1930

MAGNETIC DECLINATION IN NORTH CAROLINA IN 1930

CONTENTS

INTRODUCTION

The compass does not, in general, point true north, nor is its direction at any place constant; hence a knowledge of the compass variation (magnetic declination) and its changes is required by those who make use of the compass. Magnetic compasses are not perfect mechanical instruments and are likely to get out of order. The only way in which they can be tested in a satisfactory manner is to make observations at a magnetic station where the declination has been accurately determined by other means. Accordingly the surveyor needs to know principally the changes of the declination in the past and its value at the present time at a convenient station, with information in regard to finding the station.

The Coast and Geodetic Survey has made a magnetic survey of the United States, in the course of which magnetic observations have been made at nearly every county seat in the country and at many other places. The results of the observations, together with descriptions of the stations occupied, have been published annually, so that the results for any one State are scattered through a number of publications.

In order to present in more convenient form the material available for the use of the local surveyors having occasion to make compass surveys, a series of publications is being issued, giving for single States or groups of States detailed information regarding observations of the magnetic declination in the area covered and tables showing in detail the change of declination with lapse of time. The other publications in this series which have been issued are listed under "Bibliography."

Previous publications on magnetic declination in North Carolina, issued in 1900 and 1925, are superseded by this one. The information is presented under five heads:

1. Alphabetical list of the magnetic stations, showing in what county each one is located.

2. Tables showing the changes in declination at each county seat from as early a time as the available observations warrant.

3. A table giving the values of declination for January 1, 1930, at all magnetic stations in the State.

4. Descriptions of the stations, revised for all information available on August 1, 1931.

5. An isogonic chart of the State showing in a general way, by means of lines of equal magnetic declination, the distribution of declination over the State on January 1, 1930, based on the tabular values as plotted on the chart.

DEFINITIONS OF TERMS

As there is much confusion in the use of the word "variation," the Coast and Geodetic Survey has adopted a definite notation, which will be adhered to in this publication.

The angle between the true north and the magnetic north is called the *magnetic declination* or simply *declination,* and is considered east or west according as the compass needle points east or west of true north. It is often called "variation of the compass" or "magnetic variation" or simply "variation."

The declination at any place is constantly changing, and this change with time may be separated into several parts depending on their character.

The average value of the declination for one year differs from that for the next, and the change progresses in one direction for many years. This change of declination with the years is called its *secular change.* The amount of secular change in one year is called the *annual change.*

There is a fairly systematic departure of the declination from its daily mean value, which occurs day after day, with an easterly extreme about 8 a. m. and a westerly extreme about 2 p. m. This is called the *diurnal variation.*

Superimposed upon the diurnal variation, irregular fluctuations of the declination are of frequent occurrence. When they become large and rapid a *magnetic storm* is said to be occurring. Such a disturbance may last for several days, and the range of declination may amount to as much as a degree in North Carolina, sometimes even more.

MAGNETIC SURVEYS IN NORTH CAROLINA

Magnetic measurements in North Carolina were first made by the Coast and Geodetic Survey in 1847, when observations were made at three points in the vicinity of Albemarle Sound, in connection with work for chart construction purposes. Before this time but few declination values were available, mainly observations by surveyors and others, or values taken from magnetic charts of the period. After 1847 the number of observations increased but slowly. In 1873 and 1875 the National Academy of Sciences made observations at 6 stations, and in 1891 the Coast and Geodetic Survey made observations at 14 stations in the eastern part of the State.

Only a few other scattered observations were made until the beginning of the magnetic survey of the State in 1898. This survey was a joint project of the North Carolina Geological Survey and the United States Coast and Geodetic Survey, the latter furnishing the observer and instruments and the former paying the greater part of

his field expenses. The plan contemplated the establishment of a true meridian line, a standard of length, and a measurement of the three magnetic elements, declination, dip, and horizontal intensity at each county seat of the State. James B. Baylor of the Coast and Geodetic Survey was designated to do the field work, and the plan was carried to completion during the years 1898, 1899, and 1900, during which period Prof. J. A. Holmes was the State geologist.

