

THE MAGNETIC SURVEY OF TASMANIA.

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Section I. The History of Magnetic Observation in Tasmania.

Section II. Magnetic work in Victoria and New Zealand.

Section III. The work of the proposed Survey.

I. *The History of Magnetic Observation in Tasmania.*

THE earliest record of a magnetic determination in Tasmania I owe to the kindness of Mr. T. Stephens, M.A., one of the Vice-Presidents of this Society. From his communication to me it appears that when Sir John Franklin founded the village of Lachlan in 1839 the magnetic declination at Lachlan was $10^{\circ} 10' E.$

In the first volume of the *Tasmanian Journal* is a copy of the communication addressed by Sir James Ross on the 7th April, 1841, to the British Admiralty, in which he sets forth, among other matters, his discovery of the position of the southern magnetic pole. In latitude $76^{\circ} 14' S.$ and longitude $164^{\circ} E.$ he found the magnetic dip to be $88^{\circ} 40'$, and the declination $109^{\circ} 24' E.$; from which he deduces that he was then only 160 miles from the magnetic pole. The impetus given to magnetic research by his discovery was, probably, the determining cause which led to the subsequent selection of Hobart as the spot on which were afterwards carried out the first systematic magnetic records ever made in Australasia.

From its southerly latitude, its situation relative to the great land-mass of Australia, and its position almost in antipodes to Great Britain, Tasmania is eminently fitted as a station for magnetic observations, and, recognising this, the Royal Society of London, in the early forties, fitted out a complete survey party, with the latest form of instruments, to investigate, under the superintendence of Lieut. Kay, R.N., the magnetic elements of Tasmania, and to determine the rate of variation of these elements. The instruments were set up in the Domain, not far from Government House, and observations were taken covering the period from 1842 to 1850. The results obtained in Hobart were subjected to the closest examination by Sir Edward Sabine, and from them, taken in conjunction

with observations made at a later date in other colonial observatories, some important generalisations were obtained by Sabine with regard to the magnetic problem in the southern hemisphere.

It is a matter of regret that neither in the library of this Society, nor in the public and parliamentary libraries of Hobart, is to be found the official publication of either the magnetic observations made by Lieut. Kay and his colleagues in Hobart, or of Sabine's report thereon. In this context it may not be out of place to state that in the Hobart Observatory is a large accumulation—perhaps 60 or 70 volumes—of the actual records of observation made by the members of the Royal Society's expedition. The scientific enthusiasm of the Government Astronomer, Mr. Kingsmill, has rescued them from the decay into which they were likely to speedily depart if left in the condition in which he found them when he took possession of the observatory; and, though they now rest in the decent obscurity of a shelf in the observatory cellar, this scarcely seems to be a suitable place of interment, and I trust that this Society, as the leading scientific body in Tasmania, may see its way to secure these records, which are, so to speak, scientific heirlooms of the greatest interest.

I will now lay before the Society a brief *résumé* of the results obtained by Lieut. Kay and his party during their prolonged stay in Hobart. In 1843 the mean declination of Hobart was $9^{\circ} 53' 19''$ E., and between this date and 1848 it increased to $10^{\circ} 0' 37''$, giving a total increase of $7' 18''$, or an annual increase of about $1' 27''$. During the period covered by Lieut. Kay's observations the dip fell from $70^{\circ} 42' 18''$ in 1842, to $70^{\circ} 32'$ in 1845: it then began to increase, and in 1848 it had attained the value of $70^{\circ} 35' 42''$. The happy accident that, during Lieut. Kay's stay in Hobart, the dip passed through a minimum value, is a matter for much congratulation. It is also of great interest to find that, during the period under consideration, the mean value of the horizontal intensity also passed through a minimum value. This minimum value was reached, not in 1845, when the dip was at a minimum, but three years later—in 1848. An admirable account of the instruments used by Lieut. Kay in his magnetic work in

Hobart is given by him in Vol. I. (1842) of the *Tasmanian Journal*.

