THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XIII.—*On the Appalachian Mountain System*; by ARNOLD GUYOT, Professor in the College of New Jersey, Princeton. With a map.

THE remark has been made with justice that the Appalachian or Alleghany system of mountains, although situated in the midst of a civilized, nation is still one of the chains concerning which we have the least amount of positive knowledge. This is especially true respecting the height of the culminating points of different portions of the system. A great number of measurements, have indeed been made within the last thirty years, for the construction of railroads and canals and for other practical purposes, but this net-work of surveys, it is easy to understand, has included only the basis of the system, and the lowest points at which it may be crossed. Everything not connected with practical objects has received but little attention. True, a certain number of barometrical measurements were made a long time ago, chiefly in the north; they have not, however, proved to be exact when compared with the measurements which I have lately made with greater care and under more favorable circumstances. But we must not attribute the rarity and the imperfection of mountain measurements wholly to a want of interest in science or to the absolute preponderance of the utilitarian spirit which characterizes America. It is due, in a considerable degree, to the difficulty, which has existed until within a very few years, of procuring good instruments, and to the obstacles, often very great, which the explorer meets in these wild regions. A chain of thirteen hundred miles in length is a vast field, especially when it includes mountains covered with interminable forests, where a footpath rarely guides the traveller's step, and which it is impossible to cross except with a hatchet in the hand and with a loss of time and strength often quite disproportionate to the results which are obtained. Add to this, that in many parts of the system, the journey is to be made in an unknown region, without a reliable map, far from a human dwelling, rarely penetrated by the most hardy hunters. The explorer must be ready to march without any trusty guide, and to sleep in the open air, exposed to the inclement temperature of the elevated regions, and obliged to depend for nourishment on the food which he can carry with him. In these circumstances the danger of perishing from exhaustion is by no means imaginary, as I know by experience.

In a great portion of the Appalachian chain, especially toward the south, the lofty forests which crown nearly all the summits, and the thick underbrush, literally impenetrable, of Rhododendrons and other evergreens, in which the faint track of the bear is often the only assistance of the traveller, are not less serious obstacles. The difficulty of obtaining general views enabling one to take his bearings in the labyrinth of mountains which cover the country, is thus considerably increased; and the favorable points of observation which are necessary to determine the position of the peaks which are measured or to be measured, and for identifying them in every case are by no means numerous. Besides all this, if the relative height of different culminating points has been determined correctly, there still remains, in order to fix their absolute height, the difficulty of determining the altitude of the points of departure or of the lower stations which are often hundreds of miles from the sea coast.

These various difficulties, or at least some of them, have diminished within the last ten years. Excellent barometers are now made in America and are within the reach of any willing observer. The railroad surveys cross all the principal sections and furnish a great number of points whose altitude is sufficiently determined to serve as a point of departure for measuring the summits throughout nearly the whole extent of the system. Moreover hypsometrical tables adapted to all the barometrical scales, partly compiled and partly computed by the writer, have been published by the Smithsonian Institution, and relieve the observer of the most tedious and time-consuming portion of his task, by reducing the computation of barometrical heights to the simplest arithmetical operation. These tables can be found in the volume of "Meteorological and Physical Tables" which, by the liberality of the Institution, is now accessible to every scientific man.

One of my first labors, on arriving in America, in 1848, was to collect all the measurements of the Appalachian system which had then been published. Except the elevations determined for railroads and canals, nearly all the more remarkable heights which had been measured were in New England or New York, that is to say, in the White, Green and Adirondack mountains. Add to this the secondary heights measured, in considerable number, in Maine, New Hampshire and Massachusetts, a few points in Pennsylvania and Virginia, and some rather vague determinations in North Carolina, by Dr. Mitchell, and we have nearly all the hypsometrical wealth then at the service of the geographer. Massachusetts, the only state in the Union which has had a regular trigonometric survey, furnished besides some geodetic points determined with great accuracy. The same may be said of the admirable work of the Coast Survey still progressing under the skillful direction of Prof. A. D. Bache; but the points geodetically measured are seldom distant from the coast. All the other altitudes which were published had been obtained by barometric measurement.

The comparison of these last soon led me to see in the heights published by different authors such differences as indicated either a confusion of names, or errors in measurement too considerable to be attributed to the formulas employed in calculating, and which could only be attributed to imperfect instruments, or to circumstances too unfavorable for the work which was undertaken. As for detecting the error, when there was a disagreement, it was hopeless; for, since most of the authors gave merely their results, without the observations from which they were deduced, and without describing the instruments employed, or the circumstances of the measurement, a discriminating criticism was impossible. Moreover, the measurements which I had occasion to verify were nearly all found to be affected by errors more or less considerable. I was therefore led to regard them all only as approximations which by no means superseded the necessity of new determinations.

Since 1849, I have devoted my summer excursions to a study of the physical configuration of the Appalachian system, and to the barometric measurement of those points which were most important in the establishment of the laws of its relief. I began with the most remarkable culminating groups, namely, the White Mountains, where I made four excursions in as many different summers, the Green Mountains and the Adirondack. I afterwards visited in three excursions the central and southern portions of Virginia, and the vast group of elevated chains which covers the western part of North Carolina, between the boundaries of Tennessee, Georgia and South Carolina, and which form, as my observations fully show, the culminating region of the whole Appalachian system.

I intend to continue these explorations, so far as circumstances permit, in order to collect sufficient facts for forming a just idea of the normal proportions of the system in all its parts. Meanwhile I present the list of results already obtained, hoping that this preliminary publication will afford some interest to scientific men. At the same time I desire to have it considered as a *resumé* merely of special memoirs in which I shall give the original measurements, and shall indicate the details of the work and the method employed for deducing these results. It is my wish to do my part toward establishing an usage which should be invariable among men of science, to give the elements on which are based the results, which should be in the common treasure of our knowledge. This would furnish to sound criticism the means of determining their proper value. In this particular case, however, such details may be more fitly placed in the transactions of scientific societies.

I present the following altitudes with some degree of confidence. An acquaintance of more than twenty years with the barometer, and the thousands of measurements which I have made in the Alps and elsewhere, have long ago initiated me into the theoretical and practical difficulties of the barometric method and of the instrument itself. In all measurements I have had a double object. I desired not only to obtain an accurate result, but also to perfect the barometric method. I hope I have been able to eliminate some errors and uncertainties which too commonly affect its working, and tend to throw upon the method a degree of distrust which should rather rest upon the observers themselves. At another time I may offer some further remarks upon this subject. At present I will only add that the value of the coëfficients in the formula of Laplace must be slightly modified, in accordance with the more recent determinations of the physical data which it employs, and that the corrections which depend upon the temperature and the hour of the day in which the observations are made, deserve a much closer degree of attention than has hitherto been accorded to them.

In the volume of Physical and Meteorological Tables, published by the Smithsonian Institution, I have mentioned two instances in which my barometric measurements were followed the next year by leveling with a spirit level. This occurred in the two culminating points of the Appalachian system, Mount Washington in the White Mountains of New Hampshire, and the summit of the Black Mountains in North Carolina. The received height of Mount Washington had previously been 6226 feet. My measurements in 1851 gave 6291 feet. The measurements by spirit level, by U. A. Godwin, Civil Engineer, in 1852, gave 6285 feet, and a similar leveling under the direction of the Coast Survey in 1853, gave a height of 6293 feet.

For the Black Dome of North Carolina, the culminating point of the Black Mountains, (lately called also Mitchell's High Peak, but not the former Mount Mitchell,) my measurements in 1856 gave 6702 feet, or, by adopting the modification of the coëfficient just alluded to, 6707 feet. A measurement by spirit level in the following year, 1857, by Major J. C. Turner, Civil Engineer, who had my figures in his hand, and who set out from my point of departure, gave an altitude of 6711 feet.

To these coincidences I may add examples still more recent. Waynesville, the chief town in Haywood County, North Carolina, 27 miles from Asheville, being one of my principal stations for the measurement of all the culminating region of the Appalachian System, I determined its altitude with care by a series of hourly correspondent observations extending through several days, one at Asheville, the other at Warm Springs, thirty-seven miles below the French Broad river, near the boundary of Tennessee, the altitudes of these two points being given by the Survey of the Charleston and Cincinnati railroad which follows the valley of the French Broad, beyond the mouth of the Swannanoa. The Asheville series, in 1859, gave for the altitude of the base of the Waynesville Court House 2756 feet, assuming 2250 feet for the altitude of the Asheville Court House, according to a leveling which I was told had been executed between that point and the railroad track near the bridge of the Swannanoa. This figure of 2756 feet is that which I published early in July, 1860, in an Asheville newspaper. If I adopt the mean of the barometric measurements which I made for determining the elevation of Asheville, I find it to be 2246 feet, and Waynesville becomes 2752 feet. The series of 1860, which began at one of the benches of the railroad at Warm Springs, and which includes an intermediate station at Finescreek, gives also for Waynesville 2752 feet. But Col. Robert Love, of Waynesville, informs me that the altitude of this same point, as given to him by the Engineers of the Western North Carolina railroad, (who had just finished the location of that road,) was also 2752 feet.