The meridian lines were marked by substantial granite posts about 4½ feet long, many of which still remain in place, while others have been used to mark new stations. The upper end of the post was dressed 6 inches square, and the upper face was inscribed with a cross and the letters "N. C. G. S., U. S. C. S." Magnetic measurements were made at one end of the meridian line, and the declination results were published in Appendix 9 of the Report of the Superintendent of the Coast and Geodetic Survey for 1898–99 and in Bulletin No. 41 of the Coast and Geodetic Survey, together with an isogonic chart of the State based on the declination measurements. These publications also contained the descriptions of the monuments established and tables showing for each county the changes of declination from as early a time as the record of observations would warrant.

Between 1900 and 1923 the Coast and Geodetic Survey made enough observations in the State to keep track of the changes in the magnetic elements, and replaced a few stations which had become unserviceable. In 1923 an investigation by Dr. Joseph Hyde Pratt, Director of the North Carolina Geological and Economic Survey, developed the fact that half of the old stations had become unfit for use, and through cooperation between the Coast and Geodetic Survey and that organization, the latter paying part of the cost, all of the stations were put in good order and declination observations were made at most of them in 1923 and 1924. The results were published by the Coast and Geodetic Survey as Serial No. 303, Magnetic Declination in North Carolina in 1925.

In 1931 from questionnaires sent to local surveyors and others it was found that nearly one-fourth of the stations at county seats had become defective. Through cooperation between the Coast and Geodetic Survey and the North Carolina Department of Conservation and Development, all of these defective stations were put in good order or replaced. As a result there is now in each county, usually at the county seat, a well-marked magnetic station where the magnetic declination has been accurately determined, at which local surveyors may conveniently test their compasses. At nearly all of the stations the true bearings of a number of prominent objects have been determined and at most of them a second stone was set to mark the true meridian.

BIBLIOGRAPHY

Some of the more general problems arising in compass surveys and some of the difficulties encountered will be referred to later. The special problems of the individual surveyor are too varied to warrant an attempt to give general solutions. The books and publications listed below may be found useful for reference. The first three are standard works on surveying, in which the principles and methods of surveying are fully explained.

Gillespie and Staley, Treatise on Surveying, part 1. D. Appleton & Co., New York.

Johnson and Smith, Theory and Practice of Surveying. John Wiley & Sons, New York.

Breed and Hosmer, The Principles and Practice of Surveying, part 1. John Wiley & Sons, New York.

Compass Surveying and the Simplified Calculation of Farm Areas, by Charles Mitchell Thomas, published by the D. A. St. Clair Press, Wytheville, Va. This contains the elements of compass surveying and the calculation of areas by the method of double meridian distances. It should be intelligible to those without technical training in surveying.

A Treatise on the Law of Surveying and Boundaries, by Frank Emerson Clark, published by the Bobbs-Merrill Co., of Indianapolis. This deals with the legal aspects of surveying of both the public and private land surveys of the United States.

Manual of Surveying Instructions for the Survey of the Public Lands of the United States and Private Land Claims, issued by the General Land Office and for sale by the Government Printing Office, Washington, D. C.

A full list of the publications of the Coast and Geodetic Survey on terrestrial magnetism is contained in the List of Publications of the Department of Commerce, which may be obtained on request from the "Chief, Division of Publications, Department of Commerce, Washington, D. C." The following, which may be obtained from the "Superintendent of Documents, Government Printing Office, Washington, D. C." for the price stated, may be mentioned as particularly touching the work of the surveyor:

Special Publication No. 126, Magnetic Declination in the United States in 1925, containing an isogonic chart and secular change tables for the United States for 1925, 10 cents. A similar publication for 1930 is now (August, 1931) nearly ready for the printer.

Special Publication No. 117, The Earth's Magnetism, a history of the development of our knowledge of the earth's magnetism, 15 cents.

Serial No. 453, United States Magnetic Tables and Magnetic Charts for 1925, 60 cents.

Serial No. 237, Magnetic Declination in Arkansas in 1923, 10 cents.

Serial No. 323, Magnetic Declination in Missouri in 1925, 10 cents.

Serial No. 417, Magnetic Declination in Texas in 1927, 15 cents.

Serial No. 457, Magnetic Declination in Delaware, Maryland, Virginia, West Virginia, Kentucky, and Tennessee, 20 cents.

