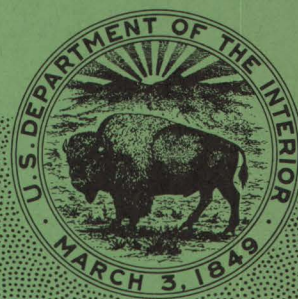


GEOLOGICAL SURVEY CIRCULAR 646



Origin of the
Brown Mountain Light
in North Carolina

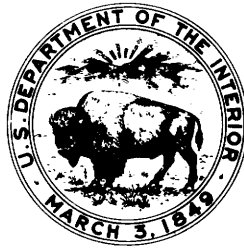
Origin of the Brown Mountain Light in North Carolina

By George Rogers Mansfield

G E O L O G I C A L S U R V E Y C I R C U L A R 6 4 6

United States Department of the Interior

ROGERS C. B. MORTON, *Secretary*



Geological Survey

W. A. Radlinski, *Acting Director*

Brown Mountain--in the Blue Ridge country of western North Carolina--is the stage and setting for the intermittent performances of the "mysterious lights" that have provoked legend and song since the beginning of the century. In 1922, responding to a general interest in the lights, the U.S. Geological Survey sent geologist George R. Mansfield to Brown Mountain to undertake a thorough investigation of the reported phenomenon. Mansfield's method of study and his conclusions were released to the press in 1922. Because of the present interest in Brown Mountain shown by visitors to this scenic area, George R. Mansfield's report to the press is reproduced here just as it was written a half century ago.



CONTENTS

	Page		Page
Government investigations made---	1	Proposed explanations-----	7
Aid received in this		The investigation in 1922-----	10
investigation-----	1	Methods employed-----	10
Topography of Brown Mountain----	2	Observations at Loven's-----	12
Geologic features-----	2	Observations at Gingercake	
Records of earlier observations--	2	Mountain-----	12
Review of earlier observations---	5	Observations at Brown	
Places of observation-----	6	Mountain-----	14
Nature and appearance of the		Conclusions-----	15
light-----	7		

ILLUSTRATION

	Page
Figure 1. Map of Brown Mountain region, N.C., illustrating origin of "Brown Mountain lights"-----	3



Origin of the Brown Mountain Light in North Carolina

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GOVERNMENT INVESTIGATIONS MADE

For many years "mysterious lights" have been seen near Brown Mountain, in the northern part of Burke County, N.C., about 12 miles northwest of Morganton. Some have thought that these lights were of supernatural origin; others have dreamed that they might indicate enormous mineral deposits; and many who have not had such visions have looked upon them as a natural wonder that lent interest to all vacation trips to the region.

In October 1913 at the urgent request of Representative E. Y. Webb, of North Carolina, a member of the U.S. Geological Survey, D. B. Sterrett, was sent to Brown Mountain to observe these lights and to determine their origin. After a few days investigation Mr. Sterrett declared that the lights were nothing but locomotive headlights seen over the mountain from the neighboring heights. This explanation was too simple and prosaic to please anyone who was looking for some supernatural or unusual cause of the lights, and when they were seen after the great flood of 1916, while no trains were running in the vicinity, even some of those who had accepted Mr. Sterrett's explanation felt compelled to abandon it.

As time went on, the interest in the lights became more general, and as one

after another local investigator failed to discover their origin, the mystery seemed to grow deeper. Finally Senators Simmons and Overman prevailed upon the Geological Survey to make a second and more thorough investigation of these puzzling lights. The present writer, to whom the task of making this investigation was assigned, spent 2 weeks near Brown Mountain in March and April 1922 and took observations on seven evenings, on four of them until after midnight, from hillsides that afforded favorable views of the lights. The results of the work are reported here.

AID RECEIVED IN THIS INVESTIGATION

The writer gratefully acknowledges his indebtedness to Messrs. R. T. Claywell, A. M. and Charles Kistler, and H. L. Millner, of Morganton, who gave him much information and assisted him in many ways in his investigation. Joseph Loven, of Cold Spring, and H. C. Martin, of Lenoir, accompanied him on some of the evenings of observation. G. E. Moore, of Lenoir, furnished valuable information. F. H. May, of Lenoir, organized a party to accompany him to the summit of Brown Mountain and generously rendered much valuable aid. Monroe Coffey and Theodore Crump, of the U.S. Forest Service, extended to him the hospitality of their camp on Brown Mountain and joined in the investigation.

¹Issued in 1922 as Press Notice 14328.

Drs. W. J. Humphreys and Herbert Lyman and Mr. C. F. Talman, of the U.S. Weather Bureau, obligingly furnished correspondence and unpublished manuscript relating to the Brown Mountain light, and W. W. Scott, of Washington, kindly lent a scrapbook containing copies of his own and other published articles relating to Brown Mountain.

The writer is also indebted to his colleagues of the Geological Survey for helpful suggestions and discussions, particularly to Arthur Keith for information about the geology of the Brown Mountain region and to R. H. Sargent, J. B. Mertie, Jr., and A. C. Spencer for aid in the interpretation of instrumental observations.

TOPOGRAPHY OF BROWN MOUNTAIN

The shape and general elevation of Brown Mountain are shown on the accompanying map. Its eastern ridge forms part of the boundary between Burke and Caldwell Counties. Its top is plateaulike and reaches a maximum elevation of about 2,600 feet. It is partly cut away by southward-flowing branches of Johns River and is separated from more intricately carved uplands on the northwest, north, and northeast by Upper and Wilson Creeks and their tributaries. Seen from a distance from almost any direction, Brown Mountain appears as a ridge having a nearly even skyline. (See map, fig. 1.)

GEOLOGIC FEATURES

The geologic features of the Brown Mountain region are the southward extension of the features seen farther north, which are described and mapped in the Cranberry folio, No. 90 of the series of folios of the Geologic Atlas of the United States. There is nothing unique or unusual in the geology of Brown Mountain. Most

of the mountain is composed of the Cranberry Granite, a rock which also underlies many square miles on the north side of the Blue Ridge.

The Caldwell Power Co. has drilled a series of holes, 50 to nearly 100 feet deep, along the lower part of the east slope of Brown Mountain preliminary to the location of a tunnel. Through the kindness of H. L. Millner, an officer of the company, the writer was permitted to examine the cores taken from these holes. Most of them consisted of ordinary granite, though a few included masses of rock of other kinds. The men who surveyed the line for the tunnel reported local magnetic attraction amounting to a deflection of about 6° , but though representative pieces of all the different kinds of cores were presented to the compass needle, they produced no noticeable effect. Dip-needle tests made to determine magnetic conditions at Brown Mountain gave readings of $41\frac{1}{2}^{\circ}$, which is slightly greater than those made at Loven's or at Gingercake Mountain (40°) but less than those made at Blowing Rock (43°) and at the Perkins place, near Adako (45°).

