Terrestrial Magnetism

and

Atmospheric Electricity

VOLUME V MARCH, 1900 NUMBER 1

THE PHYSICAL DECOMPOSITION OF THE PERMANENT MAGNETIC FIELD OF THE UNITED STATES—NO. 1. THE ASSUMED NORMAL MAGNETIZATION AND THE CHARACTERISTICS OF THE PRIMARY RESULTING RESIDUAL FIELD.[1]

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[Abstract.]

In the March (1899) issue of the Journal, L. A. Bauer published a paper entitled, "The Physical Decomposition of the Earth's Permanent Magnetic Field," and in that paper were developed the principles and formulæ upon which the decomposition was based. The present paper is an application of these principles and formulæ for a special portion of the Earth, namely, the United States of America.

This investigation is based upon the series of magnetic charts constructed by Mr. C. A. Schott for the year 1900, and published in Appendix No. 1, Coast and Geodetic Survey Reports for 1896, and 1897. These charts give us the best possible representation of the distribution of the magnetic elements in the United States up to the date of the construction of the charts.

Although they will receive modifications with the addition of later data, it is not believed that their general aspect will be very materially changed.

Values of the magnetic declination, inclination, and horizontal intensity were scaled for every two degrees in latitude from 48° N.

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to 30° N. and in longitude between 70° W. and 124° W. of Greenwich. The rectangular components X, directed northward, Y, directed eastward, and Z, directed vertically downwards, were next computed with the aid of the usual formulæ, namely:

$$X_m = H \cos D$$
$$Y_m = H \sin D$$
$$Z_m = H \tan I,$$

in which subscript m stands for "measured component;" *i. e.*, component based upon the observed magnetic elements; and H is the horizontal intensity, D, the declination, and I, the inclination.

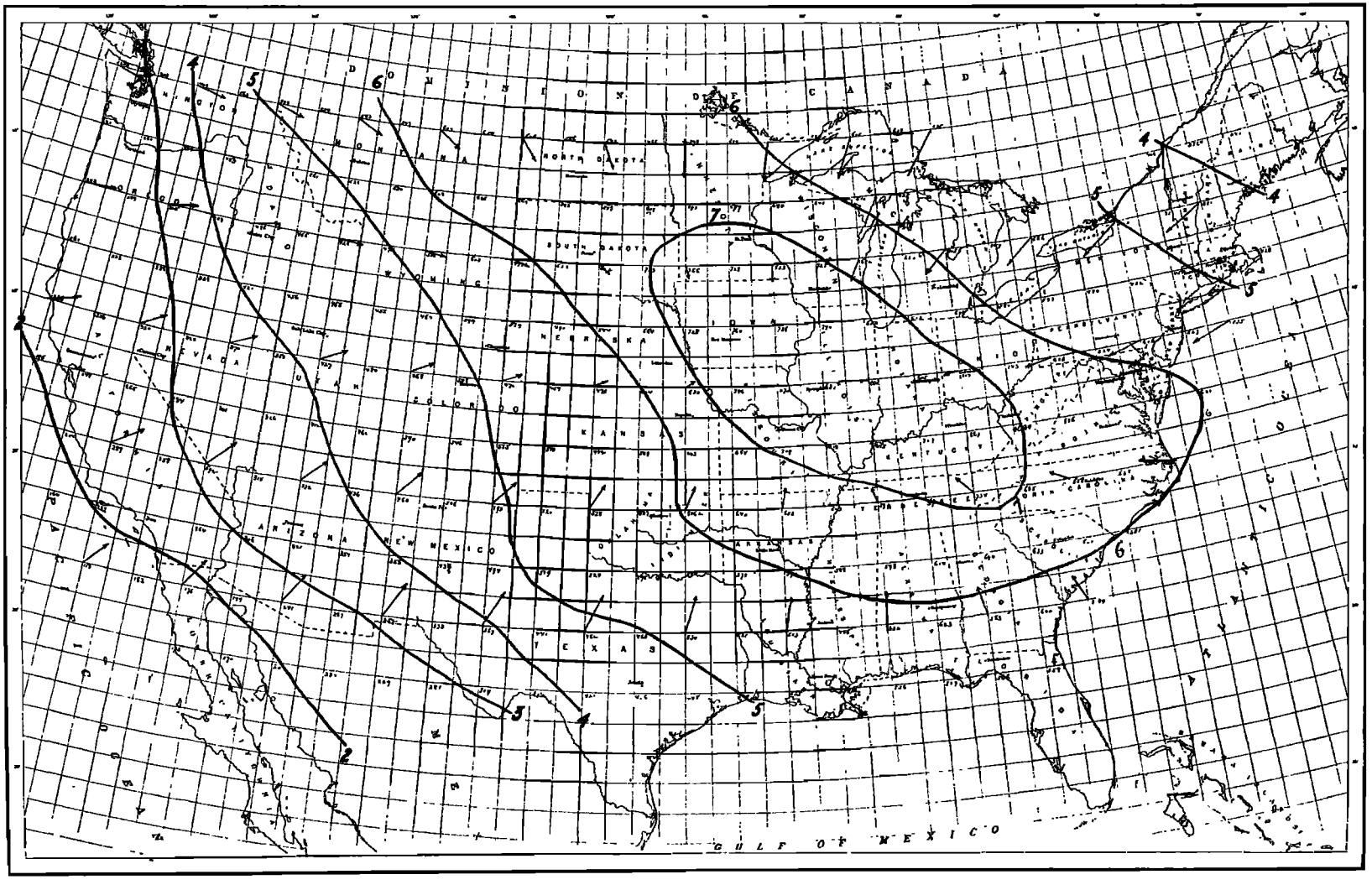
The normal magnetic components; *i. e.*, X_n, Y_n, and Z_n were obtained on the following basis:

The normal distribution of the Earth's magnetism in 1885 is defined as "that which can be regarded as resulting from a uniform or homogeneous magnetization, the axis of which intersects the Northern Hemisphere in latitude 78° 24′.3, and in longitude 68° 30′.6 W. of Greenwich, and the magnetic moment of which has the value .32298 R^3 c. g. s. units, R being the earth's mean radius."

These values of the Earth's magnetic moment and the position of the Earth's magnetic axis were obtained by Dr. Adolf Schmidt in his latest harmonic analysis of the Earth's permanent magnetic field. It remained to determine the position of the magnetic axis for 1900. This was obtained provisionally with the aid of the annual rate of motion deduced by L. A. Bauer in the March (1899) number of the JOURNAL, p. 55, where it was found that the uniform magnetic field from 1780 to 1885 had been sliding practically along a parallel of latitude from east to west at the average rate of 0°.183 longitude per annum. According to this rate of motion the position of the northern intersection of the magnetic axis on January 1, 1900, would be in latitude 78° 34′.3 N. and in longitude 71° 15′.3 W. of Greenwich.

The normal magnetization being thus defined, the normal components were computed according to the formulæ given in the paper cited above and the residual components, $X_r = X_m - X_n$, $Y_r = Y_m - Y_n$, $Z_r = Z_m - Z_n$, were derived. The quantities were checked by Mr. J. A. Fleming, of the Division of Terrestrial Magnetism.

The chart opposite shows the distribution over the United States of that part of the Earth's magnetism which can not be referred to



THE PRIMARY RESIDUAL, MAGNETIC FIELD FOR THE UNITED STATES. EPOCH, 1900.

a uniform magnetization about some diameter. The curved lines are the lines of equal residual vertical force and the arrows represent the direction assumed by the north end of a compass needle setting itself tangent to the lines of force of the residual magnetism. The figures attached to the curved lines are units of the second decimal c. g. s. It will be noted how strikingly these arrows point towards the focus of the curves approximately in latitude 42° N. and longitude 92° W.

Over the entire United States the residual vertical force quantities are positive; that is, the observed components exceed the normal components; or, in other words, the vertical force of the earth's magnetism is *increased* over the United States by some cause. The focus of the curves represents, then, in a certain sense, a secondary magnetic pole. The fact that the north end of the magnetic needle in this residual field points to the focus of maximum positive vertical force, implies (were we to apply Ampere's rule) that the cause of the residual field as might be expected *a priori* lies beneath the surface.

The largest value of the residual vertical force encountered in the United States is 796 of the fourth decimal c. g. s.; that is, about one-seventh of the observed vertical force; or, in other words, the assumed normal magnetization will represent about nine-tenths of the vertical force of the total magnetic field for the United States.

The general characteristics of this special chart are similar to those of the general chart for the Earth given in the paper to which allusion has already been made. It may again be pointed out that the maximum residual vertical force quantities are encountered in that part of the United States which is relatively cold, and that the quantities diminish as we approach the coasts, as though the unsymmetrical distribution of the earth's magnetism and temperature are, in some way, related.

The surprising regularity of the residual vertical force curves makes it clear that it will be possible to represent the greater portion of the present residual field by a secondary uniform magnetization about a diameter passing through the focus of the curves. This will be our next step, and a sub-residual field determined. The residual quantities then obtained will doubtless be of the order of those to be expected from geological formations; namely, quantities in the third decimal c. g. s. and occasionally in the second. To distinguish the residual field now obtained it has been termed, provisionally, the "*primary*, residual field."