In addition to the above publications of this series, the following have also been issued, but are now out of print:

Serial No. 262, Magnetic Declination in Florida in 1924.

Serial No. 396, Magnetic Declination in California and Nevada in 1927.

COMPASS SURVEYS

THE COMPASS AS A SURVEYING INSTRUMENT

The compass is not an instrument of precision. Moreover, the earth's magnetism on which it depends is constantly changing. Hence, results of great accuracy can not be expected with it. It has the advantage of simplicity, cheapness, and speed. Its use as a surveying instrument should be avoided when circumstances will permit. It is very useful, however, in retracing old lines originally run by compass; and for surveys where great accuracy is not required or where accuracy must be sacrificed to speed, particularly in wooded areas, the compass is indispensable. When the compass is used, precautions should be taken to eliminate as many of the various sources of error as possible.

ADJUSTMENT OF COMPASS

One frequent source of error is lack of proper care of the compass. The more important points to be examined are: See that the peep sights are vertical; look out for a sluggish needle, which may be due to a damaged jewel, a dull pivot, or loss of magnetism; see that the needle is horizontal, shifting the balancing weight if necessary, and adjust the level.

COMPASS CORRECTION

This may be determined by observing at a station where observations have been made with an instrument known to be free from error, as at one of the magnetic stations of the Coast and Geodetic Survey. The difference between the declination for such a station furnished by this office and the value determined by the surveyor's compass represents the correction which must be applied to results with the compass. For high-grade modern compasses the correction is small, but for older instruments a quarter of a degree or more is probably not unusual.

TRUE MERIDIAN

Since the direction of the compass needle is constantly changing, and since two compasses may give different readings at the same time and place, it is highly desirable to provide means for referring the compass bearings to the true meridian in every compass survey. The best method is to determine the true bearing of one of the lines of the survey by observations on Polaris or the sun, as explained in Special Publication No. 126. The difference between the true bearing and the compass bearing (with the compass correction applied) gives the magnetic declination at that particular time and place. If there is no evidence of local disturbance, this value may be assumed to apply to all the lines of the tract. When in later years a surveyor makes a resurvey of the tract, he can reestablish one of the lines by astronomical observations and determine the declination with his compass. The difference between the two values of the declination can then be used as a correction to be applied to the earlier compass bearings.

As a rule, however, the determination of a true bearing for each survey is not feasible. The next best thing is the establishment of a true meridian line centrally located in the field of the operations of the surveyor (usually the county seat in the case of the county surveyor) at which he may determine the value of the magnetic declination at any time with his compass, which value should be recorded with any survey which he makes at that time. His observations should be repeated at least once a year to guard against possible changes in his compass and to take into account the secular change in the declination.

When in later years another surveyor wishes to retrace the lines of the survey, the declination determined with his compass at the same meridian line will give him the correction to be applied to the compass bearings of the earlier survey.

MAGNETIC STATIONS

In many cases a surveyor will not be in a position to establish and maintain a meridian line which is a suitable place for testing compasses and which will remain available in future years. The magnetic

so that magnetic instruments are frequently used in detecting bodies of the ore and in outlining their extent.

One of the best-known deposits is in a belt which extends through the northern part of Avery and Mitchell Counties in North Carolina, and Carter County in Tennessee. Extensive deposits have been discovered also in Ashe, Alleghany, Catawba, Davidson, Gaston, Guilford, Lincoln, and Rockingham Counties, but this by no means exhausts the list of localities where it has been found. Anyone interested in a detailed account of the locations, or in references to the other literature on the subject, may consult Bulletin No. 32 of the North Carolina Geological and Economic Survey, Magnetic Iron Ores of East Tennessee and Western North Carolina.

In addition to disturbances due to natural conditions there may be artificial disturbances caused by the proximity of iron pipes, buildings, iron fences, electric car lines, etc. Power lines carrying alternating current will have no effect. As these artificial disturbances are subject to change with time, they should be looked out for when retracing old surveys. They are of special importance in the vicinity of a magnetic station, as they may render the station useless for determining the compass correction.

