

1860-1.

VICTORIA.

FIRST ANNUAL REPORT

OF THE

BOARD OF VISITORS

TO THE

ASTRONOMICAL AND MAGNETICAL
OBSERVATORIES.

PRESENTED TO BOTH HOUSES OF PARLIAMENT BY HIS EXCELLENCY'S COMMAND.

By Authority:

JOHN FERRES, GOVERNMENT PRINTER, MELBOURNE.

1947
1948
1949

1950-1951 1952-1953 1954-1955

1956-1957 1958-1959

1960-1961 1962-1963 1964-1965
1966-1967 1968-1969

LEGISLATIVE ASSEMBLY.

Extract from the Votes and Proceedings, Thursday, 8th December, 1859.

- "7. ASTRONOMICAL AND METEOROLOGICAL OBSERVATORIES.—Mr. Verdon moved, pursuant to notice, That in
"the opinion of this House the Astronomical and Meteorological Observatories supported by the Govern-
"ment should be under the supervision of a Board of Visitors, in accordance with the plan adopted for
"the management of the Royal Observatory, and that of Sydney.
"Question—put and resolved in the affirmative."
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Extract from the "Government Gazette," 3rd February, 1860.

"Chief Secretary's Office,
"Melbourne, 30th January, 1860.

"BOARD OF VISITORS TO THE ASTRONOMICAL AND MAGNETIC OBSERVATORIES.

"His Excellency THE GOVERNOR having consented to become a Member of the Board of Visitors to
"the Astronomical and Magnetic Observatories, His Excellency has, with the advice of the Executive Council,
"been pleased to appoint the undermentioned gentlemen to be associated with himself as Members of the
"Board, viz. :—

- "THE HONORABLE CHARLES PASLEY, CAPTAIN R.E.,
"FREDERICK BEAUCHAMP PAGET SEYMOUR, ESQUIRE, CAPTAIN R.N.,
"JOSEPH HENRY KAY, ESQUIRE, COMMANDER, R.N., F.R.S.,
"CHARLES WHYBROW LIGAR, ESQUIRE, THE SURVEYOR GENERAL,
"WILLIAM PARKINSON WILSON, ESQUIRE, M.A.,
"HENRY AMSINCK, ESQUIRE, LIBUTENANT R.N., M.L.A.,
"ROBERT GILLESPIE, ESQUIRE, M.L.A.,
"GEORGE FREDERIC VERDON, ESQUIRE, M.L.A.

"WILLIAM NICHOLSON."

THE HISTORY OF THE

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REPORT.

*To His Excellency Sir Henry Barkly, Knight Commander of the Most
Honorable Order of the Bath, Captain-General and Governor-in-Chief of
the Colony of Victoria, and Vice-Admiral of the same, &c., &c.*

MAY IT PLEASE YOUR EXCELLENCY,

Her Majesty's Government having placed the Astronomical and Magnetical Observatories under a Board of Visitors, in accordance with the resolution of the Legislative Assembly, the Board held its first meeting on the 1st May, 1860, on which occasion reports on the present state and the requirements of the two Observatories were laid before it by Mr. Ellery and Professor Neumayer: copies of them are appended. These reports contain histories of the two Observatories since their establishment, accounts of the alterations and additions that have been made at different times, and lists of the instruments at present deposited and used in them. Both reports also concur in recommending that the two Observatories should be moved from their present sites and combined in one locality.

After considering these reports, and receiving in addition oral statements and explanations from Mr. Ellery and Professor Neumayer, the Board proceeded to inspect the two Observatories.

On the 2nd May, 1860, the Board met at the Astronomical Observatory at Williamstown, and, accompanied by Mr. Ellery, entered into a careful inspection of the instruments in use, the modes of observing and recording adopted, and the nature of the work carried on.

The instruments were found to be in good working order; the system of observing adopted is that by means of galvanic registration, which enables the observer to note and record the time of any phenomenon with much greater facility and accuracy than was possible under the old system. This system has been applied by Mr. Ellery to all his instruments most successfully.

As regards the work carried on, besides the regular observations requisite for giving the time signals in the Bay and at Melbourne, the principal objects have been:—

1. The determination with extreme accuracy of the polar distances of stars which culminate in or near the zeniths of the principal trigonometrical stations in Victoria, for the purpose of determining the latitudes of those stations.

These observations are carried on by means of the transit instrument mounted in the prime vertical.

2. The determination with extreme accuracy of the right ascensions of pairs of circumpolar stars differing nearly twelve hours in right ascension.