RECORDS OF EARLIER OBSERVATIONS

So far as the writer is aware the first published account of the light was given in a dispatch from Linville Falls to the Charlotte Daily Observer, dated September 23, 1913, in which its discovery is credited to members of the Morganton Fishing Club, who saw it "more than two years ago" but who were "laughed at and accused of seeing things at night." This account is quoted in part below:

"The mysterious light that is seen just above the horizon almost every night from Rattlesnake Knob, near Cold Spring, on the Morganton road * * * is still baffling all investigators * * *. With punctual regular-

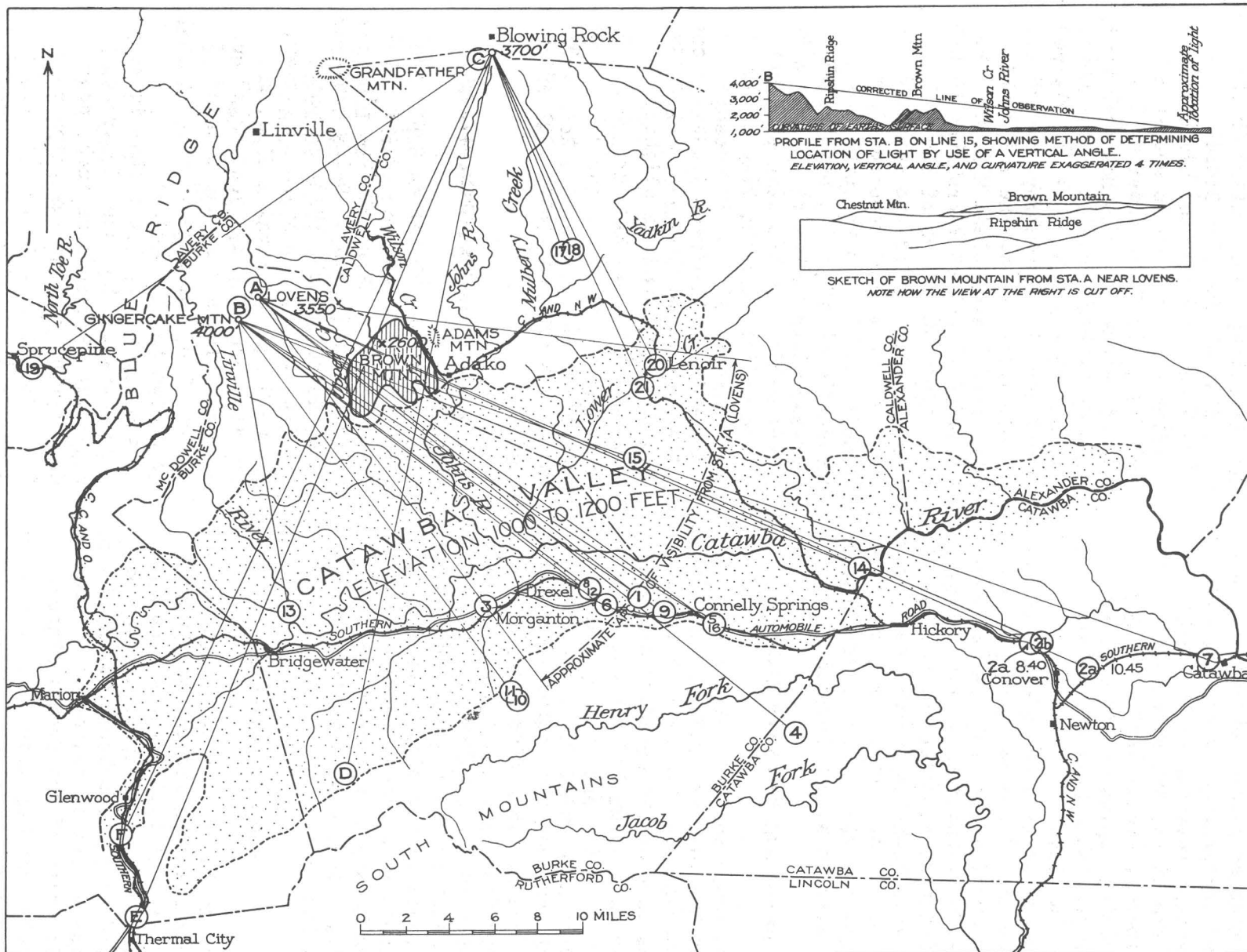


Figure 1.--Map of Brown Mountain region, N.C., illustrating origin of "Brown Mountain lights."

ity the light rises in a southeasterly direction from the point of observation just over the lower slope of Brown Mountain, first about 7:30 p.m. and again at 10 o'clock. It looks much like a toy fire balloon, a distinct ball, with no atmosphere about it.

* * * It is much smaller than the full moon, much larger than any star and very red. It rises in the far distance from beyond Brown Mountain, which is about 6 miles from Rattlesnake Knob, and after going up a short distance, wavers and goes out in less than 1 minute * * *. It does not always appear in exactly the same place, but varies what must amount in the distance to several miles. The light is visible at all seasons, so Mr. Anderson Loven, an old and reliable resident testifies * * *. There seems to be no doubt that the light rises from some point in the wide, level country between Brown Mountain and the South Mountains, a distance of about 12 miles, though it is possible that it rises at a still greater distance."

In this article in the Charlotte Daily Observer, the discovery of the lights is assigned to a date "more than 2 years ago," but conversation with B. S. Gaither, of Morganton, who participated in the fishing party mentioned, and who was the one who first saw the lights, elicited the fact that they were observed in 1908 or 1909. Rev. C. E. Gregory, who in 1910 built a cottage on the little knoll near Loven's Hotel at Cold Spring, presumably the Rattlesnake Knob referred to, was, according to local oral accounts, the first to give much attention to the lights and to bring them to public notice.