The tools of the surveyor should not be overlooked in this connection. An ax, lining pole, steel tape, or pins may deflect the needle if brought too near, and the brim of a stiff hat usually contains a strip of steel which may have an appreciable effect on the needle.

LEGISLATION

The importance of the testing of surveyors' compasses has been recognized in several States by the passage of laws requiring the establishment of meridian lines and the testing of surveyors' compasses at stated intervals. Unfortunately, in many cases the location of the meridian line was not such as to insure freedom from present and future artificial disturbances, and in others either the compass tests were not made or the results not recorded, so that the object of the laws has not been fully attained. The law of North Carolina relating to the use of meridian lines and magnetic stations is as follows:

An act regulating the use of and for the protection of meridian monuments and standards of measure at the several county seats in North Carolina. (March 7, 1899)

Whereas meridian monuments for determining the variations of the magnetic needle of the compass from the true north and a standard length for measuring surveyors' chains have already been established in nearly one-half of the counties of the State by the North Carolina Geological Survey and the United States Coast and Geodetic Survey, cooperating with the commissioners in the several counties, and similar provision has been made for establishing such standards at the remaining county seats of the State during the present year, and

Whereas it is of great importance in the making of all surveys of boundaries of land, townships, counties, etc., that the chains, compasses, and other instruments used by surveyors should at intervals be properly tested.

The General Assembly of North Carolina do enact:

SECTION 1. That every surveyor operating in any of the counties of this State with magnetic instruments, whether in a public or private capacity, shall, between the first day of January and the thirty-first day of December in each and every year, carefully test his needle upon the official meridian monuments in the county in which he resides, or the nearest county in which such monuments have been erected, by adjusting his instrument over the intersection of the lines cut into the top of one of the meridian monuments so established and sighting to the intersection of the lines cut into the top of the other meridian monument, noting the variation of the magnetic from the true meridian and the direction thereof, and shall test the chain or other instrument of linear measure upon the distance from center to center, as indicated by intersecting lines of the two brass tablets or other official monuments set at or near the county courthouse for this purpose, noting the error of such instrument as compared with the standard of the monuments. Such tests and the corrections, if any resulting therefrom, shall be returned by the surveyor in writing and under oath to the register of deeds for the county in which such meridian in situate within ten days from the taking of the observations aforesaid, setting forth the name of the surveyor, his residence, the character of the instrument tested, the date of the observations, the declination east or west of the magnetic needle from the true meridian, together with a fee of ten cents for filing and recording the same; and such return shall be filed and recorded by the register of deeds in a book properly ruled and lettered, to be furnished by the board of commissioners of the county, to be used for such purpose exclusively, and entitled "The meridian record": *Provided*, That before making surveys in any county other than the one in which the magnetic instruments and instruments for linear measure to be used have already been tested, said surveyor shall procure in writing from the register of deeds of the county in which said monuments have been established, nearest to the point where the survey is to be made, a statement giving the declination of the magnetic needle for the year in which it was last determined and the rate and direction of variation of said magnetic needle since that time, and this data shall be recorded as a part of the record of his survey: *Provided further*, That no surveyor shall be required to go outside of the county in which he resides for the purpose of testing the instruments herein named.

SEC. 2. That it shall be the duty of the board of county commissioners to maintain and protect such meridian monuments and tablets or monuments for the testing of chains or other instruments of linear measure, established by the State or National surveys, cooperating with the county authorities, in good order and condition as the official standards of the county.

SEC. 3. Any person or persons who shall in any manner injure, deface, remove, or destroy such monuments or tablets, or any part thereof, or who shall fail, neglect, or refuse to do and perform any act, matter, or thing by this act required of him or them to be done, shall be guilty of a misdemeanor, and upon conviction thereof shall pay a fine or be imprisoned, or both, at the discretion of the court, for every such offense.

SEC. 4. That this act shall be in force from and after its ratification.

An act to amend chapter six hundred and sixty-five, laws of eighteen hundred and ninety-nine, relating to the use of meridian monuments in the State

The General Assembly of North Carolina do enact:

SECTION 1. That chapter six hundred and sixty-five, laws of eighteen hundred and ninety-nine, be, and the same is hereby, amended by adding at the end of section one the following: "On every official record of a survey of lands made after the first day of July, nineteen hundred and one, in any county in which the said meridian monuments have been erected, there shall be entered by the surveyor making such survey a record as to the date of testing the magnetic instrument used and the amount of the declination or variation of the magnetic needle indicated at such test."