These determinations are requisite for the adjustments of the instruments at the several trigonometrical and other stations in the colony, for the purpose of running the meridian lines requisite in the geodetic survey, and for the determination of the azimuths of the other boundary lines in that survey.

These observations, which are of pressing importance in order to the rapid carrying on of the survey of the colony, are also themselves important additions to astronomical knowledge. The necessity for prosecuting them with vigor has left but little time for other observations of more general popular interest.

3. A series of observations on the moon, carried on in conjunction with European observatories, to aid in perfecting the theory of the motion of that body, and for determining with greater accuracy the longitude of the Observatory.

The inspection of the Observatory, while it proved to the Board of Visitors how much could be done by zeal, even under adverse circumstances, at the same time impressed upon it strongly the entire unsuitableness of the present site.

The Observatory is situated on low ground in the midst of a populous district. On the west, south, and east the Melbourne and Williamstown Railway passes within 180 yards of it. On the west Morris-street passes in close contiguity to the transit room. The Williamstown battery is within 280 yards of it. Owing to these causes the piers on which the instruments are mounted are subject to frequent and continued disturbances, which, while they impose great and incessant labor on the observers, and thus diminish the amount of effective work which they can perform, at the same time seriously impair the value of the work which is done. But not merely by the disturbances due to the railway is the usefulness of the Observatory greatly impaired, the buildings by which it is surrounded cut off the view of a considerable portion of the heavens, and by the unequal heating of the atmosphere which they produce, and the irregular refraction consequent upon it, prevent any trustworthy observations being taken in a still larger portion. Add to this the want of transparency in the atmosphere, in consequence of its being surcharged with aqueous and other vapours due to the lowness of the position, and the population by which it is surrounded, and there is combined in the site of the Williamstown Observatory every fault to which the site of an observatory can be subject. The Board has entered at length into these particulars because, knowing as it does that the Observatory must be carried on for the sake of the survey of the colony, under whatever inconveniences, and at whatever extra cost owing to these inconveniences, it is fearful lest a mistaken economy on the part of the Government should impede its present efficiency, and lead ultimately to a considerable extra expenditure.

The Board is of opinion that, even if the general advancement of Astronomical Science be left out of question, it is necessary for the accurate prosecution of the survey of the colony on the system which has been adopted, that the Astronomical Observatory should be removed to some site where it will be free from the disturbing influences to which it is at present subject.

On the 8th May, 1860, the Board met at the Magnetical Observatory on the Flagstaff Hill, and, accompanied by Professor Neumayer, examined carefully the various magnetical and meteorological instruments in use there, and the mode of reducing and combining the observations made with them.

The magnetical and meteorological portions of the work are to a great extent distinct from one another.

The latter is carried out with all the most recent scientific modes of observation, in conjunction with a corresponding series of observations carried on at a great number of stations throughout the colony.

The observations at all the stations are reduced and combined by Professor Neumayer and his assistants according to the most approved methods of the present day; and, which is a matter of very great importance, these combinations and reductions are carried on as far as possible concurrently with the observations, so that there is not at any time an accumulation of arrears.

The magnetical department of the Observatory is the basis of the Magnetic Survey of the Colony now in progress, and in connection with the survey it has two principal objects:

1st.—The determination with extreme accuracy of the mean absolute values of the three magnetic elements, declination, inclination, and absolute force at some given epoch.

2nd.—The determination of the periodic fluctuations and secular changes of these elements.

The magnetic determinations made throughout the colony must be referred to those made at Melbourne as a datum point, and the value of the Magnetic Survey of the Colony depends to a great extent on the trustworthiness of the determinations made at Melbourne. The Board of Visitors in inspecting the Magnetic Observatory, while convinced that everything was done which could be done under the circumstances to render the results of observation trustworthy, saw at once that the disturbing influences with which the Observatory is surrounded are such as seriously to impair the value of the observations.

A Magnetical Observatory should be protected to a considerable distance in every direction from disturbance by any large masses of iron or other magnetic bodies. If a mass of iron be fixed in the vicinity of an Observatory the effect of it may be eliminated by a series of observations and calculations. But every such mass of iron, however carefully its effect may be calculated, besides causing immense labor, throws some doubt on the ultimate value of the observations. Now, the land in the vicinity of the Flagstaff Hill is too valuable to be reserved for the protection of an Observatory, and in consequence the observations have been interrupted, the labor greatly increased, and the results vitiated by the erection of iron sheds, a saw mill and engine, the laying of gas and water pipes, &c., in immediate proximity to it, and, which is worst of all, by the establishment of iron works near to it, the fluctuations in the amount and position of the contents of which preclude the possibility of allowing for them by calculation.