H. L. Millner, an engineer living at Morganton, states that he did railroad surveying all through the mountains north of Brown Mountain in 1897, 1899 to 1903, and in 1905. He afterward spent many summer vacations in those mountains but says that he never saw

the lights and never heard of them until 1910. Similar testimony is given by Rev. Albert Sherrill, who served two churches in the country about Brown Mountain. In a letter to Dr. W. J. Humphreys dated January 25, 1922 he says:

"For 4 years I traveled the roads to these churches and visited in the homes of the people all about this mountain. I held revival services day and night, which gave me a chance of observation at night. This was from 1909 to 1912, inclusive. At no time in all these years did I see a light or hear of one * * *. Two years after I left there was the first I ever heard of it."

On the other hand, Col. Wade H. Harris, editor of the Charlotte Daily Observer, from which the first description of the light, quoted above, was taken, states in a letter dated October 2, 1921, addressed to Senator Simmons, that "there is a record that it (the light) has puzzled the people since and before the days of the Civil War." R. T. Claywell, of Morganton, says that people used to come to Burke County 60 years ago to see the lights. Joseph Loven, of Cold Spring, says that he noticed the lights as early as 1897, when he moved to his present home by Loven's Hotel, but that he had heard nothing about them and paid no attention to them until Mr. Gregory came, in 1910.

In October 1913, Mr. Sterrett of the U.S. Geological Survey made his investigation, as a result of which he decided that the lights were locomotive headlights. He did not visit Rattlesnake Knob but went unaccompanied to the Brown Mountain region, where he made his observations.

A newspaper article on the lights, by W. W. Scott, published November 10, 1915, aroused much local interest and started newspaper discussions, as a result of which several expeditions, made up of local observers, visited

Brown Mountain early in the winter of 1915, and in the spring of 1916 and attempted to determine the character and source of the lights. The members of these expeditions made some interesting observations but did not satisfactorily achieve their object.

Mr. H. C. Martin, of Lenoir, states that on April 11, 1916, he and Dr. L. H. Coffey organized an expedition to study the Brown Mountain light. Mr. Martin's party went to Adams Mountain. Dr. Coffey's party went to Brown Mountain. Each party subdivided into several groups and signals were arranged that whichever group first saw the light should fire a pistol. Dr. Coffey's party saw the light over the summit of Adams Mountain at 8:10 and again at 9:45, over a point somewhat farther south. About 5:10 a.m. they saw the light again over the south end of Adams Mountain. None of these appearances was seen by Mr. Martin's party, but about 11:52 his party saw two lights (floating globes), "apparently about the size of ordinary street lamps of Lenoir seen from the distance of about 1 mile," flash out among the trees on the east side of Brown Mountain about one-eighth of the distance down from the summit. These lights moved horizontally southeastward, floating in and out of the ravines, along the mountainside past a dead pine tree in Mr. Martin's line of sight for a distance estimated at 2 miles. Then they returned northwestward about half that distance, again passing the line of the dead tree. At 12:13 the lights disappeared as suddenly as they came. These lights were not seen by Dr. Coffey's party.

In the summer of 1916, a great flood swept down the valley of Catawba River, washing out bridges and railroad tracks and suspending all railroad traffic in and about Morganton, so that for several weeks no trains came within 40 or 50 miles

of Rattlesnake Knob, yet during that period the lights were reported to be seen as usual. This fact showed that the Brown Mountain lights could not be ascribed solely to locomotive headlights.

Late in 1919 the question of the origin of the Brown Mountain light was brought to the attention of the Smithsonian Institution and referred to the U.S. Weather Bureau. Descriptions given in letters from trustworthy observers led Dr. W. J. Humphreys, of that Bureau, to decide that the light was an electrical discharge analogous to the "Andes light" of South America. This Andes light and its possible relation to the Brown Mountain light became the subject of a paper presented by Dr. Herbert Lyman before a meeting of the American Meteorological Society held at the Weather Bureau in Washington in April 1921. Soon thereafter the suggestions of the physicists of the Weather Bureau were embodied in a bulletin on the Brown Mountain light issued by the National Geographic Society, in which this light was represented as a manifestation of the Andes light. Neither the Weather Bureau nor the National Geographic Society, however, had sent an investigator to Brown Mountain to observe the lights.

REVIEW OF EARLIER OBSERVATIONS

Those who have seen the lights from the south or east may with justice contend that no locomotive headlights can be seen to the north and northwest. A good topographic map, however, shows many roads on which an automobile headlight might intervene between an observer and Brown Mountain in such a way as to give much the same effect that one would get in viewing it over the mountain from Loven's or Blowing Rock.

There are two buildings on the summit of Brown Mountain. One of these

is owned by the Brown Mountain Club and the other is a Forest Service station. Lights in these and the fires of campers are the only lights known to originate on Brown Mountain and are the only lights that have been seen on the mountain by observers on the mountain. There are also some buildings on the southern spurs of Brown and Adams Mountains. Seen from favorable viewpoints these might furnish lights that could be interpreted as manifestations of the Brown Mountain light.

For some years there have been lumber camps in Upper Creek west of Brown Mountain. Some of the buildings at these camps are on the sides of the valley or on Ripshin Ridge. Viewed from favorable positions lights in these buildings might be ascribed to the Brown Mountain light.

Rare electrical discharges similar to those reported from western Virginia may take place on Brown Mountain or on other ridges on the Blue Ridge front, but they could have nothing in common with the ordinary Brown Mountain light either in appearance or in regularity of occurrence.

The lights seen by Mr. Martin from Adams Mountain can probably not be satisfactorily explained after so long a lapse of time. There is no reason to attribute to them supernatural or unusual origin, and they cannot be explained as due to mirage, which is Mr. Martin's idea. The suggestion that they might have been caused by moonshiners carrying lanterns has been rejected because of the roughness of the east side of Brown Mountain and because of the distance that the lights seemed to travel in 20 minutes. They might be due to fireflies flying relatively near Mr. Martin yet appearing unduly large because his eyes were focused on the distant hillside, the appearance of going in and out of ravines

being due to intermittence in the lights, but H. S. Barber, an entomologist of the Division of Insects of the National Museum, to whom the matter was referred, states that this explanation, though possible, is improbable, chiefly because of the lateness of the hour of observation.

PLACES OF OBSERVATION

In the article published in the Charlotte Daily Observer in September 1913, it was stated that the lights were first observed from a place near Loven's Hotel, at Cold Spring, and as late as November 1915, Mr. Scott, in his newspaper article cited above, states that "Mr. Loven's is the only place from which has been seen the mysterious light that rises over Brown Mountain." By the spring of 1916, however, the lights were being observed from several places near Lenoir. More recently they were seen from Blowing Rock, which is visited by many tourists, who find accommodations at several flourishing hotels. The lights furnish one of the many attractions afforded by this remarkably well situated and delightful little town. Among the other localities from which the Brown Mountain lights are said to have been seen are the slopes of Gingercake Mountain, about a mile and a half southwest of Cold Spring, and the toll gate on the Yonahlossee road, on the south slope of Grandfather Mountain. It is also reported that they have been seen from Morganton and from other points in the valley southeast of Brown Mountain.