SEC. 2. This act shall be in force from and after its ratification.

In the general assembly read three times and ratified this the 13th day of March, A. D. 1901.

RETRACING OLD COMPASS SURVEYS

One of the most important uses of the surveyor's compass at the present time, and the one that gives the most trouble, is the reestablishment of lost boundary lines originally run by compass. When one line of the tract has been preserved, the surveyor can use the change of compass bearing of that line to correct the original bearings of the lost lines; in fact, it is not necessary to use the compass at all, for the angles of the original surveys can be computed from the recorded bearings of the lines. When two corners of a tract are given that are not the ends of one line, a similar but more laborious method may be used. If he can find in the vicinity a well-defined line known to have been established with the same compass at about the same time as the

lines of the tract in question, that line will suffice to determine the change in the compass bearings that he must use. In any of these ways the surveyor will eliminate possible errors in the two compasses used and the uncertainty inherent in the secular change tables. It is only in the absence of any such definite information that the use of the secular change tables is recommended.

Sometimes the problem is complicated by errors introduced at the time of previous resurveys. Cases are not infrequent where compass bearings given in the original deed are repeated in a subsequent deed, perhaps 50 years later, when the bearings may have changed a degree or more. In other cases, where a piece of property has been subdivided, the bearings of the old lines are not changed in the new deed, but the bearings of the subdividing lines are given as observed at the time of the subdivision.

EXPLANATION OF TABLES AND CHART

DERIVATION OF SECULAR CHANGE TABLES

To assist surveyors in redetermining lost boundary lines fixed originally by compass, where local information on the change of bearing of lines is lacking, this bureau has made a careful study of all available data on the change of the magnetic declination with time and has prepared tables showing approximately the change from the date of the earliest observations to the present time, for all parts of the United States.

The secular change of the magnetic declination appears to be more or less periodic in character; at least, it does not go on indefinitely in one direction. Eventually a turning point is reached, and a motion in the opposite direction sets in. Apparently several centuries are required for the full development of one of these swings, a period longer than is covered by reliable observations.

One reversal has occurred in North Carolina since the beginning of the record of magnetic observations in that State. In the eastern part of the State this easterly extreme occurred about 1805; since that time the declination has changed to the westward about 6°. In the western part of the State the reversal occurred about 10 years later and the westerly motion since then has amounted to only about 4½°.

From an inspection of the tables it will be seen that the rate of change is not uniform from decade to decade. At present, west declination is increasing and east declination is decreasing all over the United States except the extreme southern part. In North Carolina the rate of change varies from a little more than one minute a year in the southwestern part of the State to about 2½ minutes a year in the northeastern part.

The determination of the secular change is entirely a matter of observation, since its cause is not known and no law or formula has been found which will represent the observed changes. Hence it is not safe to predict the change for more than a few years in advance of observation. For the past 75 years the Coast and Geodetic Survey has been making systematic observations at repeat stations in all parts of the United States to keep track of the secular change of the earth's magnetism. The present program provides for repeating observations at a network of about 150 selected stations covering the whole country, at intervals of about five years. Experience has

shown that from the changes observed at this limited number of stations the changes at intermediate stations can be estimated with sufficient accuracy for most purposes.

This bureau's knowledge of the secular change prior to 1855 is based on data collected from various sources, limited in amount and of varying degrees of accuracy. Considerable information has been received from local surveyors, based on their experience in retracing the lines of old compass surveys, and additional data from this source would be a welcome addition to that already on file.

The secular change tables given here are the same as those in Serial No. 303, with extension of the tables to 1930 on the basis of the later observations, and some modifications for places where it was necessary to establish new stations in 1931. The values of declination in a table apply strictly only to the magnetic station specified. However, the *change* of declination from year to year given in a table applies equally well to any other place in the county, even though the declination there may differ materially from that at the county seat.