Taking these points into consideration the Board is of opinion that it is necessary for the efficient carrying on the work of the Observatory and the Magnetic Survey of the Colony, that the Observatory should be removed to some site where it will be free from these disturbances.

Having thus inspected the two Observatories, and being convinced that their removal from their present sites is necessary, the Board entered on the consideration of

what would be the most suitable site for a permanent National Observatory. The reasons in favor of combining the two in one spot are obvious. If there were no other the economy as regards the space which must necessarily be left vacant round an observatory would be sufficient. Both Mr. Ellery and Professor Neumayer agree in recommending this. Two situations only have presented themselves as suitable for an Astronomical Observatory, one in the Royal Park on the brow of the hill overlooking Flemington, the other in the Botanic Garden Reserve on the top of the hill near the Botanic Museum. Mr. Ellery and Professor Neumayer were requested to make experiments for testing the suitability of these sites, and from the results of these experiments it appears that the former of these sites is unsuitable for a Magnetic Observatory.

It will be seen from Professor Neumayer's report on the subject, extracts from which are appended, that, while over a considerable district east of the magnetic meridian which passes through the University the three magnetic elements are approximately constant, to the west of that meridian these elements change rapidly with a change of position. The change is most rapid in the vicinity of the slopes forming the valley of the Moonee Ponds stream, which bounds the Royal Park to the west. Such a position is unsuitable for determining the mean absolute value of the elements as the basis of the survey. This site being thus excluded there remains only the site near the Botanic Museum, which is in all points eligible for an observatory. Several other sites were considered by the Board, but they were either so remote from the Bay that the utility of the observatory in connection with navigation would have been destroyed, or the objections to them on scientific grounds were found to be fatal.

Doubts having been raised as to the liability to disturbance from the firing of artillery for salutes and on other occasions, Mr. Ellery conducted a series of experiments for ascertaining this point, and from his report, which is appended, it will be seen that at the distance of the usual firing ground no injurious effects need be apprehended.

The Government having approved of the site near the Botanical Reserve for the National Observatory on the understanding that it do not in any way interfere with the design for the Government House; the Board would now urge upon the Government the necessity for proceeding at once with the erection of the building, and is of opinion that this can be done for a sum of (£5000) five thousand pounds. The Board further desires to remind the Government that the land set at liberty at Williamstown, and on the Flagstaff Hill by the removal of the two Observatories will far exceed in value the amount requisite for building the Observatory.

On the occasion of the Board meeting at the Astronomical Observatory at Williamstown Mr. Ellery represented to them that a large transit circle, which had been ordered from England for use in connection with the survey of the colony, was expected in about two months, and that there was no accommodation for it in the Observatory. The Board recommended that piers should be erected, and temporary accommodation provided for it at Williamstown, and the Government was pleased to carry out the recommendation of the Board.

The Government also, on the recommendation of the Board, placed the salary and allowance of an assistant surveyor at the disposal of Mr. Ellery, for the payment of an assistant and for other contingencies, in consideration of the fact that Mr. Ellery was necessarily absent from the Observatory for a great portion of his time in carrying on the geodetic survey.

On the 30th October Mr. Ellery reported to the Board that he had received from Mr. Frödsham a clock ordered by Government for the Astronomical Observatory, and that

a new chronograph had been received and set up. Mr. Ellery also stated, that he had received an application from Mr. Scott, the astronomer of New South Wales, for a chronograph apparatus, and asked the authority of the Board to allow Mr. Scott the use of the old apparatus, no longer required in the Observatory at Williamstown. The Board approved of the application, and directed the honorary secretary to communicate with the Chief Secretary on the subject, stating also, that the Government of New South Wales had afforded to this Colony the use of a Standard Bar and Zenith Sector.

In concluding its report, the Board desires to draw attention to the following points :—

The work which is now being performed by the two Observatories is necessary for the prosecution of the Geodetic and Magnetic Surveys of the Colony now in progress.

From circumstances which have arisen, chiefly since the first establishment of those Observatories, the localities in which they are placed have become so unsuitable that the work is greatly impeded, and the results vitiated.

The establishment of these institutions for the promotion of Physical Science, has already attracted attention in Europe, and redounded greatly to the credit of the Colony.

