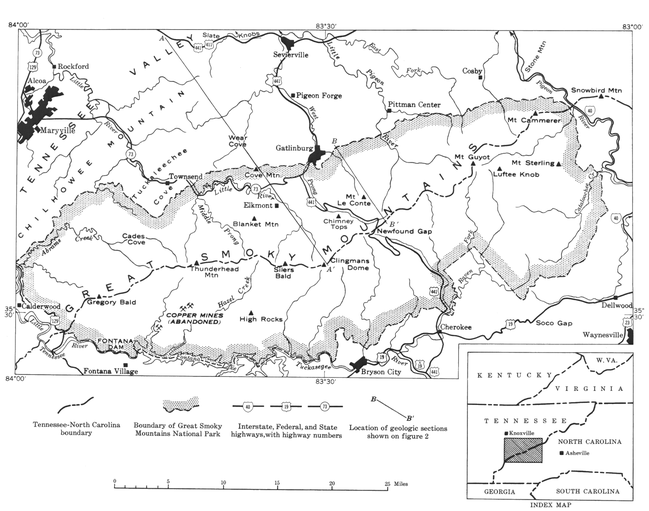

Figure 1.—The Great Smoky Mountains and vicinity, showing the location of many of the places indicated in the text and in the accompanying figures.

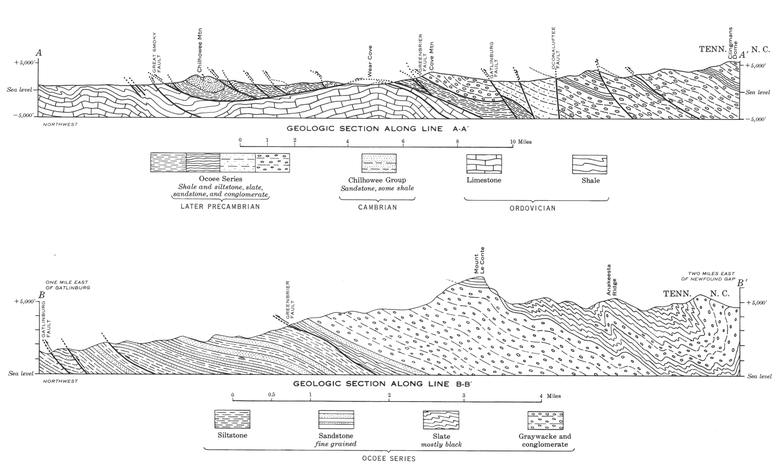

Figure 2.—Geologic sections in the northern part of the Great Smoky Mountains, showing the arrangement of the formations and the manner in which they have been deformed. Stratification is shown by thin lines. Faults, or breaks, are shown by heavy lines, the directions of movement being indicated by arrows. Section A–A' extends from the Tennessee Valley to the crest of the range at Clingmans Dome, and is by P. B. King and H. W. Ferguson. Section B–B' shows in greater detail the features along a line extending from east of Gatlinburg to east of Newfound Gap, and is by J. B. Hadley. Location of sections is shown in figure 1.

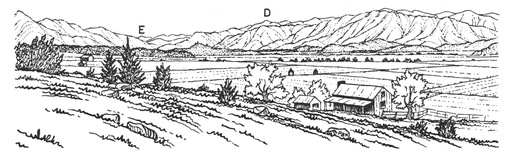

Figure 3.—View of Cades Cove, a limestone valley in the Great Smoky Mountains, looking east-southeast. D is Thunderhead Mountain and E is Blanket Mountain, also shown in figure 4. By P. B. King.

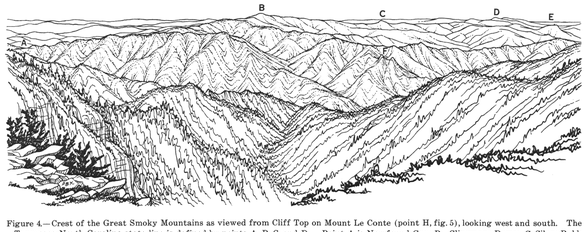

Figure 4.—Crest of the Great Smoky Mountains as viewed from Cliff Top on Mount Le Conte (point H, fig. 5), looking west and south. The Tennessee-North Carolina state line is defined by points A, B, C, and D. Point A is Newfound Gap; B, Clingmans Dome; C, Silers Bald; D, Thunderhead Mountain; E, Blanket Mountain; F, Chimney Tops. By P. B. King.

Figure 5.—The north face of the Great Smoky Mountains as viewed from Fighting Creek Gap, looking east and southeast toward Gatlinburg (G) and Mount Le Conte (H). The difference in altitude between points G and H is more than a mile, and the slope between is one of the most abrupt in the eastern states. By P. B. King.

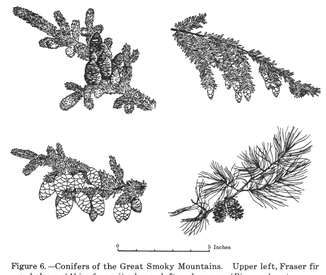

Figure 6.—Conifers of the Great Smoky Mountains. Upper left, Fraser fir or balsam (*Abies fraseri*); lower left, red spruce (*Picea rubens*); upper right Canada hemlock (*Tsuga canadensis*); lower right, pitch pine (*Pinus rigida*). Conifers on left are largely restricted to altitudes above 5,000 feet. Whereas the Fraser fir is restricted in its distribution to the higher mountains of the southern Appalachians, the red spruce occurs northward as far as Ontario and Newfoundland. Conifers on right occur at lower altitudes and are widely distributed in the southern Appalachian Highlands. By J. D. Chaffin and John Scherer.

Figure 7.—Members of the heath family in the Great Smoky Mountains. Upper left, mountain laurel (*Kalmia latifolia*); center, Catawba rhododendron (*Rhododendron catawbiense*); lower right, flame azalea (*Rhododendron calendulaceum*). The first two have evergreen leaves and occur together in the heath balds, or laurel slicks, that form the crests of many ridges. The third is deciduous and is common in the grass balds of the mountain tops. By J. D. Chaffin and Irving Fromer.