TRANSACTIONS

OF THE

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I.—MISCELLANEOUS.

ART. I.—*On the Variation of the Declination of the Magnetic Needle in the Southern Portion of the Middle Island, and Remarks on the Desirability of Establishing Magnetic Observatories in New Zealand.* By A. H. Ross.

[*Read before the Otago Institute, 24th April,* 1873.]

WHEN a magnetized steel bar is placed on a vertical axis through its centre of gravity, on which it is free to revolve, the axis being between its poles, it will oscillate on each side of a certain determinate position, in which, at length, it will come to rest. When in this position a vertical plane passing through the axis and the poles is called the magnetic meridian. This plane generally forms an angle with the plane of the true meridian of the place in which the magnet is situate. This angle is called the *declination* of the magnet. It is, perhaps, better known to British sailors and others as the variation of the compass. It is to this property of the magnetic needle that I propose to direct attention in this short paper, more particularly, however, to some remarkable variations in declination which occur in different localities in this Province which have come under my notice.

The declination of the magnetic needle is subject to variations of several kinds—secular variation, annual and diurnal variation, accidental variations or perturbations, and local variations.

Observations carefully taken in London and Paris, and extending over a period of nearly three hundred years, show that from about the year 1580 the declination was E. of N. in those places, but decreasing, which it continued to do, until 1657, when the magnetic and terrestrial meridians were coincident, and remained so until 1663. A westerly declination then commenced, and continued increasing, though not regularly, until 1818, when, at London, a

maximum of 24° 41′ was reached. Since then it has gradually diminished: it was 22° 30′ in 1850; in 1866, 20° 25′; and is probably at the present date some few minutes under 20° W.

The annual variation at Paris and London is greatest about the latter end of March in each year, diminishing from that time to the latter end of June, and increasing again during the following nine months. It does not exceed from 15′ to 18′, and it varies somewhat at different epochs.

The diurnal variation differs according to the time of year and place of observation, the mean daily range in London being about 9·3 minutes; in Paris, about 11·5 minutes. The amplitude of the daily variations is greatest from April to September.

The declination is accidentally disturbed in its daily variations by many causes, such as earthquakes, volcanic eruptions, and the aurora borealis and aurora australis. In Ganot's "Elements of Physics" it is said that "the effect of the aurora is felt at great distances. Auroras which are only visible in the north of Europe act on the needle even in these latitudes (that is, of London and Paris), where accidental variations of 20′ have been observed. In polar regions the needle frequently oscillates several degrees; its irregularity on the day before the aurora borealis is a presage of the occurrence of this phenomenon." Although there is little doubt that the declination of the needle is generally affected to a greater or less extent before and during the aurora, yet this is not invariably the case, as the following extract from Captain Parry's narrative of his third voyage for the discovery of a north-west passage will show. The extract is so short and so pertinent to the subject under consideration that I make no apology for introducing it. Speaking of the aurora borealis, he says:—

"About midnight on the 27th of January, 1825, this phenomenon broke out in a single compact mass of brilliant yellow light, situated about a south-east bearing, and appearing only a short distance above the land. This mass of light, notwithstanding its general continuity, sometimes appeared to be evidently composed of numerous pencils of rays, compressed, as it were, laterally into one, its limits, both to the right and left, being well defined and nearly vertical. The light, though very bright at all times, varied almost constantly in intensity, and this had the appearance (not an uncommon one in the aurora) of being produced by one volume of light overlying another, just as we see the darkness and density of smoke increased by cloud rolling over cloud. While Lieutenants Sherer and Ross and myself were admiring the extreme beauty of this phenomenon from the observatory, we all simultaneously uttered an exclamation of surprise at seeing a bright ray of the aurora shoot suddenly downward from the general mass of light, and *between us and the land*, which was then distant only three thousand yards. Had I witnessed