The Board trusts that, by rendering the Observatories effective for carrying on the work for which they are intended, the Government will enable the Colony to maintain and increase the reputation which it has already acquired as a patron of science.

HENRY BARKLY,
Chairman.

PAPERS APPENDED TO THE REPORT

1. ASTRONOMICAL OBSERVATORY:—Report to Board of Visitors. 14th March, 1860.
2. MAGNETICAL OBSERVATORY:—Report to Board of Visitors. March, 1860.
3. MR. ELLERY'S REPORT on the proposed sites for a New Observatory.
4. PROFESSOR NEUMAYER'S REPORT on the proposed sites for a National Observatory. 14th June, 1860.
5. LETTER from PROFESSOR NEUMAYER urging the removal of the Magnetic Observatory. 27th June, 1860.
6. REPORT of PROFESSOR NEUMAYER on a proposed site in Studley Park. 17th August, 1860.
7. REPORT of MR. ELLERY on the effect of the firing of Artillery.

ASTRONOMICAL OBSERVATORY.

REPORT TO THE BOARD OF VISITORS.

IN the Report which I have now the honor to submit to the Board of Visitors, I have endeavored, as far as possible, to present all the principal circumstances connected with the Observatory, from the date of its establishment up to the present time, and to show not only the condition it is now in, but also the nature and extent of the improvements of which I believe it to be capable.

About the middle of the year 1853 the Government determined on establishing an Astronomical Observatory; the chief object being to obtain such observations as are necessary for giving time signals, rating chronometers, and generally to afford facilities to masters of vessels for testing and adjusting their nautical instruments. In July of that year I was offered the charge of establishing and permanently superintending an Observatory for these purposes, and I accepted the appointment. On my taking charge I found that a Time Ball had been erected on the flagstaff at Gellibrand's Point, and that—as proximity to the shipping was desirable—a site for the Observatory itself had been selected in the immediate neighborhood. The instruments placed at my disposal were—a sextant, an artificial horizon, and a chronometer. A small two-roomed wood cottage, then standing on the point, was allotted to me as an Observatory, and for my quarters as observer. The sum of £2800 appeared on the Supplementary Estimates of 1853 for the erection and equipment of a suitable establishment; some instruments, also, had already been ordered from England.

With the instruments at my command I commenced giving time signals in August, 1853. The Time Ball at Gellibrand's Point was dropped daily at one p.m., and a corresponding signal was made at the Melbourne Flagstaff.

In October I was enabled to purchase a small portable transit instrument, and the works of a good astronomical clock; these I erected at once, and although the transit was too small to be of much service, the acquisition of these instruments materially assisted me.

The sum of £2800, placed on the Estimates, was voted by the Legislature at the commencement of the year 1854, and I immediately applied through the Chief Harbor Master—under whose department the Observatory had been placed—for its appropriation; but, for reasons never stated to me, the money was not expended, and the vote lapsed.

In March of the year 1854, the instruments previously referred to as being ordered from England arrived, consisting of a Time Ball apparatus, a thirty-inch Transit Instrument, a very superior Astronomical Clock, and a Sextant. The old transit instrument was immediately replaced by the new one on a more substantial foundation, and the new clock was mounted, some slight improvements being at the same time made in the transit room. The Time Ball was subsequently erected at the Telegraph Office, in Melbourne. The work, which consisted mainly of right ascension observations for clock errors and rates, and moon culminations, was performed far more satisfactorily after the erection of the new instruments. A few meteorological instruments were obtained about this time, and a more or less regular meteorological record has been kept from a date a little subsequent to my appointment.

A short time subsequently the quarrying operations then being carried on by the prisoners, at Gellibrand's Point, had approached so near to the Observatory as to most injuriously disturb the adjustments of the instruments; this fact I at once reported to the Government, who afterwards erected a small wooden room on the Flagstaff Hill, in Melbourne, to which the Observatory was to have been removed; but the dust storms, smoky atmosphere, and the proximity of some gravel quarries incidental to the new site gave the advantage to the one first selected, unsatisfactory as it evidently was. The Observatory therefore remained at Williamstown.

While the Estimates for 1855 were being prepared, I strongly urged the necessity for providing means for the erection of an Observatory and the purchase of adequate instruments, and a sum was placed on the Estimates for the purpose, but in their subsequent amendment for retrenchment the item was struck out.

In November, 1854, I was induced to take an appointment in the Electric Telegraph Department in connection with my appointment as Superintendent of Observatory; the Observatory was therefore transferred to the Department of Electric Telegraphs.