I owe to the courtesy of Mr. Presstman, chief assistant of Maj. Jas. C. Turner, Chief Engineer of the road, a communication of the altitude of two other points also included in the list of published elevations, already mentioned, to wit, the summit of the route which crosses the Balsam chain at the upper end of Scott's creek, and the confluence of this creek with the Tuckaseege, twenty miles from Waynesville. In both cases, the railroad levelings agreed within a yard with the barometric measurements, these last being the highest.

These measurements, entirely independent, and proceeding from the same given points, present an argument which is well fitted to inspire confidence in barometric results obtained with fitting precautions.

I scarcely need to add that I cannot pretend to guarantee a similar degree of accuracy in the greater number of heights measured which rest upon a single observation. All those who are acquainted with the hypsometric method fully know that, in the determinations obtained, either by the theodolite, or by the barometer, accuracy is only secured by repetitions so numerous as to permit the elimination of accidental errors incident to the variable state of the atmosphere. I may say, however, that I have taken especial precautions to avoid the two principal causes of error in barometric measurements; namely, the unequal variation, both in time and quantity, of the atmospheric pressure in the corresponding barometers, and again, the errors in the determination of the true mean temperature of the air, at the hour of observation, whether by day or by night. To prevent the first I have taken a special care to locate the corresponding barometers at stations generally distant much less than twenty, and rarely exceeding thirty miles from the points measured. As to the second, when it was not possible to eliminate the errors due to the temperature of the air, by combining observations taken both by day and by night to produce a compensation, I have resorted to the aid of tables formed from a great number of experiments to be mentioned hereafter.

That which induces me to believe that the results resting on a single observation also deserve a good degree of confidence is that having had occasion to repeat the measurement of a great number of points previously determined by careful observations, both in the Black mountains and in the county of Haywood, in different years and under different conditions of the atmosphere, the new results did not differ from those previously obtained by more than one to three yards. When the height of a mountain is known within these limits of approximation the claims of physical geography may be regarded as satisfied.

The barometers which I have employed in these different measurements are a series of Fortin barometers, modified by Delcros, and manufactured by Ernst, at Paris. These instruments, with the exception of one which is my own property, have been imported by myself under the authority of the Smithsonian Institution, for the purpose of determining by direct comparison, the relation between the standard barometer of the observatory at Paris, and the standard barometer intended for the Institution. They have been kindly left at my disposal by the Secretary, for the prosecution of these hypsometrical researches.

These instruments have been compared with the utmost care, not only before and after each excursion, but also during the progress of each, whenever there has been an opportunity. The corresponding observations have always been made with one or the other of the barometers thus compared, and their relative corrections, resulting from the equations thus established, have always been applied in the calculations. A long familiarity with Gay Lussac's syphon barometer, with Bunten's improvement, as well as with Fortin's cistern barometer, modified by Ernst, has convinced me that the latter is to be preferred, notwithstanding its weight and its greater length, if the utmost accuracy compatible with the method is to be sought. The variations of capillary attraction, and the soiling of the tube of the short branch of the syphon by the oxyd of mercury in the Bunten barometer are serious inconveniences. The impossibility of repairing such barometers in case they are injured in travelling, is a still more serious difficulty. I carry with each of my Fortin barometers, two extra tubes and a bottle of purified mercury which enable me in case of accident to reconstruct my barometer in two hours time, even in the depths of the wildest forest. This advantage is of the utmost value in America where every explorer must trust to himself and his own resources, unless he is willing to be constantly deprived of his instruments. It is difficult for me to think coolly of so many scientific expeditions, sent at great expense into unexplored countries, in which observations, even if made with an inferior instrument, would have had great value, but in which all barometric measurements became impossible by the fracture of the instrument at the outset of the journey. Such an excuse, under the ordinary circumstances, of an official expedition, is quite inadmissible.

Such were the considerations which led me to introduce in this country and especially recommend the modified Fortin barometer, when in 1849, '50, '51, I was charged with establishing, in the states of New York and Massachusetts, fifty meteorological stations under the scientific direction of the Smithsonian Institution. Acting in its behalf I superintended the construction of a series of meteorological instruments of which the manufacture was entrusted to a skillful optician, Mr. James Green, of New York, and which are now extensively employed throughout the United States, under the name of the Smithsonian Meteorological Instruments. I especially endeavored to render these instruments strong, simple and adjustable. By the latter phrase, I mean that their construction allows them to be regulated by a standard instrument so as to eliminate the error of zero in the thermometer, and in the barometer the total error due to capillarity and to the peculiarities in the construction of each instrument, so that they will all give immediately absolute values conformed to the same standard, and consequently comparable with one another. In the thermometer it is enough to suspend the tube to the scale by means of a screw, which permits the tube to be moved along the scale until the zero of the mercury coincides with that of the scale. In the barometer I obtain this result by means of a moveable scale which slides upon the brass casing of the barometric tube and which is so placed as to make its indications accord with those of the normal barometer. A line traced on the fixed scale marks the natural height of the column of mercury and makes apparent the value of the applied correction.

Each instrument made by Green, bearing a fixed number, and having been carefully compared with the standard (such, at least is the direction given) its indications may be immediately compared with those of any other of the same maker. This adjustment is evidently important for stationary observations, for it dispenses with the task of reducing by an applied correction each series of observations to a standard scale. For travelling observers and for the measurements of heights the scale of adjustments becomes of no account since it is enough to compare carefully with one another, the barometers which are employed, and to determine their equations, which otherwise are liable to vary and ought to be constantly observed anew. It is consequently better to dispense with the moveable scale, which may be disarranged by the accidents incident to a journey.

After many different experiments, and at the suggestion of Mr. Green, the cistern was modified, and instead of the two parts of the cistern screwing upon each other, a system which occasioned frequent leakage of the mercury, a means of closure by planes of contact was substituted, which not only make leakage impossible, but permit the opening and dismounting of all the parts of the cistern at any time, with the utmost ease. This construction is not only stronger, but it greatly facilitates the cleansing of the mercury, which it is well to attend to frequently. Finally it dispenses with cement and as the cistern is of injected box wood, the evil effects of extreme temperatures and of extreme moisture and dryness are avoided. Barometers of this construction are now in use throughout America, having been substituted for those of Bunten in the army meteorological stations, and having been employed in the numerous expeditions of the Pacific railroad surveys. I accordingly consider the introduction of these instruments at an epoch, when for various reasons, scientific researches were so rapidly increasing in America, as a very fortunate circumstance in enhancing the value of these same observations; for I may add that previous to this epoch, with the exception of a very few instruments imported from Europe, I scarcely found in the hands of the observers in this country a single barometer which had a scientific value.

The preceding details will not be void of interest to those who have occasion to make use of the observations recently made in America in official and other explorations. As for my own observations I would mention that they have been constantly accompanied by corresponding observations made by my young friends who have attended me in the various excursions, and who have studied under my direction the use of the barometer. I ought particularly to mention Mr. Ernest Sandoz, who has been with me in nearly all my excursions, and Mr. Emile Grand Pierre, who was my companion during three summers. I have also received the kind assistance of Dr. Bache, the Superintendant of the Coast Survey, who caused a series of corresponding observations for the measurement of Mt. Washington in 1851, to be made by two of his assistants, Messrs. Edward Goodfellow and B. F. West.

I would also mention Dr. Algernon Coolidge, who accompanied me to the Green Mountains, and to whom I owe, in addition to corresponding observations, the measurement of the Camel Hump. My young friends, Alexander Agassiz, Edward Rutledge, and Herbert Torrey, have given me active coöperation in the White Mountains. To my friend and fellow traveller in the Black Mountains, Rev. W. H. Green, of Princeton, I owe a number of corresponding barometric observations, and likewise a number to Prof. W. C. Kerr, of Davidson College, and to Mr. W. A. Benners, of Waynesville.

The corresponding observations, made by my companions in travel, were taken hour by hour, and sometimes even once every quarter of an hour, so as to allow the construction of a complete barometric curve which represents with great exactness the state of the barometer for any hour of the day, and renders the error of interpolation almost null.

For the purpose of distinguishing accurately the relative position of the regions explored, it may be well to describe the general structure of the system of mountains to which they belong.

The upheavals of ancient rocks which constitute this well connected physical structure, for which, as a whole, it is proper to retain the common name of the Appalachian system, extend in an undulating line thirteen hundred miles in a mean direction of N.E. to S.W., from the promontory of Gaspé upon the Gulf of St. Lawrence to Alabama, where the terminal chains sink down and are lost in the recent and almost horizontal strata of the cretaceous and tertiary formations which cover the greater portion of the surface of this state. This long range of elevations is composed of a considerable number of chains, sensibly parallel to each other, occupying more particularly the eastern part which faces the ocean, and of an extended plateau which prevails towards the west and northwest and descends gradually towards the inland valleys of the St. Lawrence, the lakes Erie and Ontario and the Ohio river.

