DIRECTIONS FOR MAGNETIC MEASUREMENTS.[1]

Magneticians generally will welcome the appearance of this publication, both because of its excellent presentation of the essentials of field and office practice and because of its general suggestiveness. Its aim is "to present the subject matter in such form that an observer familiar with the use of instruments of precision but without experience in magnetic work may be able to make in satisfactory manner the various observations incident to the determination of the magnetic elements, without other assistance than that to be obtained from these Directions." Not only has the author effected this purpose but he has also covered the subject of magnetic computations as fully as that of observation, by concise derivation of the various formulae involved, the discussion of their use, and numerous tables particularly helpful to the practical computer. The manual presents in a very concise and finished form, the results of the experience of the United States Coast and Geodetic Survey since its magnetic work was placed on a systematic basis by C. A. Schott, and developed subsequently, in the separate Division of Terrestrial Magnetism of that Survey, under the direction of Dr. L. A. Bauer; the system of observation, and reduction of results, as well as the general directions to observers in the field as given, are essentially those developed by the latter on the foundation laid by Schott.

After a short introduction, giving a brief account of terrestrial magnetism, derivations of the various formulae necessary for the determination of the magnetic elements are given, together with a discussion of the various observation corrections necessary. The subject of the determination of the constants of a magnetometer is carefully detailed. The discussion of the Coast and Geodetic Survey methods as regards the troublesome question of distribution coefficients is of particular interest. The rather tedious observation and computation of these coefficients is simplified for the instruments designed by the Survey, by the adoption of a ratio of length of long magnet to length of short magnet such that the first coefficient, P, is practically zero, this ratio being, from the relation $P = 2l^2 - 3l_1^2$, where l and l_1 are the lengths of the long and short magnets respectively, 1.225. In practice it is found that under

[1]HAZARD, D. L.—Directions for magnetic measurements. United States Coast and Geodetic Survey. Government Printing Office. Washington. 1911.

these conditions the value of P as computed from deflections at two distances, neglecting subsequent coefficients, is between zero and —1. The value of the second coefficient, Q, may then be supplied from the formula and a revised value of P taken, but it is shown that all terms except that in P may in this type of instrument be omitted with an error within one part in 5000. If, in the course of the season's work a systematic difference is shown in the values of log H/m at the two distances, P may be readily corrected from the relation

$$\Delta P = \log_\epsilon 10 \frac{r_2^2 r_1^2}{r_2^2 - r_1^2} \left[\log\left(\frac{H}{m}\right)_2 - \log\left(\frac{H}{m}\right)_1\right]$$

These magnetometers are so arranged that there are only two deflection distances. It would seem, however, more satisfactory, especially where the survey is to cover very wide ranges in horizontal intensity, to provide additional deflection distances so that two pairs of deflection distances might be employed, in which case values for both P and Q might be obtained from the field observations without the use of the more cumbersome method of deflections at three distances. For example, where distances 30 and 40 cm. are used for comparatively low values of horizontal intensity, 27.5 and 35 cm. may be used for higher values of the horizontal intensity. The ratio of the horizontal intensity to the magnetic moment at 30 cm. when equated to the value at 40 cm. gives an equation of the form: $aP + bQ = K$; similarly a second equation can be formed for the observations at 27.5 and 35 cm. The computation of the coefficients by such a method is quickly made and obviates any uncertainties resulting from neglecting the coefficient Q.

In the chapter of general directions for the use of observers making land observations a large section is devoted to the details of the selection, description and marking of stations, and quite properly, for these parts of the observer's work are of very great importance and there is unfortunately a general tendency to give them only secondary attention. More time is often required to select and mark a station than to make the observations, but such time is well spent since observations made at an improper location are worse than useless and a station not well marked either by monument or by detailed description can not be safely used for secular variation determinations. Secular variation data from fixed observatories cover but a very small portion of the whole

land area to be surveyed and for the larger part secular variation data from field repeat stations must be relied upon. If all observers would select and mark or describe their stations with the care contemplated in these instructions much of the uncertainty in secular variation data now ascribed to instrumental or observational imperfection would doubtless be eliminated. Detailed specimens and instructions for the use of theodolite, magnetometer, compass declinometer, dip circle compass attachment, dip circle, and earth inductor for the determination of declination, dip, horizontal and total intensity, together with descriptions of the types of instruments used, follow. The adoption of fixed forms for each class of observation is without question of much importance in the very rapid prosecution both of the field and office work in the operations and publication of the Survey.

A chapter is devoted to directions for observations at sea. The development in the instrument shop of the Survey of the Lloyd-Creak dip circle so that total intensity work can be carried out throughout the world by the provision of two deflection distances is of particular interest. This is followed by a chapter of directions regarding the installation and operation of variation instruments as used at the magnetic observatories of the Survey. It is interesting to note here again the care with which all routine work has been systematized and reduced to a uniform basis by the use of forms.

There is appended to the manual a section giving such tables as are useful for magnetic computations, including, for example, tables of refraction and parallax, correction in latitude and azimuth for sun's semi-diameter, constants for reducing circum-meridian altitude observations, corrections to be applied to the time of one oscillation for torsion effect and chronometer rate, and tables of mean diurnal variation in the elements as obtained at the observatories of the Survey for two or more years preceding 1906.

This work is a very useful and valuable compilation and is put out in a form which adapts it peculiarly to the use of the man in the field as well as the computer. Its publication and distribution among magneticians not only provides a useful manual but will furnish the standard by which the comparative efficiency of the magnetic work of the Coast and Geodetic Survey may be measured. A comparison of the details of field work and office reduction as set forth in this manual with those of other organizations as they may appear from time to time will assist in giving proper weight to the results of various agencies engaged in gathering magnetic data and thus materially aid the completion of the project of the magnetic survey of the entire earth. H. W. Fisk.

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