In January, 1855, an accident occurred to the Transit Instrument, which rendered it unfit for use, and an instrument of somewhat larger dimensions, which was in possession of the Survey Department, was transferred for the use of the Observatory.

I quote the following from my Report on the Observatory, dated December, 1856:—

In May, 1855, the piers of the Transit Instrument became very unsteady, from water having found its way to the foundations, resulting from the heavy rains falling at that time. The site, on that account, was no longer tenable for an Observatory, and I made application for a more suitable building, more especially seeing that, besides the defective foundations, the room scarcely gave sufficient shelter for the instruments. The Time Signals were necessarily suspended, and in consequence numerous applications were made by masters of vessels to me to rate their chronometers before going to sea. This, after a few days, I was unable to do with the necessary precision, and I was therefore obliged to refuse their request; upon which a very numerous signed petition from the shipmasters then in port was forwarded to the Government, praying "That the usual Time Signals, which were of such great importance to them, as affecting the safety of life and property, be quickly resumed."

In consequence of this a small canvas tent was erected as temporary accommodation, until a more substantial building should be provided. This was, however, used for a considerable time as the Observatory, indeed until, from the insufficient shelter afforded by it, the foundations became very unsteady, and the instruments suffered much from the long continued exposure to the excessive dampness of the place: I therefore felt myself again compelled to ask the Government to erect something more substantial for the Observatory; more especially as, besides the extreme discomfort of working night after night in a damp and scarcely weather-proof tent, the disturbance occasioned by the flapping of the canvas when there was any wind quite stopped observing. The result of my application was the erection of a small wooden building contiguous to the Telegraph Office, and the construction of substantial foundations for the clock and transit instrument. The building consisted of a transit room, and a small ante room which was used as a computing office; this is made mention of in my Report of January, 1858, annexed. The ground surrounding the Observatory and Telegraph was then an unoccupied reserve, but I shall have presently to remark the encroachment of the railway works has since materially affected the eligibility of the site.

At the request of the Superintendent of Electric Telegraphs, to whose department the Observatory had been transferred, I prepared an estimate of the sum required for the establishment for 1857, and subsequently for 1858; the following is a copy of the latter, and the letter accompanying it:—

	£	s.	d.
Lighting	19	0	0
Books and Stationery	60	0	0
Three-feet Transit Circle	350	0	0
Sidercal Clock	70	0	0
Refracting Equatorial Instrument	400	0	0
Micrometers	20	0	0
Collimators	20	0	0
Meteorological Instruments	26	0	0
TOTAL	£965	0	0

Sir,

In accordance with your instructions I herewith enclose an estimate of the expenditure required for the Astronomical Observatory for the ensuing year, 1858. With reference thereto, I have the honor to inform you that the estimate is made as low as is possible consistently with the efficient working of this branch of the public service. The expenses of working and maintenance under the present arrangements are very small, but the urgent want of good and efficient instruments largely increases the present estimates. As regards the need there exists of the instruments, I would beg to refer you to my reports on the Observatory. I have also the honor to inform you that in compliance with instructions received, I have for several consecutive years forwarded estimates for the above named instruments for the Observatory. And I would again most respectfully urge the necessity there exists for the Observatory being equipped with efficient instruments at once; and I trust that the Government will place on the Estimates of the ensuing year, the amount necessary for their purchase.

I have the honor to be, &c., &c.

To the Superintendent of Electric Telegraph, Melbourne.

Nothing appeared on the Estimates for the Observatory this year.

In March, 1858, I was consulted by the Surveyor-General relative to laying out lines for the survey of the colony, and in August following I was appointed to conduct the Geodetic Survey in connection with my superintendency of the Observatory; the Observatory was consequently transferred to the Crown Lands Department. At that time the Observatory was as efficient as the means at my disposal would allow, but the great demands which would now be made upon it, in connection with the survey, induced me to urge the purchase of larger instruments without delay, and the erection of a more substantial building on a better site. In the following year a sum of money was voted for instruments, and a portion of it immediately remitted for their purchase—these are now daily expected. No special sum was granted for a building.