USE OF SECULAR CHANGE TABLES

In using these tables the surveyor must bear in mind the uncertainties incident to the use of the compass and should not be surprised if, for example, the change in declination since the early part of the nineteenth centry, as given by the tables, differs by as much as half a degree from the value indicated by his own tracing of old lines. The tables are intended to give the actual change in the magnetic declination, eliminating as far as possible the errors of individual instruments; but they are only approximate, and the earlier portions are less reliable on account of the inferior character and limited amount of the data on which they are based.

The figures on any line of the tables refer to January 1 of the year given in the first column. A value for any other date must be found by interpolation from the tabular quantities. While the rate of change is not constant even for a period of five years, it is accurate enough for all practical purposes to assume that the annual change is uniform for the interval between tabular values.

In case it is desired to estimate the value of the declination at some time later than January 1, 1930, the rate of change of the declination in 1930, as it is given at the foot of each secular-change table, provides as good a means of estimating future values as is available. As already pointed out, it is not safe to predict more than a few years in advance of observation.

The following examples are intended to illustrate the use of the tables for problems similar to those which the surveyor may encounter. That table should be used which is nearest to the locality of the survey.

(*a*) What was the change of magnetic declination in the vicinity of Wake Forest, N. C., between March 1, 1848, and January 1, 1930?

The list of stations shows that Wake Forest is in Wake County. On looking up Wake County in the secular-change table, we find that Raleigh is given, and not Wake Forest; but, since the change of declination from year to year is practically the same for near-by places even when the declination itself is different, we will find the

change of declination at Raleigh for this interval. In the secular-change table we find the following:

	Declination
January 1, 1840	0° 51′ E.
January 1, 1850	0° 20′ E.
January 1, 1930	4° 07′ W.

The declination decreased 31′ between 1840 and 1850, and as March 1, 1848, is 8.2 years later than January 1, 1840, we assume a uniform change of 3.1′ per year during the 10 years and subtract 25′ (8.2×3.1′) from 0° 51′ E., which gives the declination for the dates of the problem as follows:

	Declination
March 1, 1848	0° 26′ E.
January 1, 1930	4° 07′ W.
Change of declination	4° 33′

The declination has changed 4° 33′ during this interval, and this is the correction which must be applied to magnetic bearings determined about March 1, 1848, to produce the magnetic bearings of the same lines on January 1, 1930. This should be the value of the change of declination in any part of Wake County to within a few minutes. The direction in which this correction is to be made can be found as in the next example.

(*b*) In Currituck County, in June, 1852, a line was run out with a compass and found to have a magnetic bearing N. 37° 50′ E. It is desired to know what was the magnetic bearing of the same line in August, 1891.

By turning to the secular-change table for Currituck County we find the following values of the magnetic declination at Currituck:

	Declination
June, 1852	1° 50′ W.
August, 1891	4° 17′ W.
Change of declination	2° 27′

During the interval the north end of the compass needle has been moving westward, and consequently bearings in the northeast quadrant have been increasing. The correction should then be added to the magnetic bearing in 1852 to give the magnetic bearing in 1891.

	Magnetic bearing
June, 1852	N. 37° 50′ E.
Change of declination	+2° 27′
August, 1891	N. 40° 17′ E.

(*c*) What will be the value of the declination at the magnetic station at Murphy on January 1, 1934?

By turning to the list of stations, we find that Murphy is in Cherokee County. The secular-change table for Cherokee County shows that there is a decrease of east declination of about 1.2 minutes per year in 1930. January 1, 1934, is 4 years later than January 1, 1930, so the change of declination during this period will be a decrease of about five minutes. This is to be subtracted from 1° 24′ E., the value of the declination on January 1, 1930; so the value of the declination at the magnetic station at Murphy on January 1, 1934, will be about 1° 19′ E.

FIGURE 1.—MAGNETIC STATION MARKER

MAGNETIC DECLINATION TABLE

This table contains values of the declination for January 1, 1930, for all places in the State at which observations have been made by the Coast and Geodetic Survey, arranged alphabetically by counties. None of the declinations were actually measured on that date, but for convenience in using the table the values were reduced to that date by means of secular change tables.