A long gap is now met with in the magnetic history of Tasmania. No absolute determination of the magnetic elements was again made until the visit of Dr. Neumayer to Hobart, in 1863. This observer determined the mean declination of Hobart in 1863 as $10^{\circ} 25' 9''$ E. If the mean rate of increase inferred by Lieut. Kay from his observations had held true over the period between 1843 and 1863 the declination should have been $10^{\circ} 22' 53''$. The difference between the observed and computed values of the declination for 1863 may (in part) be accounted for by the fact that the stations selected by Lieut. Kay and Dr. Neumayer were not identical, though both were situate in the Domain. I shall, later on, have occasion to refer to the part played in magnetic work in Tasmania by the volcanic rock—known as Tasmanian greenstone—which occurs so widely in the S.E. of the Colony, and, in particular, outcrops so much in the Domain. Accepting Dr. Neumayer's result as correct, the increase of declination of Hobart between 1843 and 1863 amounts to $31' 50''$, giving a mean annual increase of $1' 36''$, as against $1' 27''$ computed from Lieut. Kay's observations. The declination in 1881, when the next determination was made, should have been $10^{\circ} 53' 48''$; assuming the previous rate of increase to have been maintained, but the observations made by His Excellency Sir J. H. Lefroy at the station employed by Kay discovered the declination to be only $8^{\circ} 49' 2''$ E., a quantity somewhat more than 2° in defect of the computed value. Although the instrument employed by Sir J. Lefroy—a prismatic compass—is not the most delicate instrument for determining the magnetic declination, the difference between the observed and computed values of the declination in 1881 cannot be put down entirely to errors of observation. The explanation is not far to seek: between the dates mentioned the declination must have attained a maximum, and was, in 1881, proceeding to a minimum. In the neighbouring Colony of Victoria we know that in the 15 years preceding 1881 the declination decreased at the rate of about $2'$ per annum, and from what we know of the secular variations elsewhere, it is permissible to assume

that a state of affairs obtained in Tasmania similar to that in Victoria. If the same weight be attached to Sir J. Lefroy's determination as to that of Dr. Neumayer, we should have that, during the period under discussion, the annual average rate of change of declination was no less than $5'$ —assuming that the maximum declination was reached in 1863—the most suitable hypothesis for reducing the change of declination to a minimum. Seeing that the annual rate of change in Victoria between 1866 and 1881 only amounted to $2'$, it is difficult to accept for Tasmania an annual average rate of change so large as $5'$. The explanation may lie in the rough method of determination employed by Sir J. Lefroy; at all events, it is a matter of some importance that this difficulty should be cleared up.

If any magnetic measurements were made by the American expedition to Hobart to observe the transit of Venus in 1874, I have been unable to find them. The same remark applies to the observations made by the Austrian scientific expedition which visited Hobart between two and three years ago. As, however, the observations of the lastmentioned party were made at the Observatory, where the highly magnetic greenstone outcrops, their results are quite valueless for the purposes of comparison with those of Kay and Neumayer.

The results of the observations taken by Lieutenant Colbeck and Mr. Bernacchi of the Southern Cross, during the recent stay of that vessel in Hobart, have not yet reached me.

This brief summary of the history of magnetic research in Tasmania shows that during the visit of the Royal Society of London's expedition both the dip and the horizontal intensity passed through minimum values, and leads us to infer that after Dr. Neumayer's visit the declination passed through a maximum value, but when this occurred we do not know, and what is the present annual rate of change of the declination we do not know.

II.—*Magnetic work in Victoria and New Zealand.*

Absolute magnetic measurements were first begun in Victoria, in 1858, by Dr. Neumayer. Between that date and February, 1863, he carried out, without interruption, hourly readings of the magnetic elements, these differen-

tial observations being kept under control by frequent determinations of the absolute values of the magnetic elements, eight such absolute determinations being made, on the average, each year. During the same period Dr. Neumayer made a complete magnetic survey of Victoria, the magnetic elements being measured at no less than 235 stations. After the departure of Dr. Neumayer from Australia, absolute measurements of the elements were made from time to time by Mr. Ellery, F.R.S., then Government Astronomer, with Neumayer's instruments, until 1865. In the following year a new set of instruments was provided for the magnetic observatory, and since that time the absolute values of the magnetic elements have been determined about ten times each year. This work is now being carried on by Mr. Baracchi, F.R.A.S., Government Astronomer, to whom I am indebted for this brief sketch of the history of magnetic observations in Victoria.

Some few years ago the question of the magnetic survey of New Zealand was brought before the Government of that country, who decided to devote the sum of £500 a year to the purpose. The work was entrusted to Mr. Coleridge Farr, B.Sc., and a complete set of instruments was borrowed for him from the Kew Magnetic Observatory. At the meeting of the Australian Science Association held at Melbourne last January, a report was made to the Association by Mr. Farr, on the subject of the survey, from which it appears that up to that date he had succeeded in making absolute determinations of the magnetic elements at 69 stations.

III.—*The work of the proposed Survey.*

The investigation of magnetic phenomena may be carried on in two ways—either in the magnetic observatory, or by survey work in the field. The date seems far distant when Tasmania will possess a magnetic observatory, though, perhaps, when the value of Tasmania as a meteorological station is more fully appreciated, it may be possible to secure a magnetic observatory, to be worked in conjunction with a properly equipped meteorological observatory. The magnetic survey of a country stands on a somewhat different footing: though its work is of the highest scientific value, it is not without its

utilitarian aspect, as it may contribute information of great importance to the sciences of navigation and surveying.

I will now proceed to lay before this Society a brief account of the work proposed to be done by Professor M^cAulay and myself in connection with the magnetic survey of Tasmania, which it is our intention to begin during the coming summer.

