

COMPARISON OF THE MAGNETIC INSTRUMENTS IN THE OBSERVATORIES OF THE BRITISH ISLES.

THE committee appointed by the British Association for the purpose of comparing the magnetic instruments in the different observatories of the United Kingdom, presented a report to Section A of the Association, at its Liverpool meeting in 1896, showing that the comparison of the Kew standards with the instruments in use at Falmouth, Stonyhurst, and Valentia was carried out, during the summer of 1895, by Professor A. W. Rücker and Mr. W. Watson.

At Greenwich no comparison could be made because the magnetic surroundings of the declination needle in use there made it necessary, in order to be certain of the accuracy of the results, to place the comparing instrument on the same site, but the peculiar form of the Greenwich needle makes it impossible to put another in its place.

The magnetometer and dip circle used in the recent magnetic survey of the United Kingdom were transported from place to place for the purpose of making the comparisons, having been compared with the standard instruments at Kew Observatory in July, before setting out, and again in October upon the completion of the work at the other observatories. The comparisons were made as follows: "Let C_0 and C be the readings of the self-registering instruments at the time when the value of the element was determined by the Kew standard (K) and No. 70, the comparing magnetometer, (S'), respectively. The $K - C_0 = Z_0$ and $S' - C = Z$ are the values of the zero-line of the self-registering instrument according to the two observations. But, if the observation with No. 70 has been made at the same instant as that with the Kew standard, and if the zero-line remained unaltered in the interval which actually occurred between the two experiments, the simultaneous values of the element given by the two instruments would have been K and $S = S + C_0 - C$; therefore, $K - S = K - C_0 - (S' - C) = Z_0 - Z$."

A summary of these results is given in this table, which is to be read from left to right, thus: The declination given by the Kew standard = that given by the Falmouth instrument -0.8 .

	Falmouth	Stonyhurst	Valentia	
	-0.8	$+1.1$	-0.0	Declination
Kew	-1.6	$+2.2$	-1.8	Dip
	-0.00018	-0.00006	$+0.00029$	Horizontal Force (C. G. S. units)
				G. W. LITTLEHALES.

DISTRIBUTION OF MAGNETISM IN SOUTHERN SWEDEN.

CARLHEIM-GYLLENSKÖLD, V.: *Mémoire sur le Magnétisme Terrestre dans la Suède Méridionale*. Kongl. Svenska Vetenskaps-Akademiens Handlingar. Bandet 27, No. 7. Stockholm, 1895, 4°, 93 pp., 5 plates.

IN the important work before us the author has attempted, with the aid of old and new observations, to give for the epoch September 1, 1892, a representation of the actual distribution of the magnetic elements in southern Sweden. It is unfortunate, as the author himself has recognized, that Ångström's numerous observations were not at his command for this purpose. The observation data, which in general were unreduced, had to be corrected first for the daily and the secular variation. As, sad to say, there is no magnetic observatory provided with self-registering instruments in Sweden, use had to be made in the reduction to mean of day of the term observations

(1st and 15th of month) made during the polar year 1882-3. As the diurnal variation varies with place and date the correction thus obtained was, of course, only approximate. Furthermore, to reduce the inclination to mean of day, the data of the Pawlowsk Observatory had to be utilized.

To obtain the secular-variation correction, formulæ were established for places where long series of observations were obtainable, viz., Copenhagen, Gothenburg, Christiania, Stockholm, Upsala and Haparanda. At first a quadratic parabolic formula was used to represent the horizontal-intensity observations, but as it was found that the coefficient of the second term was very small for all the stations with the exception of Upsala,¹ a simple linear formula was employed. Next the time coefficient was expressed as a linear function of the latitude, the final formula for the annual change $\frac{dH}{dt}$, in units of the fifth decimal C. G. S. being,

$$\frac{dH}{dt} = 13.44 - 0.647 (\phi - 59^\circ.13) + 1.32 (\kappa \cos \phi - 1^\circ.48),$$

where ϕ = latitude and κ = longitude, reckoned west from Stockholm.

For the secular variation of the declination a four-term series (argument time to fourth degree) was employed. As it was found that the coefficients of the different terms for the various places were nearly alike, the final formula used was obtained by taking the mean coefficient for each term, viz.:

$$\Delta D = [0.3778] (t - 1800) + [9.0588 \pi] (t - 1800)^2 + [5.9595 \pi] (t - 1800)^3 + [4.7021] (t - 1800)^4,$$

the bracketed quantities being the logarithms of the coefficients. This close agreement of the coefficients is a matter of some surprise for, *a priori*, one might expect that, since the product $Htg\Delta D$ is an intensity component of the same kind as $\frac{dH}{dt}$, it should likewise vary with locality and according to somewhat the same laws as those of the latter component.