The base on which this large belt of mountains rests, and which may be considered as bounded by the Atlantic Ocean on one side and by the Ohio and St. Lawrence rivers on the other, is formed, in the east, by a plain slightly inclined towards the Atlantic. The width of that plain, in New England, does not vary much from fifty miles. Near the mouth of the Hudson, however, in New Jersey, it nearly disappears, but gradually increases towards the south to a width of over two hundred miles. Its elevation above the sea, at the foot of the mountains, is in New England, from 300 to 500 feet. From the neighborhood of the bay of New York, where it is nearly on a level with the ocean, it rises gradually towards the south to an altitude of over 1000 feet. On the west the table-lands which border upon the Ohio River, and which may be considered as the general base of the system, preserve a mass-elevation of a thousand feet or more, in the thickness of which the river-bed is scooped out to the depth of from 400 to 600 feet, thus reducing the altitude of the Ohio River full one-half from that of the surrounding lands.

The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which in general, runs parallel to the inflections of its chains with remarkable regularity. This system, composed of a series of corrugations tolerably uniform, does not, like the Alps, or the other great systems of fracture, have a central or main axis, to which the secondary chains are subordinated. But it is properly compared to the system of the Jura, for it is composed like that of a series of long folds, or chains, which run parallel to each other, often with great regularity. In the same part of the system the general height of the chains is sensibly equal and their summits show neither many nor deep notches. In the middle region, especially in Pennsylvania and New Jersey, they present the appearance of long and continuous walls, the blue summits of which trace along the horizon a uniform line seldom varied by any peaks or crags. In the extreme northern and southern portions, however, this character is considerably modified. There the system loses very much of its uniformity and its physical structure becomes far more complicated; the form of simple parallel ridges almost entirely disappears.

There is one feature of the Appalachian system which distinguishes it from the ranges of the Jura; it is the well marked division into two longitudinal zones of elevation, one turned towards the shores of the Atlantic, in which the form of parallel chains just spoken of predominates, and the other turned towards the interior, which is composed of elevated and continuous plateaus, descending from the summit of their eastern escarpment, in the centre of the system, in gentle stages towards the basins of the lakes and the valley of the Ohio. Occasionally minor chains, very little elevated from their base, wrinkle the surface of the table lands. Their parallelism with those of the eastern mountainous zone shows that they are but the last undulations due to the action of the same forces which have upheaved and folded that region, and which have raised at the same time, the mass of these more uniform plateaus. Thus when from any point we traverse the Appalachian system from the Atlantic, we encounter first a plain more and more undulated and gradually ascending to the foot of the mountains; then a mountainous zone with its ranges parallel and its valleys longitudinal; at length a third zone of uniform plateaus slightly inclined towards the northwest, and cut with deep transverse valleys.

Another feature not less conspicuous characterizes the region of corrugations properly so-called. This is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the Great Appalachian valley. At the north it is occupied by lake Champlain and the Hudson river; in Pennsylvania it bears the name of Kittatinny or Cumberland valley. In Virginia it is the Great valley; more to the south it is called the valley of East Tennessee. At the northeast and at the centre its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley towards the southeast is the more continuous and extends without any great interruption from Vermont to Alabama. In Vermont it bears the name of Green Mountains, which it retains to the borders of New York; in the latter State it becomes the Highlands; in Pennsylvania the South Mountains; in Virginia the Blue Ridge; in North Carolina and Tennessee the Iron, Smoky, and Unaka Mountains. On the northwest of the great valley between the latter and the borders of the plateau parallel there extends a middle zone of chains separated by narrow valleys, the more continuous of which is the range which bounds the central valley. This zone has a variable breadth in different parts of the system, and the number of chains which compose it is by no means uniform throughout.

Although these features are common to the Appalachian system throughout its entire length, nevertheless it may be divided from north to south into three *divisions* which present very remarkable differences of structure. Passing the eye over the physical chart which accompanies this article we at once distinguish in the longitudinal extent of the Appalachian system two principal curvatures, the one at the north from Gaspé to New York, the concavity of which is turned towards the southeast; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the southeast; the third from New

River to the southwest extremity of the system, the direction of which is nearly straight or forming a gentle curve concave towards the northwest. These three divisions, diminishing in extent, from the north to the south, are well marked, at the north, by the deep valleys of the Mohawk and the Hudson, which break through the Appalachian system to its base and across its entire breadth; at the south, by the New River whose deep valley with vertical walls also separates regions whose orographic characters present remarkable differences.

The *northern division* is much the most isolated; it is geologically the most ancient, since its upheavals appear coeval with the Silurian and Devonian epochs, and are thus much anterior to the rest of the system, which only emerged after the deposit of the carboniferous rocks which it has elevated. Four hundred feet more of water would separate all the vast territory of the northern division from the American continent. One hundred and forty feet would convert into an island all New England and the British possessions as far as Gaspé; for the bottom of the valley occupied by Lake Champlain and the Hudson does not in any part exceed this level.

I distinguish in this northern portion three physical regions; 1st, the triangular plateau of the Adirondack, with its mountain chains more or less parallel, between Lake Champlain and the St. Lawrence, Lake Ontario and the Mohawk: 2nd, New England, with the two swells of land separated by the deep valley of the Connecticut, and forming the base of the Green and White mountains: 3rd, the northern region, with the prolongation, towards the northeast, of the same features of relief, from the source of the Connecticut through Maine into Canada and New Brunswick to the promontory of Gaspé and the bay of Chaleurs.

The *middle or central division* extends in length about 450 miles. The eastern region, or region of folded chains, at first very narrow about New York, presents towards the centre, in Pennsylvania, its greatest breadth which again diminishes towards the south. It is composed of a considerable number of chains much curved towards the west, and remarkable for their regularity, their parallelism, their abrupt acclivities, the almost complete uniformity of their summits, and their moderate elevation, both relative and absolute, which varies from 800 and 1500 to 2500 feet. The chains, however, increase in elevation towards the south, while they become more numerous and more indented. In the Peaks of Otter, in Virginia, they attain to 4000 feet.

The western region, or the region of plateaus, is quite narrow in the southern part, but acquires towards the north the greatest breadth which it attains in any part of the Appalachian system. Its high terraces occupy all the State of New York south of the Mohawk, and a considerable part of Pennsylvania and culminate in the plateaus in the neighborhood of Lake Erie, where the mean altitude of the plateau reaches 2000 feet, the valleys preserving a height of 1500 feet while the hills reach 2600 feet.

This tableland forms a remarkable water-shed from which the waters descend by the Susquehanna into the valley of the Chesapeake and the Atlantic ocean, by the Genesee and St. Lawrence to the same ocean, and by the Alleghany and Ohio to the Gulf of Mexico. The Susquehanna thus starts from Lake Erie at the extreme western border of the plateau, and runs across all the Appalachian system and its mountain ranges to its eastern base. More to the southward the eastern escarpment of the plateau divides, as far as the sources of the Potomac, the waters of the Atlantic coast from those of the Gulf of Mexico. It is the same escarpment which bears the local name of Alleghany Mountain, a name which continues to be applied, south of the waters of the Potomac, to the dividing ridge along the sources of the various branches of James River, and even to the irregular hills which form a water-shed between the waters of the upper Roanoke and New River, across the Great Valley, near Christiansburg. Through all this middle region the name of Blue Ridge is applied to the main eastern chain which separates the Great valley from the Atlantic slope, and which is cut by all the rivers which flow out of it.

The *southern division*, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only 100 to 300 feet in Pennsylvania, and 500 in Virginia near James river, it is 1000 to 1200 feet in the region of the sources of the Catawba. In the interior of the mountain region the deepest valleys retain an altitude of 2000 to 2700 feet.

From the dividing line in the neighborhood of Christiansburg and the great bend of New River the orographic and hydrographic relations undergo a considerable modification. The direction of the principal parts of the system is also somewhat changed. The main chain which borders the Great valley on the east, and which more to the north, under the name of the Blue Ridge, separates it from the Atlantic plain, gradually deviates towards the southwest. A new chain detached on the east, and curving a little more to the south, takes now the name of Blue Ridge. It is this lofty chain, the altitude of which, in its more elevated groups, attains gradually to 5000 and 5900 feet, which divides in its turn the waters running to the Atlantic from those of the Mississippi. The line of separation, of the eastern and western waters, which, to this point, follows either the central chain of the Alleghanies, or the western border of the tableland region, passes now suddenly to the eastern chain, upon the very border of the Atlantic plain. The reason is that the terrace which forms the base of the chains, and the slope of which usually determines the general direction of the water courses, attains here its greatest elevation, and descends gradually towards the northwest. The base of the interior chain which runs alongside the Great valley is thus depressed to a lower level, and though the chain itself has an absolute elevation greater than that of the Blue Ridge, the rivers which descend from the summits of this last, flow to the northwest towards the great central valley which they only reach, in southern Virginia and North Carolina, by first passing across the high chain of the Unaka and Smoky mountains through gaps of 3000 or 4000 feet in depth.

This southern division thus presents from southeast to northwest three regions very distinct.

The first is the high mountainous region comprised between the Blue Ridge and the great chain of the Iron, Smoky, and Unaka mountains which separate North Carolina from Tennessee. It commences at the bifurcation of the two chains in Virginia, where it forms, at first, a valley of only ten to fifteen miles in breadth, in the southern part of which flows New River; it then enlarges and extends across North Carolina and into Georgia, in length more than 180 miles, varying in breadth from twenty to fifty miles. The eastern chain, or Blue Ridge, the principal water-shed, is composed of many fragments scarcely connected into a continuous and regular chain. Its direction frequently changes and forms many large curves. Its height is equally irregular. Some, groups elevated from 5000 feet and more, are separated by long intervals of depression in which are found gaps whose height is 2200 to 3700 feet, often but little above the height of the interior valleys themselves with which they are connected. The interior, or western chain, is much more continuous, more elevated, more regular in its direction and height, and increases very uniformly from 5000 to nearly 6700 feet.