It is significant that, though many persons have from time to time camped on Brown Mountain and have spent nights watching for the lights, yet, so far as the writer has been able to ascertain, no one has actually observed the light on Brown Mountain when he himself was on that mountain,

but, as in Dr. Coffey's observation, it has been seen from Brown Mountain as apparently over Adams Mountain or some hills farther south. Monroe Coffey and Theodore Crump, of the U.S. Forest Service, have spent many nights in and about Brown Mountain and have built a fire-control station on the summit of the mountain near the cabin of the Brown Mountain club, but at the time of the writer's visit neither of them had ever seen the Brown Mountain light.

NATURE AND APPEARANCE OF THE LIGHT

In his letter to Senator Simmons already cited, Colonel Harris writes as follows concerning the light:

"It is a pale white light, as one seen through a ground glass globe, and there is a faint, irregularly shaped halo around it. It is confined to a prescribed circle, appearing three or four times in quick succession, then disappearing for 20 minutes or half an hour, when it repeats within the same circle."

Prof. W. G. Perry, of the Georgia School of Technology, in a letter dated December 15, 1919, addressed to Dr. C. G. Abbot, of the Smithsonian Institution, describes the light as seen from the Cold Spring locality as follows:

"We occupied a position on a high ridge. Across several intervening ridges rose Brown Mountain, some 8 miles away. After sunset we began to watch the Brown Mountain direction. Suddenly there blazed in the sky, apparently above the mountain, near one end of it, a steadily glowing ball of light. It appeared to be about 10° above the upper line of the mountain, blazed with a slightly yellow light, lasted about half a minute, and then abruptly disappeared. It was not unlike the "star" from a bursting sky rocket or Roman candle, though brighter * * *.

"We were impressed with the following facts: The region about Brown Mountain and between our location and the mountain is a wild, practically uninhabited mountain region--a confusion of mountain peaks, ridges, and valleys. Viewing the lights from a fixed position our estimate of their location was most inexact; the varying color (almost a white, yellowish, reddish) may have been due to mist in the atmosphere; the view of the lights was a direct one and not a reflection; there seemed to be no regularity in their time of appearance; they came suddenly into being, blazed steadily, and as suddenly disappeared; they appeared against the sky and not against the side of the mountain.

"Others who have seen this phenomenon make very different reports of their observation; and some who have seen it several times report that they have seen it in varying fashion; sometimes the light appears stationary (as was uniformly the case when I saw it); sometimes it appears to move rapidly--upward, downward, horizontally."

Rev. C. E. Gregory is reported to have noted upon one occasion that the light appeared like a ball of incandescent gas, in which a seething motion could be observed.

PROPOSED EXPLANATIONS

Many explanations of the Brown Mountain lights have been offered. The principal ones that have come to the notice of the writer are briefly outlined below.

1. Will-o'-the-wisp: A light called will-o'-the-wisp is sometimes seen over marshy places and is supposed to be due to the spontaneous combustion of marsh gas. There are, however, no marshy places on or about Brown Mountain, and the lights seen by the

writer could not be ascribed to such a cause.

2. Phosphorus: It has been suggested that the lights may be caused in some way by the element phosphorus. Phosphorus, however, is so easily oxidized that it does not occur in the free state. It is usually locked up in stable and relatively insoluble chemical compounds and therefore cannot be a cause of the Brown Mountain light.
3. Phosphorescence (fox fire): Some organic bodies, such as stumps or logs, become luminous or phosphorescent by slow oxidation and combustion in the course of their decay. Such lights are too feeble to be seen at a distance of several miles and are unlike the lights seen by the writer.
4. Radium emanations: The late F. H. Hossfield is reported to have found a piece of pitchblende, an ore of radium, near the southwest end of Brown Mountain, and some therefore think that Brown Mountain may contain a large body of radium ore, which might by emanation produce the observed lights. So far as the writer has been able to learn, the material that was supposed to be pitchblende was never so identified by actual tests, and the place where it was found is not accurately known. The specimen itself has been lost; but pitchblende, even if it occurred in large deposits, could not give rise to lights like those seen over Brown Mountain. No known radium ore shows that kind of luminosity.
5. Chemical reaction between hydrogen sulfide and lead oxide: In a letter received from Mr. E. C. Ivey, of Hickory, it is suggested that the lights may be so caused, and it is stated that both

hydrogen sulfide and lead oxide occur in Brown Mountain and that hydrogen sulfide will ignite in the presence of lead oxide. Sulphur springs occur on the west side of Brown Mountain and lead prospects are reported on the east side, but the possibility that there is any direct relation between them is so slight as to be highly improbable.

6. "Blockade" (illicit) stills: Many stills have been operated by "moonshiners" in the vicinity of Brown Mountain. A man who claims to have been an eyewitness states that screens are placed about these stills to shut off the light from the fires but that from time to time the fires are raked out and the covers of the stills removed, so that the clouds of steam which arise from them are illuminated by the fires below. The "moonshiners" are also said to use lights for signaling. It is possible that the light with "seething motion" seen by Mr. Gregory may have been of this origin, but there are not enough such stills and they probably would not be in sufficiently continuous operation to produce lights in the number and in the regularity of appearance of those seen at Brown Mountain.
7. St. Elmo's fire: St. Elmo's fire is a brushlike, luminous, electrical discharge that sometimes takes place from masts, lightning conductors, and other pointed objects, especially during thunderstorms. In his correspondence with Messrs. Clark and Perry, the trustworthy observers already mentioned, Dr. C. G. Abbot, of the Smithsonian Institution, suggested that the Brown Mountain light may be due to St. Elmo's fire, but there

seems to be little in common between the lights seen by the writer and St. Elmo's fire as usually described. In a second letter to Dr. Abbot, dated January 9, 1920, Professor Perry states the case clearly when he says, "My own impression of St. Elmo's fire and similar phenomena was that it occurred at the extremity of some solid conductor instead of occurring, as in the case of the Brown Mountain lights, in the air, at a great distance from any object."