this phenomenon by myself, I should have been disposed to receive with caution the evidence even of my own senses as to this last fact; but the appearance conveying precisely the same idea to three individuals at once, all intently engaged in looking towards the spot, I have no doubt that the ray of light actually passed within that distance of us. About one o'clock on the morning of the 23rd February the aurora again appeared over the hills in a south direction, presenting a brilliant mass of light very similar to that just described. The rolling motion of the light laterally was here also very striking, as well as the increase of its intensity thus occasioned. The light occupied horizontally about a point of the compass, and extended in height scarcely a degree above the land, which seemed, however, to conceal from us a part of the phenomenon. It was always evident enough that the most attenuated light of the aurora sensibly dimmed the stars, like a thin veil drawn over them. We frequently listened for any sound proceeding from this phenomenon, but never heard any."

Now let us see what Captain Parry says in reference to the action of his compasses during the continuance of this phenomenon:—"Our variation needles, which were extremely light, suspended in the most delicate manner, and, from the weak directive energy, susceptible of being acted upon by a very slight disturbing force, were never in a single instance sensibly affected by the aurora, which could scarcely fail to have been observed at some time or other, had any such disturbance taken place, the needles being visited every hour for several months, and oftener when anything occurred to make it desirable."

I believe that the officer in charge of the Dunedin Telegraphic Station has generally observed, on the day preceding a display of aurora, a considerable disturbance in the needles attached to his instruments. Those needles are, however, placed under very different conditions to those to which the needle of a declination compass would be subject; and whilst a current of induced electricity may perhaps (independent of the battery) be directed along the copper wire, which is in close proximity to the telegraph needle, and in accordance with the established law that "electrical force and magnetic force are exerted at right angles to each other," deflect it from its normal position, the isolated declination needle may remain unaffected, or affected only in a slight degree.

In addition to the secular, annual, and accidental variations of the declination, there are also local variations. Within our own Province of Otago there are many such, some of them of a very remarkable character.

The secular variation in the "declination" of the needle, as determined from astronomical observations taken on board ship, in the vicinity of our coast line, is stated on the Admiralty charts to be progressing in an easterly direction at the rate of nearly two minutes per annum.

The first magnetical observation on our shore of which I can find any record was taken by Captain Cook, at Dusky Bay, in May, 1773—one hundred years ago. The declination he found, by the mean of three different needles, to be 13° 49′ East, and the dip, or inclination, 70° 5′ 45″. The next observation in the same place was taken by Captain Stokes, in 1851; the declination was then found to be 15° 34′ E., and the dip, or inclination, 69° 47′. These observations show the secular variation to have progressed at an average annual rate of 1·34 minutes, amounting in the elapsed interval of seventy years to 1° 45′.

I have not alluded to the dip, or inclination, of the magnetic needle, nor did I intend to have done so, but I think it worthy of notice here that the secular variation in the angle of inclination, though of small extent, is in the same direction as at London and Paris, where the dip during the last 150 years has been decreasing at the rate of about 2·6 minutes per annum, and continued to do so during the decrease, as well as during the increase, of the secular variation of the westerly declination.

Proceeding northward to Bluff Harbour, I find, in the "New Zealand Pilot," that the declination there in 1849 was 16° 16′ E. Observations taken in 1866, by Mr. McKerrow, show it to have been at that date 14° 40′ 40″ E., giving a decrease of 1° 35′ 20″. At this place, then, it appears that the secular variation is proceeding in an opposite direction to that indicated on the Admiralty charts, unless we suppose the last observation to have been made at a time of peculiar magnetic disturbance, of which this locality and the neighbouring district between the Bluff and New River are likely to be very susceptible. This may be inferred from the following extracts, the first of which is from the journal of Mr. C. H. Kettle, first Chief Surveyor of this Province, a gentleman whose professional acquirements were of the highest order, whose urbanity and amiability commanded the esteem of all who knew him, and rendered his untimely removal by death a matter of the deepest regret to all who possessed the honour of his friendship or the pleasure of his acquaintance.