For the representation of the secular variation of the inclination a three-term series (argument time to third degree) was used. In this case, however, the coefficients were found to be dependent upon geographical position. But since the observations were insufficient to permit expressing the coefficients of the higher terms as functions of ϕ and κ , the mean values simply were taken and only the coefficient of the first term was treated as a linear function of ϕ and κ . The final formula obtained was:

$$\Delta i = [-1'.437 + 0'.129 (\phi - 60^\circ) + 0'.0101 \kappa] \tau + 1'.683.10^{-3} \tau^2 + 0'.304.10^{-3} \tau^3,$$

where the time, τ , is reckoned from the year 1850. It should be mentioned that the observations, before the computation, were combined into eleven-year means, in order to eliminate as far as possible the sun-spot and polar-light period.

In this manner all available observations were reduced to the same epoch, giving

Declinations at	278 stations, or one to every 532 ^{km} ² .
Horizontal intensities at	336 " " " 441 "
Inclinations at	233 " " " 635 "

¹This fact appears to be of some interest since there are considerable local disturbances at this place which most likely exert an influence upon the progress of the secular variation. Of course it is also possible that this case of exception is partly accidental, since the series of observations extends back only to 1869.

The isomagnetic lines of all three elements were next drawn without elimination of local disturbances. As was to be expected, these curves presented a most complicated appearance, in the case of the isogonic chart; for example, there are no less than 35 isolated closed areas. The author next proceeds to a mathematical discussion computing first the surface density requisite to produce the observed distribution. This was done with the aid of Gauss's formula *Allgemeine Lehrsätze*, etc., § 35, viz:

$$-4\pi\sigma = \frac{1}{R} (P_0 + 3P_1 + 5P_2 + 7P_3 + \dots)$$

or

$$-4\pi\sigma = \frac{U}{R} + 2V,$$

where R = Earth's mean radius, U = Earth's magnetic potential, and V = vertical intensity. U can be obtained to within a constant term by integration of the equation:

$$dU = -H \cos \epsilon ds,$$

ds being the arc element of the Earth's surface and ϵ the angle it makes with the magnetic meridian. The surface density σ obtained thus, reckoned from an arbitrary zero point, the author regards as the sum of two quantities σ' and σ'' , of which the first is to be referred to the normal distribution of the Earth's magnetism and for the area considered can be taken as linearly variable with geographical position, viz.:

$$\sigma' = a_{00} + a_{10}(\phi - \phi_0) + a_{01}(\kappa - \kappa_0)^2$$

By the method of least squares σ' was obtained and then the residuals $\sigma'' = \sigma - \sigma'$ were derived; σ'' was then to be regarded as representing the surface density of the disturbing magnetic masses. After representing cartographically in colors the distribution of the disturbance surface density, the potential, U , was treated in a similar manner except that in the computation of U , of the normal distribution terms of the second order likewise had, of course, to be taken into account. The chart of the equipotential lines of the disturbing masses, as was to be expected, exhibited great similarity to that of the distribution of σ'' , so that, as a rule, a maximum of south-pole magnetism on the latter chart corresponded to a minimum potential on the former and *vice versa*—the two methods of representation thus mutually checking each other. Again, both charts, as far as the positions of the maxima and minima are concerned, agree, on the whole, very well with that which might be expected from the distribution of the iron bearing rocks. For details we must refer to the original. The author finally raises the question whether the magnetic rocks have been magnetized by induction in the Earth's field, or whether they contain permanent magnetism, in which latter case their magnetism can be considered to be an integral part of that of the Earth's. In the first case, one would expect that the maxima of the south pole magnetism would be more sharply defined and distributed over a much smaller area than those of the opposite magnetism, but the author finds that the ratio of the areas of positive and negative disturbance surface density is as 7:6, or nearly unity, which apparently would declare in favor of the second hypothesis. It seems to the reviewer, however, that this can only have been the result of including in the computation the surface area of the surrounding ocean, and that, therefore, this question must still be regarded as an open one.

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¹ The last term would really have to be further multiplied by $\cos \phi$.