8. Andes light: The name "Andes light," according to information furnished to the writer by Dr. Herbert Lyman, of the U.S. Weather Bureau, is given to a very striking luminous discharge of electricity seen over the crest of the Andes in Chile, where ordinary thunderstorms are almost unknown. The mountain peaks appear to act as gigantic lightning rods, between which and the clouds silent discharges take place on a vast scale.

The principal writer on the Andes light is Dr. Walter Knoche, who was for several years director of the Central Meteorological and Geophysical Institute at Santiago, Chile, and who says that he has seen this light at distances greater than 300 miles. Most of the discharges appear to produce glimmering lights that have circular borders. The flashes are bright at their starting points but diminish rapidly in intensity and then slowly disappear. The area of this silent discharge is at first small and lies over the main cordillera, but it soon extends far over the zenith and sometimes reaches over the coast cordillera and out to sea. The phenomena is best seen in a

clear sky.

Dr. Guy Hinsdale, in the Scientific Monthly for September 1919, reports that in western Virginia, where there are "numerous parallel ridges with intervening deep and narrow valleys, it occasionally happens that an electric discharge takes place from the summits of these ridges into the atmosphere. There is nothing audible, but merely the sudden glow of the higher clouds in the dark night."

The appearance of the Andes light, as shown in illustrations given by Dr. Knoche and in the accounts of it already cited, is totally different from that of the Brown Mountain light as seen by the writer during his investigation or as described by others, and there appear to be no geologic conditions at or near Brown Mountain that would produce electrical discharges there rather than at Blowing Rock or Grandfather Mountain or any other prominent point in this region.

9. Mirage: Mr. H. C. Martin, in the Lenoir Topic for April 19, 1916, and afterward in conversation with the writer, has suggested that the lights may be due to mirage. He thinks that air currents of different temperature and density may produce between them reflecting surfaces, from which bright stars or other lights might be reflected in such a way as to produce the effects commonly seen. According to this explanation the wavering of the reflecting surface would cause the sudden appearance, wavering, and disappearance of the light.

A mirage is a phenomenon of the daytime rather than of the night. The requisite conditions

are that the air must be still and that the lower layers, heated by radiation from the underlying surface, must become less dense than the overlying layers and yet be unable to escape. With the least disturbance of these unstable conditions the overheated air suddenly "spills" upward and mirage disappears. The conditions in a mountain gorge such as that of Wilson Creek east of Brown Mountain are entirely unfavorable to mirage, for as soon as the lower air becomes warmed it may escape up the surface slopes, and at evening there is likely to be a downward draft of cool air from the neighboring uplands. Yet Mr. Martin, in seeking in air currents of different temperature and density an explanation of the light, has hit upon what the writer believes to be a fundamental element in the problem, as will be more fully explained below.

10. Locomotive headlights: D. B. Sterrett, of the U.S. Geological Survey, who investigated the light on October 11, 1913, noted that the headlights of westbound Southern Railway locomotives could be observed from Brown Mountain and that they were brilliant enough to be seen in the same straight line from Loven's place, 6 miles beyond. He checked on the train schedules and concluded that locomotive headlights were "beyond doubt" the cause of the Brown Mountain light. Objection to this view has been raised on the ground that a locomotive headlight casts a beam, which, like that of a searchlight as frequently seen, can be readily identified. This objection is considered under the heading

"Conclusions."

11. Automobile headlights: Powerful headlights on automobiles have been suggested as a source of the Brown Mountain light. The objection made to this suggestion is similar to that made to the suggestion that they are caused by locomotive headlights, and it fails for the same reasons. When seen at long distances the two kinds of headlights behave in a similar manner. Of the 23 lights recorded by instrumental observation in the investigation here reported 11 were probably automobile headlights.

THE INVESTIGATION IN 1922

METHODS EMPLOYED

After a conference in Morganton with men who are familiar with the lights the writer set out to take observations at the place near Loven's Hotel and at other places from which, according to reports, the lights could be seen, Brown Mountain itself being one of the places. The instruments used consisted of a 15-inch planetable (a square board mounted on three legs), a telescopic alidade, pocket and dip-needle compasses, a barometer for measuring elevations, a fieldglass, a flashlight, and a camera, besides topographic maps of the region.

In making the observations a topographic map was fastened flat on the board, which was leveled and the map turned to a position in which the directions north, south, east, and west on the map correspond with the same directions on the ground. Sights were then taken to known landmarks with the alidade, which is essentially a ruler fitted with a sighting telescope, and corresponding lines were drawn along the ruler on the

map. The meeting point of the lines thus drawn marked the location of the observer's instrument on the map. From this location, which was determined in the daytime, sights were taken at night with the alidade on the map. The telescope of the alidade swings in a vertical as well as in a horizontal plane and can therefore be used for measuring vertical angles along the lines of sight. The dip-needle compass is so arranged that the needle swings in a vertical instead of in a horizontal plane. It is used to detect differences in magnetic attraction.

Three stations were occupied--one on the knoll by the cottage formerly occupied by Rev. C. E. Gregory, near Loven's Hotel; one in a field on the east slope of Gingercake Mountain; and one on the terrace in front of the summer residence of Miss Cannon, at Blowing Rock. These stations are marked on the map (fig. 1) by the letters A, B, and C, respectively. Two nights were spent on Brown Mountain, but the conditions were so unfavorable that no station was occupied there. At each station at which observations were made, vertical angles to parts of Brown Mountain were noted, dip-needle readings were made, and photographs were taken. Vertical angles were also measured when practicable from each station to each light seen. The procedure adopted was first to get a line of sight to the light and then to note its time of appearance and measure its vertical angle, but occasionally a light remained visible for so short a time that it had disappeared before the telescope could be trained upon it and a line drawn to fix its direction. Few records were kept of lights for which lines of directions were not drawn, but the total number seen may have been nearly twice the number recorded. The atmosphere proved too

hazy for satisfactory photographs.

The train registers at Connelly Springs and at Hickory were examined, and subsequently train schedules for the evenings of observation were obtained from many station agents throughout the region.

The observations obtained in the field were afterward adjusted on the map. Many profiles along lines of sight were constructed, the vertical angles were plotted, and corrections for the curvature of the earth's surface and for refraction were made. In this way the sources of some of the lights were approximately determined. The inset profile (fig. 1) illustrates the method of locating a source of light by means of a profile and vertical angle drawn from station B along line 15.