The area comprised between these two main chains, from the sources of the New River and the Watauga, in the vicinity of the Grandfather Mountain, to the southern extremity of the system, is divided by transverse chains into many basins, at the bottom of each one of which runs one of those mountain tributaries of the Tennessee, which by the abundance of their waters merit the name of the true sources of that noble river.

Between the basin of the Watauga and that of the Nolechucky rises the lofty chain of the Roan and Big Yellow mountains. The northwest branch of the Black mountain and its continuation as far as the Bald mountain separate the basin of the Nolechucky from that of the French Broad river. Between the latter and the Big Pigeon river stretches the long chain of the Pisgah and the New Found mountains. Further to the south the elevated chain of the Great Balsam mountains separates the basins of the Big Pigeon and the Tuckasegee; next comes the chain of the Cowee mountains between the latter river and the Little Tennessee. Finally the double chain of the Nantihala and Valley River mountains separates the two great basins of the Little Tennessee and the Hiwassee. The bottom of these basins preserves in the middle, an altitude of from 2000 to 2700 feet. The height of these transverse chains is greater than that of the Blue Ridge, for they are from 5000 to 6000 feet and upwards; and the gaps which cross them are as high, and often higher than those of the Blue Ridge. In these interior basins are also found groups, more or less isolated, like that of the Black mountains, which, with the Smoky mountains, present the most elevated points of the system.

Here then through an extent of more than 150 miles, the mean height of the valley from which the mountains rise is more than 2000 feet; the mountains which reach 6000 feet are counted by scores, and the loftiest peaks rise to 6700 feet; while at the north, in the group of the White mountains, the base is scarcely 1000 feet, the gaps 2000 feet, and Mount Washington, the only one which rises above 6000 feet, is still 400 feet below the height of the Black Dome of the Black Mountains. Here then in all respects is the culminating region of the vast Appalachian system.

It is worthy of notice that in the Appalachian, as in many other systems of mountains, the culminating points are situated, neither near the middle, nor in the neighborhood of what may be called its central axis, which is here the Great valley, but near the northern and southern extremities, and on the eastern side, almost outside of the system. These culminating regions seem almost exceptions to the normal structure of the system. The high mountainous region of North Carolina which has just been described is, from the bifurcation of the Blue Ridge near the great bend of the New River, an additional fold which attaches itself on the east along the principal chain which bounds the Great Valley, just as the swell, which runs along the east of the Connecticut River, upon which the group of the White mountains is situated, is an additional fold attaching itself to the east of the normal chain of the Green mountains.

The second region of this southern division is the continuation of the Great Central Valley which is divided by a general swell of the land about the sources of the Holston, into two distinct basins, the one in Virginia, narrower and more elevated, which in the basin of the New River, rises gradually towards the south from an elevation of 1600 feet to 2600 feet; the other in Tennessee, where the valley widens to nearly sixty miles between the Smoky mountains and the Cumberland mountains, but where it has a mean elevation of not more than about 1000 feet, that is, only one-half of the height of the neighboring valleys in the mountainous region of North Carolina.

The third region is that of the plateaus which, in Tennessee, are reduced to a table land about thirty or forty miles wide, called the Cumberland mountains on account of the abrupt edges which it presents upon the east and the west, and which give to it the appearance of a mountain chain. Further north, in Virginia, the plateaus expand and fill a vast area to the west of the Clinch and the Cumberland mountains and extend over a part of Kentucky, the central portion of which, near Lexington, preserves an altitude of more than 1000 feet.

The rapid sketch here given shows that in a hypsometrical, as well as from a geological, point of view, and even to a certain extent from its physical structure, the Appalachian system seemed to be divided into two sections of nearly equal extent; a *northern section*, which is geologically more ancient, comprehending the northern division from the mouth of the Hudson to Gaspé; and a *southern section*, which is more modern, comprising the central and southern divisions, which are bound together by more than one characteristic common to both. The separation is distinguished by a remarkable general depression of all the altitudes of the eastern zone, or parallel mountain chains, a depression which attains its lowest point in New Jersey in the parallel of New York City.

Passing from this region, where the Blue Ridge and the Kittatinny mountains are but little more than 800 or 1000 feet high, and the Great valley 50 to 150 feet, the altitude in the northern section increases rapidly, but regularly, towards the northeast, where, almost in the same parallel, lat. 44° N., we find the culminating points at Mount Washington 6288 feet high in the White Mountains, Mount Mansfield 4430 feet in the Green Mountains, and Mount Tahawus or Mount Marcy 5739 feet, in the Adirondack group. Further north the Adirondack group terminates, and the Green Mountains lose somewhat of their continuity, but show here and there, as far as Gaspé, scattered groups of mountains which still preserve an elevation of 3000 or 4000 feet.

In the southern section the altitude increases from the northeast to the southwest with the same regularity but less rapidly, and it is only towards the extremity of the system in North Carolina that they attain their maximum elevation in the Black Mountains 6700 feet, and the Smoky Mountains 6660 feet. Here, as at the north, beyond the culminating points the general altitude is but little diminished until we arrive almost to the termination of the mountains.

The following figures demonstrate the law which I have announced above:

Upon the ridge which borders the Connecticut river on the east and where the elevation gradually increases from the sea coast until it reaches in Connecticut 1000 feet, in Massachusetts 1100 feet, and in New Hampshire 1600 feet at the sources of the Connecticut river, we meet with a series of mountains more or less isolated, which appear to have no other relation to each other than that they are placed on a common base.

The most remarkable of these, proceeding from the south towards the north are the following:

Mount Wachusett, in Massachusetts, - -	2018	feet	high.*
Grand Monadnock, in New Hampshire, -	3718	"	"
Mooschillock " " " - - -	4790	"	"
Lafayette Mount, } Group of - -	5290	"	"
Mount Washington, } White Mountains, -	6288	"	"

In the double chain of Green Mountains are the following remarkable peaks gradually increasing in height from the south to the north:

North Beacon, in the Highlands of the Hudson,	1471	feet	high.
Bald Peak, in Massachusetts, - - -	2624*	"	"
Greylock, or Saddle Mount, in Massachusetts,	3505*	"	"
Equinox Mount, in Vermont, - - - - -	3872	"	"
Killington Peak, " - - - -	4221	"	"
Mansfield Mountain, " - - - - -	4430	"	"

North Beacon was probably measured by Capt. Partridge, the others were measured by myself.

In the Adirondack group I have cited only the most elevated point, Mount Tahawus or Mount Marcy, which is the only one of the great peaks which I have as yet measured. I found its height 5379 feet. This height differs from that of Redfield given in the Geology of the State of New York, (5467 feet), and from that of Prof. T. Benedict, (5341 feet). But it is to be remarked that the heights given by the first are all too great by reason of the defective nature of the instrument employed, as I have had occasion to convince myself; and also that Prof. Benedict, although provided with a Bunten barometer, was only able to make use of corresponding observations made at a considerable distance. From Tahawus the height of the peaks diminishes both towards the north and towards the south and the chains dwindle away before they reach Lake Champlain or the Mohawk River.

In the southern part the law of gradual increase is still more regular. It can also be exhibited at the exterior base of the mountains, along the Great valley, and in the principal chains

* Geodetic points in the triangulation of Massachusetts.

which border it. I have already said that the interior border of the Atlantic plain rises gradually from 50 to 1200 feet, from New Jersey to the upper region of the Catawba, near Morganton. The grade of the railroads gives us in the Great valley a series of significant points:

The Great valley	at Easton, on the Delaware in Penn.,	165 ft.
" " "	near the Schuylkill, Penn.,	250 "
" " "	at Harrisburg, on the Susquehanna,	328 "
" " "	at Chambersburg, Penn.,	600 "
" " "	near Staunton, south fork of Shenandoah, in Central Virginia,	1261 "
" " "	at Salem, in the upper valley of the Roanoke,	1014 "
" " "	Newbern in the valley of New River,	2065 "
" " "	Mt. Airy Ridge, highest point near the sources of the Holston,	2595 "
" " "	Abingdon, in Southern Virginia,	2071 "
" " "	Bristol, on the N. boundary of Tennessee,	1678 "
" " "	Greenville, Tennessee,*	1581 "
" " "	Knoxville, "	898 "
" " "	Chattanooga, "	675 "

The principal chain along the eastern border of the Great valley under the name of Blue Ridge, Iron, Smoky and Unaka Mountains, presents in the same manner an increasing altitude.