The increased duties devolving on me in the survey took me much away from personal superintendence of the Observatory work, and, having no assistants, I had to entrust a great portion of the observing and computing to three gentlemen—Messrs. Verdon, Smibert, and

Fullarton—who had become pupils. These gentlemen were most indefatigable and diligent, so much so that during my frequent periods of absence all the necessary observations were most carefully made and reduced; and I had every confidence in leaving the work in their hands as often as my absence rendered it necessary. Finding that my time was being more and more occupied in the survey, and that inconvenience was sustained by my assistants from the fact that they were acting on sufferance only—having no status in the Observatory, I addressed a letter to the Surveyor-General, requesting that they might be appointed *Honorary Assistants*. The result of this letter was a communication from the Surveyor-General requesting their acceptance of honorary appointments, to which they willingly assented, and continued to perform the duties with enthusiasm and efficiency. Mr. Verdon, however, on entering on his legislative duties as member for Williamstown, had necessarily to resign his portion of the work. Mr. Smibert also was unable for several months from sickness to attend to his duties; my more constant personal attendance became therefore necessary, Mr. Fullarton only assisting me.

The want of a more commodious computing room had given rise to great inconvenience, and at my request a room for the purpose was added to the building.

In preparing the estimates for the Observatory and Geodetic Survey, at the request of the Surveyor-General, the following item was placed under the head of Lands and Survey:—

ASTRONOMICAL OBSERVATORY.

Lighting and Contingent Expenses	...	...	...	...	...	£150
Assistance	...	...	...	...	...	300
						£450

As estimates similar to those of 1859 were afterwards adopted, these items did not appear.

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I now proceed to explain to the Board the present condition of the establishment:—

BUILDINGS.

The *Observatory* consists of a wooden building, of which a plan and elevation are hereunto annexed.

The *Light House Tower* is also used as a Standard Geographical Point to connect the Observatory with the Stations of the Geodetic Survey. It was previously used in connection with the Observatory for giving Time Signals, and it is intended as soon as the necessary observations for the survey have been made from the tower, to erect the Time Ball now on the Telegraph Office on it, and to use it specially for the purpose of Time Signals, it being the most eligible position obtainable.

Time Balls.—There is a Time Ball erected on the Telegraph Office, Williamstown, which is dropped daily at one o'clock. There are also Time Balls on the Telegraph Office in William-street, Melbourne, and at Ballarat.

INSTRUMENTS.

The *Transit Instrument* is 45-inch focus, and has $3\frac{1}{4}$ -inch effective aperture; made by Troughton and Simms, of London. It has two *setting circles* and a *micrometer* in the eye piece. It is mounted on stone piers, resting on a solid foundation of bluestone. This instrument has performed satisfactorily in every way within the limit of its power; the *pivots* are of hard gun metal, and are nearly perfect both as regards equality and figure. With this instrument all the observations for Right Ascension are made—the Galvanic mode of Registration having been adopted.

A *Collimator*, made from the small Transit Instrument first used in the Observatory, is erected on a solid stone pier, just outside the north transit window; it is principally used for obtaining the collimation error of the Transit Instrument, and also serves generally as a meridian mark.

The *Altazimuth Instrument* is by Troughton and Simms; its horizontal and vertical circles are both eighteen inches diameter, divided to *five minutes* of arc, and reading to *one second* by micrometers. This very useful instrument, to which I have referred in my report of December, 1856, annexed, is now used in the field on the Geodetic Survey, where it is imperatively needed, thus unfortunately leaving the Observatory without any extra-meridional instrument.

Clocks.—The *Transit Clock* is an eight-day one, by Charles Frodsham, of London; it has the “dead-beat” escapement and “mercurial pendulum.” It was made in 1853 for the Observatory, and has proved to be an excellent instrument. It stands at present on, and against a substantial stone pillar, near the Transit Instrument, as shown on the plan attached.

Mean Time Clock.—This is the clock of which the works were purchased on the first establishment of the Observatory, and of which I made mention previously. It was made by

Evans, of Birmingham, and is also an excellent clock. It is placed in the Electric Telegraph Office, Williamstown, and is in galvanic connection with the Chronograph or Galvanic Registering Apparatus, and the other clocks in the Observatory; it is principally used in giving the different time signals, and for the transmission of time by telegraph generally.

There is also an *Electric Motor Clock*, by Shepherd, in the Observatory; it is at present under regulation, and when that is completed it is intended by its use to drop the time balls, give all time signals, and regulate clocks at the different telegraph and railway stations, for which purposes it is peculiarly adapted.

There are also two very good *Marine Chronometers*, a *Sextant*, two *Artificial Horizons*, &c., belonging to the Observatory, but which are now used in the field.