Space does not permit a detailed statement of the individual observations made and of the inference drawn from them. The geographic positions of the sources of light as determined by instrumental observations are only approximate because of the difficulties attending the use of the instruments in darkness. The stations were from 1,000 to 1,500 feet higher than the summit of Brown Mountain, so that the lines of sight to the lights seen all passed several hundred feet above the top of the mountain as shown in inset profile (fig. 1). This fact caused the lights to appear over the mountain rather than on or below its crest, a feature noted both in the first published description of the lights, in the Charlotte Observer, and in Professor Perry's description, already quoted. The appearance of the lights as described in these two accounts, especially in that given by Professor Perry, agrees so closely with their appearance as observed by the writer that no additional description of them need be given here.

OBSERVATIONS AT LOVEN'S

At station A (elev. 3,550 ft), near Loven's Hotel, which is the place from which the light was first seen, the outlook is restricted on the south by a projecting ridge (see inset sketch, fig. 1), which cuts off the view of the region west of the eastern part of Morganton, approximately the region southwest of line 3 on the map. Northward from Lenoir the country becomes rougher, and few lights from areas north of that place may be seen from Loven's, so that practically all the lights that originate beyond Brown Mountain and are seen from station A lie in an arc between Lenoir and line 3 and are therefore seen over Brown Mountain. This fact accounts for the original association of the observed lights with Brown Mountain and hence for the name "Brown Mountain light." It also probably accounts for the "prescribed circle" of appearance of the light noted in Colonel Harris' letter to Senator Simmons.

On the evening of March 29, the writer was accompanied to station A by Joseph Robert and Earl Loven, of Cold Spring, and Robert Ward, of Morganton. The light on line 1, when viewed in the telescope of the alidade, was accompanied by one or two subordinate lights. Its position was unchanged throughout the evening, but it varied in brightness. At some times, for long periods, it was so dim that it was practically invisible to the naked eye, though it was faintly shown in the telescope. At other times it flared brightly, so that Joseph Loven pronounced it a true manifestation of the Brown Mountain light. Its position and its relation to the accompanying lights were not affected by the flaring. Two of the observers said that they could see it waver or move, but as seen through the telescope each time this statement was made its position was found to be unchanged.

At about 8:40 lights appeared successively and nearly in the same line over the middle of the mountain. The directions of those lights are shown in lines 2a and 2b. Line 2a is tangent to a curve in the track of the Southern Railway about a mile and a half northwest of Conover. From train schedules it was determined that a westbound freight train passed this curve at the time noted. Line 2b is probably a poorer sight at the same light and may represent an error of observation due to the writer's inability in the darkness to use the crosshairs of the instrument. It may, however, point to an automobile headlight.

The light at 10:45 on line 2a appears from its vertical angle to have originated about a mile and a half east of Conover. It is not accounted for by the train schedule for that evening and was probably an automobile headlight.

Lines 3 and 4 are credited to automobiles. Line 5 represents a locomotive headlight near Connelly Springs.

The flares seen from station A all looked much alike and corresponded closely with the description quoted from Professor Perry's letter. Robert Loven said that the lights as he had usually seen them were so much brighter than these that he did not think the party had actually seen the Brown Mountain light. Joseph Loven, however, said that he had seen the lights both when they were brighter and when they were not so bright, and he was satisfied that the lights observed were a fair average exhibition of the Brown Mountain light.

OBSERVATIONS AT GINGERCake MOUNTAIN

Station B, on Gingercake Mountain, is about 500 feet higher than station A, and the arc over which the lights are visible is correspondingly increased. Brown Mountain covers about

half of this arc. The fellow observers at station B were Joseph Loven and Robert Ward. On the evening of April 1, the mist in the valley was so dense that only one observation could be made--the one on line 6, which is ascribed to an automobile on the State highway near Drexel. The highway runs for some distance nearly parallel with the railroad.

The conditions for observation on the night of April 2, though poor, were more favorable than on the preceding night, and sights 7 to 16, inclusive, were recorded on the corresponding lines. At 7:35 a light appeared over Brown Mountain on line 7. This line, when extended, coincides practically with the track of the Southern Railway about half a mile west of Catawba station. The station agent reports that on April 2 a westbound train left Catawba at 7:32 p.m. It is therefore clear that the source of this light was a locomotive headlight. At 7:45 and 8:55 lights flared out over the south end of Brown Mountain on lines 8 and 12, respectively. When corrected these observations fell on the same line, near the station Drexel. A report from the station agent shows that westbound freight trains on the Southern Railway left Drexel at the times specified. Lights 9, 10, 11, 14, and 15 are ascribed to automobiles.

Throughout the evening a light, one of a small group, was seen on line 13. Its position remained the same, but it flared at longer or shorter intervals. Between the flares it could be dimly seen with the naked eye. As corrected, the position of this source of light seemed to fall near the dam at the foot of the big reservoir on Linville River, not shown on the map.

Train No. 35, a westbound passenger train on the Southern Railway, is due at Connelly Springs at 12:25 a.m. The writer decided to remain on watch until the time for that train in

order to get answers to two questions: First, could the headlight at Connelly Springs be seen from the Gingercake Mountain station over Brown Mountain, and second, if the headlight could be seen, would it look like the true Brown Mountain light? Accordingly, about 10 minutes before train time the telescopic alidade was directed toward the curved track about a mile east of Connelly Springs. All observers then waited for the train. At 12:33 a light flared over Brown Mountain and was seen in the telescope on line 16. Though the train was 8 minutes behind its schedule all observers were convinced that the light seen was the headlight of train No. 35. To the writer it looked much like the other lights that Mr. Loven had called the Brown Mountain light on this and on preceding evenings. Mr. Loven himself declared that it looked like the Brown Mountain light, though he thought it had a slightly more bluish tint. Upon later examination of the train register at Connelly Springs it was found that train No. 35 had arrived at the station at 12:35. Allowing for the time required for the train to run from the curve to the station at Connelly Springs the train register may be confidently regarded as verifying the observation.

On this night, as on the first night, all the lights seen looked much alike, though some of the flares were brighter than others. Mr. Loven was asked several times if he felt satisfied that the lights seen by the party were actually the Brown Mountain light. He replied that he was satisfied and that it was a fair average exhibition.

On April 3 station C was established at Blowing Rock, at an elevation of about 3,700 feet. Although not so high as the station on Gingercake Mountain, this station commands a wide, sweeping view of the country

to the south, a view through nearly a quarter of a circle, but Brown Mountain occupies only a small part of this space. The moon was shining brightly, but a heavy mist overhung the valley and completely obscured Brown Mountain. H. C. Martin, of Lenoir, was present during part of the time of observation and Robert Ward, of Morganton, during the whole time.