The latitudes and longitudes were derived from various sources and vary considerably in precision. A few stations were also geodetic stations, and precise positions were available for these. In numerous other cases it was possible to make an accurate location of the magnetic station on one of the nautical charts of the Coast and Geodetic Survey or on one of the topographic sheets of the Geological Survey. Where none of these methods could be followed, the positions adopted were usually those resulting from the astronomic observations which accompanied the magnetic observations. The probable error of these observations is about one-half a minute in latitude and about one minute in longitude. Where the position is given to the nearest minute only, it was usually scaled from the map published by the Post Office Department.

The last column of the table gives the date of the last report on the condition of the station, which may be either the date on which it was last occupied for magnetic observations, or the date on which it was visited by a public-spirited citizen, whether surveyor or not, who responded to the request of the Coast and Geodetic Survey for information in regard to stations which it had not been possible to visit in the course of magnetic work. Where no date is given, either the station was not permanently marked or is known to be no longer available for use. In most cases where the station is no longer available for use the given value for the station does not refer to a point which can be recovered, but must be considered as valuable for giving a general value for the region, or for magnetic map-making purposes, in which the marking of the station is of no significance.

DESCRIPTIONS OF STATIONS

Magnetic observers are required, as a rule, to mark each point at which observations are made and to furnish a description of the station, so that it may be found by anyone desiring to make subsequent use of it. In the first magnetic survey of North Carolina meridian lines were established at nearly every station, the ends marked by substantial stone posts lettered "N. C. G. S., U. S. C. S." In recent years a stone post set with its top projecting but little above the surface of the ground, or a hole filled with concrete, are the usual forms of marker. In the top of the marker is set a bronze disk 3½ inches in diameter, with a stem 3 inches long, as shown in Figure 1. The year of setting the marker is stamped on the disk.

Most descriptions include the true bearing of one or more prominent objects, from which the direction of true north may be obtained just as well as from a meridian mark. In using these objects care should be taken to insure identification, preferably by measurement of the angle between two objects. The observer is instructed to select

objects about which there can be no confusion, but this is not always possible. Also, with lapse of time there may be changes in the objects used at the time of observation.

With change of surroundings due to growth of cities or other causes, descriptions of stations frequently require modification. Some cases of such changes have already been reported by local surveyors and others and have been incorporated in the descriptions. Anyone having occasion to use any of the stations is requested to note needed changes in the descriptions and report them to this office.

It should be understood that when the description says the stone is "north," for example, from a given object, it means merely that it is in a general northerly direction.

ISOGONIC CHART

The isogonic chart is intended to show graphically by means of lines of equal magnetic declination (isogonic lines) the general distribution of the magnetic declination throughout the State on January 1, 1930, and thus to furnish means for finding approximately the value of declination at a place where observations have not been made. The lines have been drawn for each full degree of declination, which, in view of the prevalence of local disturbance, seems frequent enough to show the distribution as well as it can be done from the number of observations available. The values of declination upon which the chart is based are shown on the map to the nearest tenth of a degree.

In general, there are very few values which are exactly the amount selected for a particular line—there are very few stations, for example, at which the reduced declination is exactly 4° west—so that the location of the line must depend largely upon interpolation between values a little larger and a little smaller than the selected amount. At first sight it would appear that a particular line should be drawn so that all greater plotted values will fall on one side and all smaller values on the other. This practice can be followed where the distribution is regular, or nearly so, but where there is local disturbance—as in North Carolina—a little consideration will show that this method will not give the best representation of all the data.

An inspection of the plotted values shows that there is a marked lack of uniformity in the changes between stations. The real lines of equal declination would be a very complex system of bends and loops or closed curves, which could not be fixed accurately without observations many times as numerous as those now available. It is probable that in many cases the areas of local disturbance are quite limited in extent, so that direct interpolation between observed values would give a less reliable value of declination for an intermediate place than would be obtained from the smoothed isogonic lines.

Because of the prevalence of local disturbance in North Carolina, values of declination obtained from the isogonic chart for places where observations have not been made are subject to considerable uncertainty. Some idea of the amount of this uncertainty may be obtained from a comparison of the observed values of declination with values taken from the chart. For 55 per cent of the stations in the State the difference between chart and observations is less than 15 minutes,

for 78 per cent less than 30 minutes. There are a dozen places where the difference is of the order of 1° and at one station at Concord it amounts to over 2° 30′.