The Chronograph or Galvanic Registering Apparatus has not long been completed, but is now in full operation and gives great satisfaction in its performance. A description of it would be out of place here, and it will be sufficient to say that by its use every beat of the pendulum of the transit clock is recorded on a moving fillet of paper by the indentation of equidistant dots, and that by a convenient arrangement either the beats of any of the other clocks of the establishment, or the moments at which any phenomena are observed by the transit or other instruments can also be recorded.

There is attached to the Observatory a set of Meteorological Instruments, with which regular observations are made.

Of a *Library*, there is at present only the nucleus. The volumes of the Results of the Greenwich Observations have been presented yearly by the Lords Commissioners of the Admiralty—these at present extending from 1847 to 1856. A few months ago I received from the Directors of the United States National Observatory the volumes of the United States Observations from 1847 to the present time, as well as a set of Commander Maury's Wind and Current Charts, and the most recent edition of his Sailing Directions. I have also lately received a presentation to the Observatory, by the Madras Government, of all the volumes of the Madras Observatory Observations. These, with volumes of the Nautical Almanac, and four volumes of the Logarithmic Tables, form the library, supplemented, however, by Star Catalogues and other Astronomical Works, the property of myself and my honorary assistants.

PERSONAL ESTABLISHMENT.

Astronomer (who also at present superintends the Geodetic Survey.)—On him devolves the general superintendence and responsibility of the observations, the revision of computations, correspondence with other observatories, &c., &c.

Honorary Assistants.—A considerable portion of the observing has devolved upon the honorary assistants, Mr. J. Smibert undertaking most of the right ascension computations and reductions, as well as the regulation of mean time.

Messenger.—His duties comprise that of office-keeping, preparing the lamps, cleaning, &c. He also makes most of the Meteorological Observations. The intelligence and application possessed by the youth filling this office are fast making his services in the Observatory extremely valuable.

With regard to the condition and capacity of the Observatory generally, I think it will already have become apparent to the Board that it is very far from complete, and from what a National Observatory should be. There is not a single Observatory in the whole southern hemisphere, among the many that are established for commercial and other purposes, which has so little to boast of as that of Victoria. The building, both from its site and accommodation, would scarcely be recognized as a Government establishment at all, much less as one of so great importance as an Observatory. It consists of two or three small wooden rooms only, and the astronomer has no residence attached or in the vicinity. The material of the building renders the instruments not only liable to every excess of temperature but to destruction by fire; and the accommodation, although it is *made* sufficient now, will be totally inadequate for the reception of the new and larger instruments daily expected. The building should be of a most substantial nature, and the rooms for the instruments should be large, so as to be as free as possible from sudden transitions of temperature. It is absolutely indispensable, and for obvious reasons, that the residence of the astronomer should be adjoining or contiguous to the Observatory. The site is also a matter of great consideration. The Observatory as it is at present could not perhaps be in a worse position. The Railway works are rapidly encroaching on what has hitherto been a reserve surrounding the Observatory. A street of the municipality runs within forty feet of the foundations of the Transit Instrument, and although it is at present but little used, there is every reason to believe it will be; when such is the case the tremor caused by vehicles passing will be destructive to the repose so necessary to foundations for astronomical instruments. An Astronomical Observatory should be erected in as secluded a spot as possible, well removed from any roads, and in a locality free from dust, and smoky or unevenly-heated atmosphere. I would therefore beg to urge upon the Board the great necessity there exists for a more substantial and fitting building, and trust that they will be able to obtain a sufficient sum, either from the amount already voted for public

buildings, or by a special vote, for the erection of a substantial Observatory. The great value and importance of the Observatory, in its indispensable connection with the general survey, renders the demand for permanent and substantial arrangements still more urgent. In the belief that the Government would eventually grant means to build an Observatory, I have considered the question of the best site, and the probable cost of a suitable building. A clear atmosphere, free from smoke and dust, proximity to the nautical community, and an uninterrupted view to the principal Trigonometrical stations on the ranges are the chief desiderata. I selected a spot on the shore to the south of Williamstown as best fulfilling all these conditions, and as possessing, too, the considerable advantage of a suitable formation for good foundations. I estimated the cost of the building to be from £2500 to £3000, and when the Estimates for the current year were being framed I applied to the Inspector-General of Public Works to endeavor to get placed on the Estimates the sum of £3000 for the purpose. He quite concurred with my suggestions, and with the necessity there existed for an improved building; but I regret to say he did not succeed in getting a place on the Estimates for this item.