A steady group of lights was dimly visible most of the evening on lines 17 and 18. These lights were reddish and were accompanied by what appeared to be smoke. These lights appeared to originate on a ridge north of Mulberry Creek. Their smoky appearance suggests that they came from brush fires.

At 8:35 a reddish light appeared on line 19. It flared brightly twice and then, as seen by the unaided eye, apparently went out, but it continued for a time to show dimly in the telescope. The line of sight corrected for curvature and refraction clears by a short distance the mountain mass at the county line and falls near a curve of the Carolina, Clinchfield & Ohio Railway about a mile southeast of Sprucepine. No agent is on duty at Sprucepine at night, and thus far the writer has been unable to learn whether or not there was a southbound train on the track there at the time noted.

Mr. Martin said that the light on line 19 looked very much like the Brown Mountain light but that it was too far to the right. When questioned as to wherein the two differed, he replied that in the first place the light was not seen over Brown Mountain and second, it did not trail off laterally or obliquely as the Brown Mountain light usually did.

At 9:05 a light flared on line 20. The source of the light was determined to be in the streets of Lenoir. There were no northbound trains that

night; so the light probably came from an automobile headlight.

On the night of April 4, on account of unfavorable conditions, only one observation (No. 21) was obtained. This was ascribed to a locomotive headlight.

With the exception of lights 17 and 18, ascribed to brush fires, the lights seen from Blowing Rock were practically indistinguishable in general character and appearance from those that were seen at Loven's and at Gingercake Mountain and that were said by Mr. Loven to be the Brown Mountain light. A lady at Blowing Rock declared that on a clear evening "you could go out on the hill and see lights popping out all over the valley, all looking as much alike as so many peas in a pod." Mr. Martin, on the other hand, said that the Brown Mountain light had distinctive features and that the party had not seen it on either evening. The principal distinctive feature indicated appears to be the lateral or oblique motion above referred to.

OBSERVATIONS AT BROWN MOUNTAIN

On April 5 the writer ascended Brown Mountain with a party organized by F. H. May, of Lenoir. Theodore Crump, of the Forest Service, kindly placed at the disposal of the party his station on the summit of the mountain. Rain and fog interfered with the observations, but watch was kept from about 8 to 10:30 p.m. and again from 12:15 to 12:45 a.m. No lights were seen. On the following day, April 6, several members left the party, but Monroe Coffey, of the Forest Service, joined it. That evening there was no rain, but fog prevented any extended view from the summit of the mountain. Somewhat below the summit, however, the fog was less dense, and it was possible to have seen any lights that might arise

over the Brown Mountain mass. About 9:30 the party made a circuit from the summit to the hill above Parke Creek, in the south-central part of the mountain, returning to the summit shortly before midnight. Had any lights arisen over the mountain mass some member of the party would probably have seen them, but none appeared.

CONCLUSIONS

The writer feels confident that the lights he saw were actually a fair average display of the so-called Brown Mountain light. He not only has Mr. Loven's word to sustain this conclusion, but he is certain that the lights he saw agree closely in appearance and behavior with those originally described in the Charlotte Daily Observer and by Professor Perry.

The lights observed have nothing in common with the Andes light or with St. Elmo's fire. There is no geologic basis for the idea that the lights seen are natural wonders of any sort, but there are certain interesting surface features and atmospheric conditions that are effective in producing some of the appearances of the light.

By reference to the map it will be noted that the Catawba Valley east of Marion is a basinlike area--an area nearly surrounded by mountains, of which the Blue Ridge on the north, with its fringe of southward-projecting spurs, is the highest and most rugged part. After sunset cool air begins to creep down the tributary valleys into the basin, but the air currents come from different sources and are of different temperature and density. The atmospheric conditions in the basin are therefore very unstable, especially in the earlier part of the evening, before any well-defined circulatory system becomes established. At any given place in the basin the air varies in density

during the evening and hence in refractiveness. The denser the air, the more it refracts light or bends waves of light emanating from any source. The humidity of the air affects its density and hence its refractive power. Mist, dust, and other fine particles tend to obscure and scatter the light refracted and to impart to it the reddish or yellowish tints so frequently observed. Thus it is that the light is most active in a clearing spell after a rain, as noted by many observers. When the mist is very dense, the light is completely obscured.

Lights that arise from any source in the basin are viewed at low angles. Even those observed from altitudes of 3,500 or 4,000 feet, the heights of the stations on Gingercake or on Blowing Rock Mountain, had vertical angles of less than 3° . Thus, the refractive effect of the atmosphere through which the light waves must travel is at a maximum.

The effect of variations in the density of the atmosphere between the observer and the source of light is at one time to increase and at another time to diminish the intensity of the light. This fact accounts for the flares on lines 1 and 13. The diminution of a light after such a flare is so marked that to the casual observer or to one without a fieldglass the light may seem to be completely extinguished. In the telescope, however, it still appears in the same relative position, though it is somewhat fainter. Lights that are in view for brief periods, such as the headlights of automobiles or locomotives, which show only when they are turned toward the observer, produce similar flares; but when they are turned in other directions, they become extinguished so far as the observer at a given station is concerned.

Probably few if any basins on the Blue Ridge front are so favorably

located as to show as well as this one the atmospheric phenomena described, and the opportunities here for the observation of such phenomena are perhaps no less exceptional. Loven's Hotel and Blowing Rock, which are resorts that attract fishermen or tourists, are among the most favorable places of observation. The valley is fairly well settled and has a network of roads, three railroads, and several large towns, so that the possible sources of light are very numerous.

As the basin and its atmospheric conditions antedate the earliest settlement of the region, it is possible that even among the first settlers some favorably situated light may have attracted attention by seeming to flare and then diminish or go out. As the country became more thickly settled the number of chances for such observations would increase. Before the advent of electric lights, however, it is doubtful whether such observations could have been sufficiently numerous to cause much comment, though some persons may have noted and remarked upon them.

According to local estimates electric lights have been in use in the larger towns of the region for about 30 years. Lights from those towns viewed from the locality near Loven's, which for a long time was the only locality from which the lights were observed, are, with the exception of those from Morganton and Blowing Rock, all seen over Brown Mountain; hence the "prescribed circle" mentioned by Colonel Harris.