Mr. Kettle, who was engaged in laying off the native reserve at the eastern head of the New River estuary, has this entry in his journal:—"Saturday, 10th April, 1852.—Prince and myself went forward to explore until we came in sight of Barracouta Point, from the top of the hills, when we returned to the others, and continued the cutting of the line. Weather cleared up in the afternoon, when we completed the line to the top of the hill. Immense masses of ironstone rock amongst manuka scrub on the descent towards Barracouta Point, which affected the compass so as to turn the north point westward, making the south point dip extremely."

The other extract I shall give is from a report, presented in the early part

of 1857, to the Commissioners of the Waste Land Board, by Mr. J. T. Thomson, Chief Surveyor of Otago, and is as follows:—"In a district like this, situated on one of the great volcanic zones, where terrestrial galvanic currents may be supposed to prevail, it will be correctly surmised that the surface sometimes indicates forcibly the presence of magnetic disturbance. This disturbance was more or less sensibly indicated in our observations, but the most remarkable is on the Bluff Peninsula, as will be seen by the following:—

"On the summit of Bluff	variation	6° 54′ E.
"Thirty feet north of the same	„	9° 36′ W.
"Thirty feet west of the same	„	5° 04′ E.
"Thirty feet east of the same	„	46° 44′ E."

To this report is appended the following note:—"The bearing of the magnet is affected in all parts of the Province where hard compact traps crop out. These are found principally on the higher parts of ridges and mountains."

Proceeding northward, we find at Kuriwao Hill the declination to be 13° 53′ 27″ E.; at Toetoes, 14° 19′ 32″; and at Chimney Hill, 14° 56′ 50″. From this to Port Chalmers no remarkable variation in declination has been recorded. I may observe, however, that at all stations on land near the seaboard the declination is less than it is shown to be at sea on the Admiralty charts, the mean difference, after the declination has been corrected for difference of dates of observations, amounting to nearly 2 degrees. At Port Chalmers the declination observed by Mr. Kettle, in 1846, was 16° 10′ E.; by Captain Stokes, in 1850, 15° 40′ E.; in 1864, by Mr. McKerrow, it was 15° 40′ 08″ E., so that in the four years, 1846 to 1850, a decrease of 30′ is shown; while in the fourteen years, 1850 to 1864, no change whatever has been observed, the results given by Mr. McKerrow being virtually the same as those given by Captain Stokes.

North of Port Chalmers the disturbing force at many of the stations is very considerable. In the immediate vicinity of the port at Mihiwaka the declination is shown to be 19° 20′ 48″ E.; at Flagstaff it is 14° 14′ E.; in Nenthorn District, at Mount Stoker, it is 35° 21′ 44″ E. In recording this observation in his field book, Mr. McKerrow made the following entry:—"Hard bluestone boulders on Mount Stoker." At Highlay Hill the declination is 2° 24′ 32″ E.; in Hawksbury District, at Mount Watkins, it is 3° W.; and at Taieri Peak, a few miles to the north, it is 104° 47′ E. In Moeraki District, at Trig. Station O, it is 26° 10′ E.; and at Trig. Station P it is only 50′ E. In Kauroo District, at Mount Difficulty, the declination is 1° 02′ W.; at Trig. Station L, 13° 30′ E.; at Trig. S, 22° E.; at Black Cap, 8° 54′ W. These four stations are included within a radius of about two and a-quarter miles; and, lastly, the declination at Kauroo Hill, about five miles N.E. of Black Cap, is 41° 03′ 35″ E.