Blue Ridge in New Jersey about 1000 to - -	1500	feet.
Peaks of Otter in Virginia, the highest, - - -	3993	"
White Top, on the boundary of Virginia, North Carolina, and Tennessee, - - - - - - -	5530	"
Bald Mountain, west of the Black Mountains, - -	5550	"
Smoky Dome, Clingman's Mountain, culminating point in the chain of the Smoky Mountains, - -	6660	"
Thunderhead, in Smoky Mountains, - - - -	5520	"
Great Bald, highest peak, in Smoky Mountains, near the cut of Tennessee River, - - - - -	4722	"
Hangover, highest peak of the Unaka Mountains, about	5600	"
Great Frog Mountain in Tennessee, highest peak near the south end of the System. - - - - -	4226	"

The chain which from Christiansburg takes the name of Blue Ridge and forms the barrier which separates the waters along the Atlantic plain does not appear to exceed the altitude of 4500 feet in Virginia. This is only an estimate, for I have made no measurements in this portion of the Blue Ridge. In North Carolina the culminating points are much higher, but more to the south they gradually decrease as far as Georgia.

* I am indebted to Prof. Jas. M. Safford, State Geologist of Tennessee, for a statement of the altitudes on the railroads through this State.

Grandfather Mountain, at the sources of the Yadkin and Watauga rivers, measures - - - - -	5897	feet.
The High Pinnacle, which touches the Black Mountain,	5699	"
Great Hogback, at the sources of the Tuckasegee, - -	4792	"
White-Side, near the sources of the Chatooga, - -	4931	"
Mud Creek Bald, near the head of Little Tennessee, Georgia,	4705	"
Tray Mountain, in Georgia, at the sources of Hiwassee River, - - - - - - - - - -	4426	"

Furthermore the transverse chains, which in North Carolina unite the two principal chains, and the interior isolated groups in which the highest summits are found, present altitudes increasing as they proceed, culminating, however, more towards the north.

Roan Mountain, High Knob, which joins the Iron mountain chain on the east, - - - - - -	6306	feet.
Black Dome, or Mitchell's High Peak, the culminating point of the Appalachian System, - - -	6707	"
Richland Balsam, in Big Pigeon Valley, - - -	6425	"
Amos Plott's Balsam, in Tuckasegee valley, - -	6278	"
Yellow Mountain, Cowee Chain, between the Tuckasegee and Little Tennessee valleys, - - - - -	5108	"
Standing Indian, highest point in the Nantihala chain,	5518	"
Fodders' Bald, in Hiwassee valley, Georgia, - -	4821	"

The law of general increase of altitude towards the southwest in all parts of the Appalachian system, is thus fully established; but it is to be remarked that the different elements of which it is composed do not arrive to their maximum of altitude in the same locality nor in the same latitude. The bottom of the Great valley reaches its greatest elevation near the sources of the Holston, at about 37° N. lat. The mass elevation, or terre-plein, culminates in the vicinity of Grandfather and Big Yellow mountains. The isolated groups and intermediate chains, culminate in the Black mountains, a little south of 36° N. lat., although, in this region, the principal chains on the two sides do nowhere rise to 6000 feet; while these last, the Blue Ridge and the Smoky Mountains, reach their greatest mean and absolute height at the north of 35° N. lat., between the valleys of the French Broad and Little Tennessee, in the northern part of Haywood and Jackson counties. Although the high peaks of the Smoky mountains are some fifty feet lower than the isolated and almost exceptional group of the Black mountains, by their number, their magnitude, the continuity and general elevation of the chains, and of the base upon which they repose, they are like a massive and high citadel which is really the culminating region of all the Appalachian system.

To complete this brief review I ought to add that this increasing altitude towards the south which is so well marked in the mountain zone of the Alleghanies, is scarcely observed in the zone of the plateaus. A transverse section from New York to Lake Erie shows that the depression of the system does not extend to the western zone which preserves in appearance a height very nearly uniform, from the plateau of Adirondack in the State of New York as far as to the Cumberland mountains in Tennessee. There is here no well marked region of subsidence as in the eastern zone, but only a tendency to it which is slightly manifested upon a line between the maximum of eastern depression and Pittsburg. It is towards that central line of depression that the Alleghany and Monongahela rivers flow from opposite directions, thus proving the existence of inclined planes which meet about Pittsburg, forming a sort of shallow trough. North of this line the plateaus rise to the sources of the Alleghany and Susquehanna rivers, where, as was said above, they reach an altitude of over two thousand feet; still keeping, further north, on the table-land of Adirondack a mean elevation of 1500 and 1600 feet. Towards the south also the plateaus rise to the sources of the Monongahela. In Virginia and Tennessee they appear to reach 2000 or 2500 feet, at least near the mountains, but the measurements which I possess are too few in number and too uncertain to allow me to speak with certainty on this subject.

This remarkable depression of the Appalachian system in the region noticed, of which the bay of New York is the center, causes a great part of the continental plains, which form the natural base of the mountain folds, to disappear under the waters of the ocean. The waters of the tide thus come to bathe the very base of the mountains, and the region of plains fades away on the frontiers of New Jersey and New York, while towards the south the emerged portion enlarges gradually as it rises according to the law of gradual increase indicated above, so that it reaches a breadth of more than 200 miles in the Carolinas. This depression seems to be due to a local subsidence of the earth crust at an epoch, undetermined, it is true, but which must have been posterior to the principal upheaval of the Appalachian mountains. A fact, the discovery of which is due to the sagacity of Prof. J. D. Dana, seems to give weight to this opinion. He demonstrated by means of numerous soundings marked upon the excellent marine charts published by the U. S. Coast Survey, the existence of an ancient channel, a continuation of that of the Hudson river, which goes out from the bay of New York through the Narrows and advances far out under the waters of the ocean. It is not possible to suppose that such a channel which is constantly liable to be obliterated by sand banks formed by the motion of the sea, could have ever been formed in its present position. In order that the current of the river should excavate this channel it is necessary to suppose that the bottom of the sea has once occupied a higher level, above, or very near the surface of the ocean. The shallowness of the ocean for a considerable distance from the coast of New Jersey also indicates a prolongation of the continental plains under the sea, and the limit of the deep waters is there found at a distance nearly double that which is observed off the coast of the Carolinas. Moreover the parallelism which exists between the line of coasts and all the great general inflections of the Appalachian system, a parallelism which is well marked from Nova Scotia to Florida, here undergoes a modification which is well explained only by a local depression of this part of the system. The fact that all New Jersey is now undergoing gradual submergence from Cape May to the Bay of New York, which is proved by the numerous facts gathered by Prof. G. H. Cook in the Geological Survey of the State of New Jersey, is here not without signification.

The disposition of the relief indicated above would be readily accounted for by supposing that it is the result of a tilting motion from the north to the south, which, while depressing the northern portion below the mean altitude, elevated the southern region in the same proportion, the centre or axis of the tilt being in the vicinity of Christiansburg, near the Great Bend of the New River. As the movement affected more particularly the eastern, or mountainous belt, and not that of the plateaus of the west, the result of it was a twisting, the effect of which was to raise, in the southern part, the mass of the land on the extreme eastern border and thus to produce an inclined plane towards the northwest; while in the northern part, the general depression of the land along the Atlantic, a depression not participated in by the plateaus of the northwest, left to these latter all their altitude and produced an inclined plane from the extreme western border towards the southeast. It is then this particular disposition of these two general slopes which gives us the key of the hydrographic system of the central and southern divisions of the Appalachian mountains, which at the first glance appears so abnormal. In the central section, as has been remarked above, north of New River, the water-shed is situated along the edge of the plateaus in the Alleghany mountain proper in Virginia and Pennsylvania, from which descend the James River and the Potomac; and still further to the west in the plateaus of New York from which flow the Susquehanna and the Delaware, traversing all the chains of the mountainous region to the Atlantic. In the southern division, south of New River, the water-shed between the Atlantic and the Mississippi basin is situated upon the summit of the Blue River at the extreme eastern edge, and the numerous tributaries of the Tennessee which descend from it also traverse the whole mountainous region, but in an inverse direction, from the southeast to the northwest, and, united in the

Great Valley at the very foot of the plateaus of the northwest, flow down by the sole channel of the Tennessee to the basin of the Mississippi.

As many of the nâmes of mountains given below in the list of the heights measured are new, I may be allowed a few words on the subject of mountain nomenclature.

It is a mistake to suppose that names have been given to even the most prominent points in the mountains of the Appalachian system. Just in the wildest and most elevated regions, such as western North Carolina, for instance, the great majority of them have yet to be named. In a country without a regular chart, and in the midst of forests rarely visited, far from any human habitation, and in places where the primitive inhabitants have disappeared, leaving scarcely a trace of their traditions, it is not surprising that this should be the case.

The uniformity of physical configuration in a great portion of the system does not favor distinguishing different parts by specific names. Frequently people are satisfied with giving a name to a mountain range, or to a district of great extent. The observer who measures the height of definite points must do more. In order to make his labors useful, he ought to designate them individually, and determine their position so that they can always be identified, or afterwards traced upon a chart. It is, therefore, almost a matter of necessity for him to sketch such a map while proceeding, and to name, either ill or well, the points determined by his observations. A good geographic nomenclature, however, is not an easy thing; the chart of the United States proves this.

The names of objects in physical geography now in use in this country are essentially of three kinds. The Indian names which have been bequeathed to us by the aborigines, and are applied more commonly to the water courses and lakes, and especially to their towns or districts; descriptive names, as White Mountains, Black Mountains, Green Mountains, which designate entire chains or groups of mountains; and the names of men, which are applied to all. These last are the more numerous.