The use of powerful electric headlights on railway locomotives, which began about 1909, furnished new sources of strong lights in the valley and introduced an element of regularity in their appearance, which may account for the "punctual regularity" noted in the first description. After Rev. C. E. Gregory took

up his summer residence near Loven's Hotel, in 1910, the Brown Mountain light began to acquire notoriety.

Meanwhile, automobiles were coming into use throughout the country, and many of them were equipped with powerful headlights. Within the last few years their number has been greatly increased, and this fact is in keeping with the general deduction already made--that on a favorable evening the lights are seen more frequently now than formerly.

During the flood of 1916, when train service was temporarily discontinued, the basin east of Marion, where the atmospheric conditions are disturbed, was still the scene of the intermittent flare of favorably situated lights. Automobiles were then in use in the larger towns and on some of the intervening roads, and their headlights were doubtless visible from Loven's over Brown Mountain. One need only remember the network of roads in the valley region (see topographic maps of the Morganton and Hickory quadrangles) to realize the almost infinite number of possibilities for automobile headlights to be pointed toward Brown Mountain and stations of observation beyond. It should be emphasized, too, that automobile headlights and locomotive headlights, when seen at distances and under atmospheric conditions such as those which prevail in this region, possess no characteristic that clearly distinguishes them from other lights. On the contrary, as stated by the lady at Blowing Rock, they look "as much alike as so many peas in a pod," though this statement should not be understood to mean that some may not be brighter than others.

Col. Wade H. Harris, in his letter to Senator Simmons already cited, says: "A locomotive headlight is easily and unmistakably distinguished as such, not only by the rays it shoots forth, but from its movements * * *."

It [the Brown Mountain light] is as distinct in characteristics from a locomotive headlight as a candle flame is to a naked arc light." Again, in an article in the Charlotte Observer for March 27, 1922, the same writer adds that "a headlight has characteristics that distinctly and unmistakably identify it as such."

The writer's observations, made in company with persons long familiar with the light, failed to substantiate these statements. Of the 23 lights noted by instrumental observation and recorded on lines 1 to 21, seven proved to originate from locomotive headlights, and an eighth (No. 19) is probably of similar origin, though the data are insufficient to establish that fact, but none of these seven lights cast a beam or possessed any special quality that distinguished it from the other lights observed, and only one of them (No. 16) was known at the time of observation to be a locomotive headlight. The other six were identified as such only after the lines and angles of the record had been plotted, profiles had been drawn, and train schedules had been checked some days after the observations were made. A locomotive headlight seen at distances such as those from which the Brown Mountain light is observed has no visible motion and emits no "rays." When its line of direction coincides with the line of observation, the light flashes on or, if the air is misty, it flares, much as an incandescent electric light flares when it is turned on. When its line of direction leaves the line of observation, the light disappears just as suddenly as it came.

The behavior of headlights in the Brown Mountain region in this respect is comparable to that of the lights in the lighthouses on the Atlantic Coast. From the seawall at Gloucester, Mass., the writer has repeatedly seen the light at Minots Ledge, southeast

of Boston, nearly 25 miles away in a direct line. This light is identified by a series of flashes that may be represented by the numerals 1-4-3. There is no beam and there are no rays. The light cannot be seen unless the air is fairly clear. Then it simply flashes once, four times, three times, and it has much the same appearance as the Brown Mountain light.

The supposed motion of the light at times may be due to errors of observation. Reference has already been made here to the fact that two observers who were present with the writer at station A thought they saw the light move when it was actually motionless as seen in the telescope. Some years ago McNeilly Du Bose, an engineer then employed near Morganton, tested observations made by himself and others by tying a cord across the fork of a tree in a place where he could see the light across the cord and was surprised to find that the light was stationary with respect to the cord. Professor Perry, whose letter has been quoted, notes that the light was uniformly stationary when he saw it. The eye is easily deceived at night as to the stability or motion of an object, and an observer's impressions are to a considerable extent affected by his mental and physical condition at the time of observation. It is not surprising that under the circumstances different eyewitnesses give quite different accounts of the light, especially as the light may appear suddenly against a dark background with nothing nearby that can be used as a scale to determine its size or its possible motion.

There remains the question of the identity of the Brown Mountain light as seen from Blowing Rock. Mr. Martin specified two requirements: namely, the light must be seen over Brown Mountain and it must have motion. The

element of motion has already been considered.

The arc of view intercepted by Brown Mountain is a little greater than the arc between the lines D and F on the accompanying map (fig. 1). Line D is drawn to a road that seems to be a thoroughfare near Brindletown. Line E is drawn tangent to the Southern Railway near Thermal City. Just east of this line is a thoroughfare, and a short distance farther east is the track of the Carolina, Clinchfield & Ohio Railway. Line F is drawn to the same road and railroads a few miles farther northwest.

Automobile headlights on any of the numerous roads that point toward Blowing Rock within the area designated and south of Catawba River would be visible from Blowing Rock over Brown Mountain.

The writer was told at Blowing Rock that a good time to see the light was from 9:30 p.m. to 10 or a little later. The agent of the Southern Railway at Thermal City states that a northbound train on that railway passes that station at 9:30 p.m., maintaining approximately the same schedule the year round. The agent at Glenwood on the same railway reports that a train is due there at 9:53 the year round. Data for the other railroad are not available, but doubtless there are some northbound evening freight trains on it. The agreement of the train schedule with the above statement about the time to see the

lights is certainly more than a coincidence.

It may be questioned whether a locomotive headlight could be seen for a distance so great as that between Blowing Rock and Thermal City, which is about 45 miles. The Minots Ledge light, already mentioned, is rated at 75,000 candlepower by the Bureau of Lighthouses and is visible for distances greater than 25 miles. The writer was told by Mr. Chadwick, of the Engineering Department of the Southern Railway, that the headlights in common use on that system are incandescent nitrogen lamps rated at 250 watts and 32 volts. Fitted with 16-inch silvered-copper parabolic reflectors, these lights yield about 600,000 candlepower. There is therefore no reason to doubt that the headlights would be visible at a distance of 45 miles.

The high power of these lights accounts for the brilliancy ascribed to the Brown Mountain light by observers who have seen it when the air was exceptionally clear, and it also accounts for the fact that some of the lights seen are brighter than others.

In summary it may be said that the Brown Mountain lights are clearly not of unusual nature or origin. About 47 percent of the lights that the writer was able to study instrumentally were due to automobile headlights, 33 percent to locomotive headlights, 10 percent to stationary lights, and 10 percent to brush fires.