The instruments to be employed are the bifilar magnetometer and declinometer of the latest Kew pattern; they have been lent to us by the University of Sydney, through the kind offices of Professor Pollock of that University.

Having regard to the short time—8 or 10 weeks—during which the instruments will be at our disposal, we consider that the most valuable results will be obtained by limiting our observations, for this summer at least, to about 10 well-selected stations. By this means we hope to be able to get a fairly complete grip of the general magnetic distribution in Tasmania, and expect that the information disclosed by this summer's work will be of the greatest value when we come to select stations of observation at any future time. The stations we propose to select are :—Hobart, Port Esperance, Port Davey, Strahan, Mt. Lyell, Wynyard, Longford, Scottsdale, St. Helens, Spring Bay. If time permit, Oatlands will also be made a station of observation. It will be seen that the places selected are fairly spaced through the Island of Tasmania; if the magnetic elements are determined at these points, it will be easy to compute them approximately for any other station.

Our selection of the stations enumerated has been largely guided by geological considerations, owing to the prevalence in Tasmania of magnetic rocks. At a meeting of this Society held as far back as the 2nd April, 1845, attention was drawn by Mr. R. C. Gunn to the magnetic properties of the greenstone taken from the summit of Brady's Look-Out, and most surveyors of experience in Tasmania can testify to abnormal deviations of their compasses arising from masses of greenstone and basalt close at hand. An interesting illustration of this is to be found in the University grounds, where the declination varies from 7° E. to 11° E.,

according to the spot at which the instruments are set up. It may be added, that highly magnetic greenstone occurs on the summit of Mount Wellington. Our sites of observation have obviously been chosen so as to avoid, as far as possible, proximity to volcanic masses known or suspected to be magnetic.

At each of the selected stations we propose to determine, in absolute measure, the declination, dip, and horizontal magnetic intensity. These quantities being known for ten places, well distributed over the Island, we shall be in a position to construct a rough magnetic map of the country, on which the iso-magnetic lines will be shown. This map, as a first approximation, will not allow for the abnormal magnetic phenomena introduced by the greenstone and basalt: the determination of the local abnormalities so introduced must be left to some future time. The variation of the magnetic elements is of not less scientific interest than the determination of the absolute values of the elements themselves, at any given date. To ascertain the variation, it will be necessary to redetermine, after an interval of a few years, the magnetic elements at the stations previously employed; and to properly effect this, it is necessary that the sites of observation should be suitably marked, so that future observers may have no difficulty in picking them up. The erection of permanent marks, such as are employed in all important geodetic operations, appears, to Professor M'Aulay and myself, to be so important that we have laid before the present Government of the Colony an application for a grant of £150, to defray the cost of their erection and other incidental expenses incurred in the survey. In the event of this grant of the public moneys being made, we propose that the work of the survey should be carried out in co-operation with the Surveyor-General's Department. We are assured of the cordial assistance of the Surveyor-General in all matters connected with the survey.

At the selected stations of observation we propose to mark out the true geographical meridian, and, when the stations are suitable, to determine the bearings relative to the site of observation, of any prominent landmarks in view. The information so acquired may be of value in supplementing that already acquired for the purpose

of constructing the map of Tasmania. A full description of the exact locality of each site of observation will be lodged with the Surveyor-General, together with a detailed account of the method employed to lay out the meridian.

It is scarcely necessary for me to detain the members of this Society by pointing out the importance, to all concerned with navigation, of an accurate knowledge of the magnetic declination, and of its rate of variation. So many of our selected stations are on the shore-line of Tasmania, that we hope to be able to make some considerable additions to the information already acquired on these points.

With the exception of the large properties of the Van Diemen's Land Company, whose boundaries were laid down by astronomical methods, it may be said that surveying in Tasmania has been, in the past, practically based on magnetic methods. The element of uncertainty introduced into surveys by the variation of the declination may not obtrude itself in any field work for some time, but directly any attempt is made to collate the county maps with the trigonometrical survey, there is reason to fear that grave discrepancies will show themselves. Surveying according to astronomical methods is in many parts of Tasmania very tedious and difficult, owing to the climate, and a more complete knowledge of the declination than is now possessed would be useful and convenient to surveyors, especially in the case of isolated surveys, and groups of surveys being made in new districts.

It is to be hoped that before long the trigonometrical survey of Tasmania will be proceeded with, so that a new map of the Island may be compiled; and it is probable that much information of value towards this end may be collected during the magnetic survey.

There are long gaps in the magnetic history of Tasmania, but when an accurate knowledge of the variation of the magnetic elements has been again attained, it may be possible, by analysing the magnetic records of Melbourne and Sydney, to reconstruct the past magnetic history of Tasmania, and form an approximately correct idea of the magnetic changes which have taken place since Lieutenant Kay first set up his instruments, in Hobart some sixty years ago.