Wherever an Indian name is in use it ought to be preserved except where, as sometimes happens, its pronunciation is impossible for us. These names, especially in the languages of the south, are often harmonious and they are all significant, but unhappily without meaning for us. In the south they are rarely applied to mountains, although the Indian name of a river which flows near frequently extends to a neighboring chain of mountains. Indian names, designating special mountain peaks, are not common, perhaps because not preserved by the white settlers, who did not live with, but succeeded the Indian population. The more modern descriptive names have the defect of great similarity, for in an extent of thirteen hundred miles the topographical characters are singularly analogous. The multiplication of the same name in all parts of the system becomes here, as in political geography, a serious evil. Green, Blue, and Black mountains are found alike at the south and at the north; White mountain, White face, White side, &c., are also numerous. Chestnut, Oak, Pine mountain and Laurel mountains are found everywhere. In the South, Balsam mountains occur at every step from southern Virginia to Georgia. This name designates a mountain whose summit is covered with *Pinus Balsamifera*, or with its analogous species, *Pinus Frazeri*, which only grow on heights which exceed 5000 or 6000 feet. The Bald Mountains whose summits are destitute of forests, a thing comparatively rare at the south, are yet very numerous. It only remains for the geographer, in order to avoid intolerable confusion, to add to such names another name, or epithet, as Richland Balsam, Smoky Bald, and other similar designations.

These difficulties explain, and excuse perhaps in part, the frequent use in America of names of men to designate places, rivers, and mountains. This course requires the least effort of the imagination. A river without a name commonly takes that of the first planter who erects there his cabin or farm-house, and if there is a remarkable mountain near, it is soon designated by the same name. This is the origin of a great number of the names, more convenient than elegant, of the mountains and valleys of the Alleghanies. It is but recently, since scientific measurements have been made, that the names of men, distinguished either in the political or scientific world, have been given to prominent mountains in New England, in the state of New York and at the South.

The principles which have seemed to me proper and which have guided me in the adoption of names of mountains are to give preference to the name employed in the immediate neighborhood of the point designated. When more than one name has been given to the same point, as happens when it is seen from valleys on two different sides of the mountain, it seems proper for the observer to adopt that name which appears most natural or more euphonic. When the choice lies between the name of a man and that of a name which is descriptive and characteristic, I should choose the latter. In regard to points without established names, but recently named by scientific observers, and not by residents of the country, the right of priority ought to be respected, provided the identity of the points can be sufficiently established, a matter by no means easy, unless the positions have been determined by instruments, or otherwise, with considerable care. But it is evident that popular usage will decide in the last resort and that the name universally adopted will, in time, become that which geography ought to accept. When I have myself given names to mountains, I have almost always preferred a descriptive name to any other; but I acknowledge that the invention of names is a thankless and difficult task. I have, therefore, frequently had recourse to the names of neighboring rivers, or to a fortuitous circumstance, or to some little adventure, connected in my memory with this or that point to designate it, without any other object than that of distinguishing it from every other, since here as elsewhere it is better to accept almost any name rather than to leave it all in confusion.

The map which accompanies this paper was first published in Petermann's *Mittheilungen*, No. vii, 1860: it was drawn, in Gotha, with all the data at his command, by my friend and assistant Mr. E. Sandoz under the kind and skillful direction of Dr. A. Petermann, who by his admirable cartographic labors and manifold services rendered to the science of the physical globe, has long since placed himself among the most useful and scientific geographers of the day. The special map of the Black Mountain has been constructed from my own observations; the points measured having been located by means of a portable theodolite and sextant. In the map of the White Mountains the position of the points measured has been taken from the anonymous map which we owe to Prof. Bond, of Cambridge Observatory, and which was constructed from similar observations by himself. In this new edition of the general map an important correction has been made. The mountain region of North Carolina was engraved anew from a sketch founded upon my observations of 1859 and 1860. A map of that interesting region, on a larger scale, and one of the Black Mountains, showing the position of all the points measured, are in preparation and will be published, together with the discussion and results of the barometric observations, in the Smithsonian Contributions, to which I must refer for further details.

The accompanying list of heights which I have measured is classified according to physical regions. The measurements are of two kinds: those which are marked B are the heights regularly measured by the barometer; those marked P L are heights measured at a distance with a pocket level in the following manner. Wishing to measure a mountain in sight, at a moderate distance, and not exceeding in elevation the one on which I stand, I seek, with the instrument in hand, a point on a level with the summit of the mountain to be measured. Taking then at that point a barometric observation, I consider the result, corrected for the curvature of the earth and for refraction, as the height of the mountain. With an accurate level, a signal upon the mountain, and the knowledge of the exact distance a measurement thus taken would stand the same chance of accuracy as the former; with a pocket level, without a telescope, the results must be considered as approximations which may be very nearly correct, but which also may, according to the distance from which the observation was taken, vary by the height of a tree, that is to say from thirty to fifty feet. They are therefore only preliminary measurements which, while the country remains comparatively unknown, have their proper value in physical geography. I have added for reference a few points marked R R, which are elevations obtained from recent surveys for railroads, and L, which are also determined, for other purposes, by spirit-level. The chart was in part engraved before the revision of the heights given below. New measurements of points previously determined having since taken place, their results ought to have their due influence on the final values. It may happen therefore that there may be found a difference of several feet between the figures given in the table and those inscribed in the map; in those cases the figures given in the table are those which I regard as nearest to the true height. Some ancient measurements of heights in New England have been inadvertently inserted in the chart such as Wachussett 3000 instead of 2018, and some others of this sort which have been recently corrected.

The heights are given in English feet, and above mean tide-water. They are all reduced to the ground, or, for the rivers, to the level of the water.

Culminating Region of the Northern Section.

WHITE MOUNTAINS AND VICINITY.

Western Slope.—Valley of the Amonoosuc.

		Height.
R.R.	Connecticut River, junction with Wells River,	407
R.R.	Bath village,	521
R.R.	Lisbon village,	577
R.R. and B.	Littleton, R. R. station,	817
R.R.	Whitefield, summit between Littleton and Lancaster,	1057
	Whitefield village,	957
R.R.	Lancaster village,	860
R.R.	Israel River, Lancaster bridge, St. Lawrence and Atlantic R. R.	849
B.	Bethlehem village,	1450
B.	Carrol house,	1428
B.	Bethlehem bridge on the Amonoosuc,	1221
P.L.	Brabrook's hotel,	1551
B.	Fabyan's Hotel (old house, now burnt),	1583
B.	Crawford Hotel (Crawford house), White Mt. Notch,	1920
B.	Franconia village, iron foundry,	921
B.	Gilmanton Hill, summit between Franconia and Littleton,	1329
B.	Franconia Valley, crossing of road to Bethlehem,	979
B.	Franconia Notch, Profile house,	1974
B.	Franconia Notch, height of land towards Franconia,	2014
B.	Echo Lake,	1926
B.	Cherry Mt., Summit road,	2192
B.	Cabin, foot of Lafayette Mt.,	1780
B.	Flume house, road front of the Hotel,	1431
B.	Thornton, road opposite the Post Office,	1223
R.R.	Plymouth R. R. station,	473

Eastern Slope.—Valley of the Saco.

		Height.
B.	Notch of White Mts., Crawford house,	1920
B.	The Notch,	1904
B.	Willey house, road opposite the hotel,	1335
B.	Old Crawford's or Davis's hotel,	986
B.	Hart's location, Farm junction, Sawyer's River,	880
B.	Upper Bartlett's Post Office,	644
B.	Crossing of the road's junction of the Saco and Ellis River valleys,	576
B.	South Conway Post Office,	450
Δ	Pleasant Mt., east of Freyeburg, Me. (Coast Survey),	2021

Valleys of Ellis and Sawyer's Rivers.

B.	Jackson Village, hotel foot of the Falls,	771
B.	Pinkham Notch, summit near Glen Ellis Falls,	2018
B.	Junction of Carrigain Brook and Sawyers River,	1494

Northern Slope.

R.R.	Gorham, N. Hampshire, R. R. station, St. Lawrence and Atlantic R. R.,	802
L.	Glenhouse hotel,	1632
B.	Bowman's place, Summit road, between Moose and Israel Rivers,	1446
R.R.	Lowest Summit, R. R. Summit " " " " " "	1473
B.	Peabody River, crossing of path near Glenhouse,	1543
R.R.	Great Androscoggin River at Bethel station,	632
R.R.	Paris station, St. Lawrence and Atlantic R. R.,	396
R.R.	Little Androscoggin River at Danville junction,	276

Mt. Washington, the main chain or the chain of the Presidents, ascending from White Mountain Notch.