It should be borne in mind, however, that there may be local disturbance where none is indicated by surrounding stations and also that an anomalous observed value may be due to a disturbed area of very limited extent; but in most parts of the State the difference between chart and observations is a good guide to the reliability of a chart value in that locality.

List of stations

Station	County	Station	County	Station	County
Aberdeen	Moore.	Hayesville	Clay.	Roan High Bluff.	Mitchell.
Albemarle	Stanly.	Henderson	Vance.	Robbinsville	Graham.
Asheboro	Randolph.	Hendersonville	Henderson.	Rockingham	Richmond.
Asheville	Buncombe.	Hertford	Perquimans.	Rocky Mount	Edgecombe.
Bakersville	Mitchell.	Hillsboro	Orange.	Roxboro	Person.
Bayboro	Pamlico.	Jackson	Northampton.	Rutherfordton	Rutherford.
Beaufort	Carteret.	Jacksonville	Onslow.	Salisbury	Rowan.
Big Butt	Madison.	Jamesville	Martin.	Sand Island	Dare.
Block House	Polk.	Jefferson	Ashe.	Sanford	Lee.
Boone	Watauga.	Kenansville	Duplin.	Scotland Neck	Halifax.
Brevard	Transylvania.	Kinston	Lenoir.	Shelby	Cleveland.
Bryson City	Swain.	Knotts Island	Currituck.	Smithfield	Johnston.
Burgaw	Pender.	Lake Waccamaw.	Columbus.	Snow Hill	Greene.
Burnsville	Yancey.	Laurinburg	Scotland.	Southport	Brunswick.
Camden	Camden.	Lenoir	Caldwell.	Sparta	Alleghany.
Cape Hatteras	Dare.	Lexington	Davidson.	Statesville	Iredell.
Cape Lookout	Carteret.	Lillington	Harnett.	Swanquarter	Hyde.
Carthage	Moore.	Lincolnton	Lincoln.	Tarboro	Edgecombe.
Chapel Hill	Orange.	Littleton	Halifax.	Taylorsville	Alexander.
Charlotte	Mecklenburg.	Louisburg	Franklin.	Trenton	Jones.
Chicamacomico	Dare.	Lumberton	Robeson.	Troy	Montgomery.
Clinton	Sampson.	Manteo	Dare.	Wadesboro	Anson.
Columbia	Tyrrell.	Marion	McDowell.	Wake Forest	Wake.
Columbus	Polk.	Marshall	Madison.	Warrenton	Warren.
Concord	Cabarrus.	Mocksville	Davie.	Warsaw	Duplin.
Currituck	Currituck.	Monroe	Union.	Washington	Beaufort.
Dallas	Gaston.	Morganton	Burke.	Waynesville	Haywood.
Danbury	Stokes.	Mount Airy	Surry.	Webster	Jackson.
Dobson	Surry.	Murphy	Cherokee.	Weldon	Halifax.
Durham	Durham.	Nashville	Nash.	Wentworth	Rockingham.
Edenton	Chowan.	New Bern	Craven.	Whitakers	Edgecombe.
Elizabeth City	Pasquotank.	Newland	Avery.	Whiteville	Columbus.
Elizabethtown	Bladen.	Newton	Catawba.	Wilkesboro	Wilkes.
Enfield	Halifax.	Northwest	Currituck.	Williamston	Martin.
Fair Bluff	Columbus.	Ocracoke N. E. Base.	Carteret.	Wilmington	New Hanover.
Fayetteville	Cumberland.	Oxford	Granville.	Wilson	Wilson.
Franklin	Macon.	Pittsboro	Chatham.	Windsor	Bertie.
Franklinton	Franklin.	Plymouth	Washington.	Winston-Salem	Forsyth.
Gatesville	Gates.	Poore	Wilkes.	Winton	Hertford.
Goldsboro	Wayne.	Raeford	Hoke.	Yadkinville	Yadkin.
Graham	Alamance.	Raleigh	Wake.	Yanceyville	Caswell.
Greensboro	Guilford.	Riddicksville	Hertford.		
Greenville	Pitt.				
Halifax	Halifax.				

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