I think it unnecessary to notice further observations which have been taken in other parts of the Province. I may state, however, that I have been informed by the officer who triangulated the Moeraki and Hawksbury Districts (Mr. England) that, in many localities other than those noted, aberration of the action of the magnetic needle prevailed to such an extent at the time he was engaged on his survey, that it was in some cases a matter of great difficulty, and in others quite impossible, for him to delineate accurately the topographical features of the country from compass observations. The disturbing force in this District, whatever it may be, exerts its influence beyond the limits of the coast line. Conversing, only yesterday, with the captain of one of our sea-going steamers, I asked him whether he ever perceived anything unusual in the action of his compasses in sailing along the coast. He replied, "Yes; at Moeraki my compasses are always affected," and added that many other masters of vessels had noticed similar irregularities. I was prompted to ask this question by remembering some circumstances in my own experience which, when I relate them, if they do not suggest a probable cause of the effect I have noted, may at least be considered as a somewhat remarkable coincidence. Twenty-five years ago, in the course of business, I held much intercourse with the masters of vessels navigating the north-east coast of England. Frequently, when the action of their compasses was the subject of conversation, I have heard the captains in the coal trade (who, at that time, oftener held their positions in virtue of their having certificates of servitude than of competency; but who, nevertheless, were generally shrewd, observant, and sensible men) remark that in hugging the land when passing a particular place on the Yorkshire coast, which they pointed out on the chart, the compass cards danced about in all directions, and were, so far as indicating the ship's head was concerned, positively useless. Many years subsequent to this—I forget the exact date—those immense deposits of magnetic ore in the Cleveland Hills, the works in connection with which are now giving employment to several thousands of human beings, were discovered, and to their existence, when it became known, the erratic action of the mariner's compass in the locality referred to was attributed—possibly erroneously.

It is not my intention to-night to place before you any of the theories which have been enunciated by the many eminent men who have made this branch of physical science their study, to account for the phenomena connected therewith. I have no hypothesis of my own to offer. I have sometimes been amused—not only amused, but amazed—at the facility with which some persons, enunciators of whimsical theories, by a fanciful manipulation of *data* which ordinary mortals cannot comprehend, have given to the offspring of an excited imagination or an erratic intellect the appearance of an absolutely demonstrated truth. I do not, however, possess this faculty of hypothesizing.

My object is simply to direct attention to a department of science, the existence of which seems in New Zealand to have been wholly forgotten, and to suggest the desirability, nay the necessity, of establishing magnetic observatories in the Colony, where regular and systematic observations may be made of the ever-varying, ever-interesting phenomena. I think that no person will deny the desirability, and that the necessity exists will be apparent when I tell you that, for scientific purposes, the results of the observations I have noted are of comparatively little value; and to say this is not disparaging to the observers, who, I have no hesitation in saying, have taken these observations carefully and accurately. But when we consider that the results obtained by the celebrated Halley, on a voyage made expressly to collect the *data* necessary to determine the elements of magnetic geography, "were deprived of the chief part of the advantages which ought to have attended them, because of the absence of uniformity in his instruments and the neglect of making proper comparisons of them with others," we need not wonder that results obtained by surveyors, when prosecuting their routine duties, are, from similar causes, of little value, and of least value when at the place of observation magnetic disturbance prevails to the greatest extent.

In conclusion, I would suggest, firstly, that a set of magnetical instruments similar to those supplied to the Colonial Observatories at Canada, St. Helena, Cape Colony, Tasmania, Victoria, and India, be furnished to the Observatory at Wellington, and placed under the supervision of Dr. Hector, the Director of the Geological Survey, or some other competent officer; secondly, that a declination compass and dipping needle be supplied to the meteorological observatories in each province*; thirdly, that systematic and regular observations be taken at each station; and, lastly, that at out-stations where any remarkable features present themselves, as at the Bluff, Observation Point, Moeraki and Kauroo Districts, in this Province, periodic observations be made under assimilated conditions. If these suggestions are acted on, I believe that New Zealand will be in a fair way to take a prominent part in removing the veil which yet conceals from mankind what may be termed the moving mysteries of terrestrial magnetism.

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* Some Provinces may possibly be already possessed of some of the required instruments. A very excellent declination compass is, I know, among the stored instruments belonging to our Provincial Government, and which, I think I am correct in saying, has not during a dozen years been taken out of its box, except once, when it was taken out in order to be shown, along with other scientific instruments, at the Exhibition held in Dunedin eight or nine years ago.