B.	Mt. Clinton,	4320
B.	Mt. Pleasant,	4764
B.	Mt. Franklin,	4904
B.	Mt. Monroe,	5384
B.	Mt. Washington, culminating point of northern section,	6288
B.	Mt. Clay,	5553
B.	Mt. Jefferson,	5714
B.	Mt. Adams,	5794
B.	Mt. Madison,	5365
B.	Lake of the Clouds, head waters of Amonoosuc River, foot of Monroe,	5009
B.	Gap between Madison and Jefferson,	4912
B.	" " Jefferson and Adams,	4939
B.	" " Adams and Clay,	4979
B.	" " Clay and Washington,	5417
B.	" " Washington and Monroe,	5100
B.	Little Monroe, W.S.W. of Monroe,	5204
B.	Gap between Franklin and Pleasant,	4400
B.	" " Pleasant and Clinton,	4050
B.	Limit of trees on Washington, N. side, and Madison,	4150
B.	Halfway house on new road, below the Steep slope,	3840
B.	Limit of trees on Clinton,	4250

Secondary chains around the main.—West of Amonoosuc River.

B.	Mt. Deception, near Fabyan's,	2449
P.L.	Cherry Mt., approximately,	3670

Chain, East of Peabody R. and Glenhouse.

P.L.	Wildcat Mt.,	4350
P.L.	Mt. Carter, South Peak,	4830
P.L.	Mt. Carter, North Peak,	4702
P.L.	Mt. Morijah,	4653
P.L.	Crawford Mt.,	3134

Chains South of the Amonoosuc River.

P.L.	Echo Mt., highest point,	3170
P.L.	The Villey, or Notch chain, the lowest or 3d N.W. peak,	4070
P.L.	Middle or highest peak, very much as Clinton by level about,	4330
P.L.	Willey Mt. proper, 1st or East peak,	4300
P.L.	Twin Mt., the highest peak,	4920

South side, between Saco Valley and Merrimac River.

		Height.
B.	Carrigain Mt.,	4678
B.	Summit of Eastern Spur,	4419
P.L.	Brick house Mt., in the line N.E. 2 miles from Carrigain,	3850
P.L.	Pemigewassett Peak,	4420
P.L.	Tremont Mt.,	3393
P.L.	Green's Cliff,	2958
P.L.	Table Mt., 3 miles S.S.E. of Hart's ledge,	3305
P.L.	Sandwich Dome, above Campton,	3969
P.L.	Mad River peak, head of Mad River,	4397
P.L.	Whiteface, N.E. peak, the highest,	4030
P.L.	Tripyramid, N.W. of Whiteface, S. of Carrigain,	4086
P.L.	Chicorua, highest peak south,	3540

Group of Franconia Mts.

P.L.	Eagle Cliff, facing the Profile house,	3446
B.	Eagle head, near the pond,	4216
B.	Eagle pond, foot of last peak,	4170
B.	Lafayette or Great Haystack,	5290
B.	" " " South peak,	5101
P.L.	Summit of Blue or Bog-Eddy Mt., the highest part of the chain of Cannon, Kinsman and Blue Mt.,	4370
P.L.	Kinsman Mt. about	4200
B.	Cannon Mt., the prospect, appr.,	3850

West and South of the White Mts.

B.	Moose hillock, highest peak north,	4790
P.L.	Carr's Mt., highest summit,	3480
P.L.	Owl's head,	2950
P.L.	Webster side, south side of the R. R. opposite,	2210
B.	Highest farm foot of Moose hillock S.,	1681
R.R.	Warren Village,	736
R.R.	Summit of Road,	1063
R.R.	East Haverhill,	773
R.R.	Woodville R. R. station opposite Wells' River,	448
R.R.	Connecticut low water, " " "	407
R.R.	Rumney R. R. station,	520
R.R.	Plymouth village, R. R. station,	473
R.R.	Meredith Village,	542
R.R.	Concord, N. Hampshire, R. R. station,	237

Redhill and Winnipeseogee Lake.

R.R. and Canal.	Lake Winnipeseogee, mean level,	501
B.	Senter house at Centre Harbor, Lake Winnipeseogee,	553
B.	Eastern summit of Redhill,	1769
B.	Western summit " "	2025

GREEN MOUNTAINS.

B.	Manchester R. R. station,	713
B.	" Village courthouse,	864
B.	Equinox Mt., highest peak,	3872
R.R.	Rutland R.R. station,	530
B.	Herrick Mt., near Rutland,	2692
B.	Shrewsbury Peak,	3845
B.	Pico Mt., north of Killington,	3954
B.	Killington Peak,	4221
R.R.	Waterbury R. R. station,	425
P.L.	Hogback Mt.,	3648
B.	Stowe Village, foot of Mansfield Mt.,	700
B.	Mansfield Mt., the Nose,	4094
B.	Mansfield Mt., the Chin, highest,	4430
P.L.	Sterling Chain,	3700
B.	Camel Hump,	4088
P.L.	Lincoln Mt.,	4078

PLATEAU AND MOUNTAINS OF ADIRONDACK.

Profile from Lake Champlain to Mt. Tahawus from E. to W. by N.

		Height.
L.	Lake Champlain, mean level,	93
B.	Crown Point tavern,	206
B.	Bradford farm, road summit,	695
B.	Amyhill summit road,	844
B.	Buckhollow, hamlet water of Putnam Creek,	719
B.	Penfield, water of Putnam Creek,	910
B.	Height of land dividing the Hudson and St. Lawrence waters,	1199
B.	Hammond's furnace,	1132
B.	Paradox Creek at Hammond's saw-mill,	911
B.	" " " crossing of road from Paradox Lake to Root's,	873
B.	Summit of road between Paradox crossing and Johnson's pond,	1256
B.	Johnson's pond,	964
B.	Summit of road between Johnson's pond and Root's in Schroon valley,	1262
B.	Root's farm, ground, in Schroon Valley,	842
B.	Sturtevant's mill on Mud creek,	1113
B.	Mudpond creek,	1206
B.	Summit of road between Mud creek, crossing of French's,	2013
B.	French's farm, road before,	1962
B.	Grand Boreas river, bridge,	1736
B.	Summit road, west of Boreas river,	1935
B.	Lake Sanford at Millpond,	1731
B.	Adirondack Village, or McIntyre's iron-works, hotel,	1785
B.	Summit above Beaver Marsh,	2782
B.	Lake Colden,	2786
B.	Hudson River, Great Bend,	3264
B.	Limit of trees on Mt. Marcy and Whiteface,	4851
B.	Mt. Tahawus or Mt. Marcy,	5379
L.	Lake Henderson,	1829
L.	Head of Falls,	2550
L.	Surface of Beaver marsh,	2677
L.	Summit above Beaver marsh,	2762
L.	Surface of opalescent River (Hudson),	2744

These last five altitudes are derived from levels above Lake Sandford taken by Prof. E. N. Horsford.

Culminating Region of the Southern Section.

THE BLACK MOUNTAINS AND VICINITY.

Valley of the Swananoa.

R.R.	Junction of Flat Creek with Swananoa River,	2250
B.	Joseph Stepp's house,	2360
B.	Burnett's house,	2423
B.	Lower Mountain house, Jesse Stepp's house, floor of Piazza,	2770
B.	W. Patton's cabin, end of carriage road,	3244
B.	Resting place, brook behind last,	3955
B.	Upper Mountain house,	5246
B.	Passage, main branch of Swannanoa above Stepp's ascending to	
B.	Toe River Gap,	3902

In the Blue Ridge.

B.	Toe River Gap, between Potatoe Top and High Pinnacle,	5188
B.	High Pinnacle of Blue Ridge,	5701
B.	Rocky Knobs, south peak,	5306
B.	Big Spring on Rocky Knobs,	5080
B.	Greybeard,	5448

Craggy Chain.

B.	Big Craggy,	6090
B.	Bull's Head,	5935
B.	Craggy Pinnacle,	5945

The Black Mountain, main chain.

B.	Potatoe Top,	6393
B.	Mt. Mitchell,	6582
B.	Mt. Gibbs,	6591
B.	Stepp's Gap, the cabin,	6103

		Height.
B.	Mt. Hallback (or Sugarloaf),	6403
B.	Black Dome (or Mitchell's high peak, or Clingmann of State map),	6707
B.	Dome Gap,	6352
B.	Balsam Cone (Guyot of State map),	6671
B.	Hairy Bear,	6610
B.	Bear Gap,	6234
B.	Black Brother (Sandoz of State map),	6619
B.	Cattail Peak,	6611
B.	Rocky Trail Gap,	6382
B.	Rocky Trail Peak,	6488
B.	Cattail Gap,	5720
B.	Deer Mt., North Point,	6233
B.	Long Ridge, South Point,	6208
B.	" " Middle Point,	6259
B.	" " North Point,	6248
B.	Bowlen's Pyramid North End,	6348
	The Black Mountain, Northwestern Chain.	
B.	Blackstock Knob,	6380
B.	Yeates's Knob,	5975
B.	Cock's Comb,	5426
	Caney River Valley.	
B.	Green ponds at Th. Wilson's, highest house,	3222
B.	Th. Wilson's new house,	3110
B.	Wheelers' opposite Big Ivy Gap,	2942
B.	Cattail fork Junction with Caney River,	2873
B.	Sandofer Gap or low Gap, Summit of Road,	3176
B.	Burnsville, courtsquare,	2840
B.	Green Mountain near Burnsville, highest point,	4340
	Group of the Roan Mountain.	
B.	Summit of Road from Burnsville to Toe River,	3139
B.	Toe River ford on the Road from Burnsville to the Roan Mountain,	2131
B.	Baily's farm,	2379
B.	Brigg's house foot of Roan Mt., Valley of Little Rock creek,	2757
P.L.	Yellow Spot above Brigg's,	5158
P.L.	Little yellow Mount, highest,	5195
B.	The cold spring summit of Roan,	6132
P.L.	Grassy Ridge Ball N.E. continuation of Roan Mt.,	6230
B.	Roan high Bluff,	6296
B.	Roan high Knob,	6306
	From Burnsville to Grandfather Mountain.	
B.	South Toe River Ford,	2532
B.	Toe River; ford near Autrey's,	2547
B.	North-Toe River ford, below Childsville,	2652
B.	Blüe Ridge, head of Brushy creek,	3425
B.	Linville river ford below head of Brushy creek,	3297
B.	Linville River at Piercy's,	3607
B.	Headwaters of Linville and Watauga River, foot of Grandfather Mt.	4100
B.	Grandfather Mt. summit,	5897
B.	Watauga River at Schull's millpond,	2917
B.	Taylorsville, Tennessee,	2395
B.	White Top, Virginia, corner of Tenn. and N. Car.	5530
	From Burnsville to the Bald Mt.	
B.	Sampson's Gap,	4130
B.	Egypt cove at Proffitts,	3320
B.	Wolfs' camp Gap,	4359
B.	Bald Mt. summit of highest peak,	5550

These four points computed by me from observations made by Prof. W. C. Kerr of Davidson College.

	Valley of the Big Ivy Creek.	
B.	Dillingham's house, below Yeates' Knob, or Big Butte,	2568
B.	Junction of the three forks of Big Ivy,	2276
B.	Salomon Carter's house,	2215
B.	Stockville, at Squire Black Stocks',	2216
R.R.	Mouth of Ivy River, by Railroad survey,	1684

REGION OF THE GREAT BALSAM MOUNTAINS.

		Height.
	From Asheville to Mt. Pisgah.	
B.	Asheville courthouse,	2250
B.	Sulphur springs, the spring,	2092
B.	Hominy cove at Salomon Davis's,	2542
B.	Little Pisgah west,	4724
B.	Great Pisgah,	5757
	Big Pigeon Valley.	
B.	Forks of Pigeon at Col. Cathey's,	2701
B.	East fork of Pigeon, at Cap. Th. Lenoir's,	2855
B.	Waynesville, courthouse,	2756
B.	Sulphur spring, Richland Valley, at James Love's, Esq.,	2716
B.	Mr. Hill's farm, on Crabtree creek,	2714
B.	Crab Tree creek, below Hill's farm,	2524
B.	Cold Mountain,	6063
	Chain of the Richland Balsam, between Richland Creek and Big Pigeon River.	
B.	Richland creek, at E. Medford's,	2938
B.	E. Medford's farm, foot of Lickstone Mt.,	3000
B.	Lickstone Mountain,	5707
B.	Deep Pigeon Gap,	4907
B.	Cold Spring Mountain,	5915
B.	Double Spring Mt.,	6380
B.	Richland Balsam, or Caney fork Balsam divide,	6425
B.	Chimney Peak,	6234
B.	Spruce Ridge Top,	6076
B.	Lone Balsam,	5898
B.	Old Bald, head of Richland Creek,	5786
	Chain of Westener Bald.	
B.	Westener Bald North Peak,	5414
B.	" " " Pinnacle,	5692
	Great Middle Chain of Balsam Mountains between Scott's Creek and Soco Creek.	
B.	Enos Plott's farm North foot of chain,	3002
B.	Old Field Mountain,	5100
B.	Huckelberry Knob,	5484
B.	Enos Plott's Balsam first Balsam North End,	6097
B.	Junaleska, or Jones' Balsam N. Point,	6223
B.	" " S. End,	6055
B.	Rockstand Knob,	6002
B.	Brother Plott,	6246
B.	Amos Plott's Balsam, or Great divide,	6278
B.	Rocky-face,	6031
B.	White-Rock Ridge,	5528
B.	Black-Rock,	5815
B.	Panther-Knob,	5359
B.	Perry Knob,	5026
	Valley of Scott's Creek.	
B.	Love's Sawmill, on Richland Creek,	2911
B.	Maclure's farm " "	3285
B.	Road Gap head of Scott's Creek,	3357
B.	John Brown's farm, Scott's Creek Valley,	3049
B.	Bryson's farm,	2173
B.	John Love's Esq., farm,	2226
B.	Webster Courthouse,	2203
	Valley of Tuckasegee and tributaries.	
B.	Tuckasegee River and mill below Webster, near road to Qualla,	2004
B.	Junction of Savannah creek,	2001
B.	" " Scott's creek,	1977
B.	Quallatown, main store,	1979
B.	Soco River, ford to Oconaluftee,	1990
B.	Soco Gap, road summit,	4341
B.	Amos Plott's farm, in Jonathan's Creek Valley,	3084

		Height.
B.	Oconaluftee River, junction Bradley fork,	2203
B.	Robert Collins, Esq., highest house,	2500
B.	Junction of Ravens, and Straight forks,	2476
B.	Junction of Bunch's creek,	2379

CHAIN OF THE GREAT SMOKY MOUNTAINS.

North of Road Gap.

B.	Luftee Knob, head of straight fork of Oconaluftee River,	6232
B.	Thermometer Knob,	6157
B.	Ravens Knob,	6230
B.	Tricorner Knob,	6188
B.	Mt. Guyot, (so-named by Mr. Buckley), in Tennessee,	6636
B.	Mt. Henry,	6373
B.	Mt. Alexander,	6447
B.	Mt. Alexander, South peak,	6299
B.	The Three Brothers, highest or central peak.	5907
B.	The Thunderknob,	5682
B.	Laurel peak,	5922
B.	Reinhardt Gap,	5220
B.	Top of Richland Ridge,	5492
B.	Indian Gap,	5317
B.	Peck's peak,	6232
B.	Mt. Ocona,	6135
B.	Right hand, or new Gap,	5096
B.	Mt. Mingus,	5694

Group of Bullhead, Tennessee.

B.	Central peak or Mt. Leconte,	6612
B.	West peak, or Mt. Curtis,	6568
B.	North peak, or Mt. Safford,	6535
B.	Cross Knob,	5931
B.	Neighbor,	5771
B.	Master Knob,	6013
B.	Tomahawk Gap,	5450
B.	Alum Cave,	4971
B.	Alum Cave creek junction with little Pigeon River,	3848

Great Smoky Mountains, South of Road Gap.

B.	Road Gap,	5271
B.	Mt. Collins,	6188
B.	Collins Gap,	5720
B.	Mt. Love,	6443
B.	Clingmann's Dome,	6660
B.	Mt. Buckley,	6599
B.	Chimzy Knob,	5588
B.	Big Stone Mt. head of Forney Ridge,	5614
B.	Big Cherry Gap,	4838
B.	Corner Knob,	5246
B.	Forney Ridge peak,	5087
B.	Snaky Mountain,	5195
B.	Thunderhead Mountain,	5520
B.	Eagle Top,	5433
B.	Spence Cabin,	4910
B.	Turkey Knob,	4740
B.	Opossum Gap,	3840
B.	North Bald,	4711
B.	The Great Bald's Central Peak, near the Gap of Little Tennessee,	4922
B.	" " " South Peak,	4708
B.	Tennessee River, Hardin's,	899
B.	Chilhowee Mt. Summit road to Montvale Springs,	2452
B.	Montvale Springs Tennessee, Main Building,	1293

The numerous altitudes measured in the summer of 1860 during an exploration of two months not being ready for publication, will be given in another communication.

Princeton, New Jersey, January, 1861.


PHYSIKALISCHE KARTE
DES
ALLEGHANY - SYSTEMS.
Nach allen vorhandenen Messungen und Untersuchungen
gezeichnet von
ERNEST SANDOZ.
(Das unterseeische Terrain von A. Petermann.)
Maasstab 1:6.000.000
Deutsche Meilen (15 = 1°)
See Meilen (60 = 1°)
Die Zahlen bezeichnen die Höhe über dem Meere und ebenso die Tiefe unter dem Meere in Engl. Fuss.
KARTE
der
WHITE MOUNTAINS
(WEISSEN BERGE)
zur Übersicht der Höhenmessungen
von
Professor A. Guyot.
Maasstab 1:600000
Seemeilen (60 = 1°)
ORIGINALKARTE
der
BLACK MOUNTAINS
(SCHWARZEN BERGE)
zur Übersicht der Höhenmessungen
von
Professor Arnold Guyot.
Maasstab 1:600000
Seemeilen (60 = 1°)
Westl. Länge von Greenwich
Westl. Länge 80 von Paris
C A N A D A
ATLANTIC OCEAN
L. ONTARIO
LAKE ERIE
MISSOURI
ILLINOIS
INDIANA
ARKANSAS
Long Island
Sandy Hook
Philadelphia
C. Henlopen
C. May
C. Henry
C. Charles
C. Hatteras
C. Lookout
C. Ann
C. Cod
C. Sable
Montauk Pt.
Nashville
Raleigh
Niagara Fall
Toronto
Kingston
Bay of Fundy
Northumberland Strait
Prince Edward Id.
Mt. Washington
Asheville 2250
Morganton
Marion