In consequence of the fact that the site of the Magnetical Observatory on Flagstaff Hill is fast becoming untenable for that purpose, a proposition has been made that, if the Government grant means for the erection of the Observatory, it will be desirable that accommodation be provided so that the Meteorological and Magnetical Observatory, under Mr. Neumayer, might be combined with the Astronomical Observatory. I have had several conferences with Mr. Neumayer on the subject. Such an arrangement would no doubt result in economy in these branches of the public service; and it will remain with the Board to decide on this proposition. It may be here mentioned that, as very few sites are available for a Magnetic Observatory, and perhaps *that* most suitable would be altogether unfitted for an Astronomical one, it therefore becomes necessary to be very careful in the selection of a site for the combined establishments. The site before mentioned, on the shore at Williamstown, would be altogether unsuited for Magnetic observations, being on a basaltic formation; I therefore visited with Professor Neumayer two other sites—one in the Royal Park, the other on the hill by the Botanical Gardens. As far as Magnetism is concerned I think they are both suitable, and for Astronomical purposes I believe the Royal Park to be the best, although the atmosphere in either place is not nearly so generally clear as on the coast. The additional cost of erecting the required accommodation for the Magnetical establishment would be probably £2000.

With regard to instruments, no doubt can exist as to the insufficiency of the present staff to meet the great demands now made by the general or Geodetic Survey on the Observatory. But on the arrival from England of the instruments (now daily expected), the establishment will have at its command nearly all that will be required for the more strictly practical purposes. It would, nevertheless, be highly desirable that the means of obtaining incidental observations, and of prosecuting more purely scientific research, should, when possible, be added. The acquisition, therefore, of a good and powerful Equatorial is a subject to which I would beg to draw the attention of the Board.

The instruments already ordered for the Observatory, and for the Geodetic Survey are as follow:—

- One 4-feet Transit Circle.
- One Zenith Sector.
- One Portable Prime Vertical Transit Instrument.
- Two Barometers (Gay Lussac's).
- Three Portable Transits.
- One 14-inch Universal Instrument, from Munich.
- Three 10-inch ditto.
- One 5-feet Prime Vertical Instrument.

A great deficiency appears in the Library, as, with the exception of the volumes of the observations contributed from other Observatories, scarcely any books belong to the Observatory. A small but good Library of reference is much wanted, and I would urge upon the Board the necessity of obtaining a small yearly grant for the purpose.

It is of the most immediate importance that permanent and paid assistance be afforded. It would be impossible for me with undivided attention to perform all the duties connected with an Astronomical Observatory; and from the necessity there exists at present of my devoting much of my time to the superintendence of the Geodetic Survey, in the field, I have been obliged to depend on the gratuitous assistance of the honorary assistants for aid. I trust therefore the Board will take into immediate consideration the appointment of an assistant; this becomes more urgent as it is of paramount importance that for the sake of any survey that is undertaken, and more especially for the Geodetic Survey, that the places of a great many stars that culminate in the zeniths of all latitudes included in the colony be most accurately determined. This will involve a long and laborious series of observations, and the necessity of exceeding the usual limit of observing (midnight) and instituting "watches."

In conclusion I would suggest to the Board the propriety of placing the Astronomical Observatory as an establishment *per se* on the Estimates of each year, for hitherto it has had to depend on the vote for contingencies of any department under which it has been placed at the time for support, and as no item appears on the Estimates this year for the maintenance of the

establishment I would recommend that in the formation of the Supplementary Estimates the following should be put on:—

Astronomer.
 Assistant.
 Messenger.
 Lighting, Fuel, and Water.
 Books.
 Stationery.
 Incidental Expenses.

I would further suggest to the Board the desirability of making some rules with regard to visitors to the Observatory, and more especially to offer every facility to persons engaged in rating chronometers, or in the adjustment and testing of scientific instruments.

In preparing this Report I have studiously avoided entering into detail; such would more properly appear with the yearly or half-yearly report accompanying the results of observations. But I have attached the several reports which I have from time to time furnished to the Government. I hope shortly to complete the "First Volume of Observations," which will contain, besides the usual star catalogues, *Observations and Comparisons with other Observatories for Longitude; Observations for the determination of the 144th or Secondary Standard Meridian; Descriptions of Instruments; Meteorological Observations, &c.*

ROBT. L. J. ELLERY, F.R.A.S.,

Astronomer, and Superintendent of the Geodetic Survey.

March 14th, 1860.

MAGNETICAL, NAUTICAL, AND METEOROLOGICAL OBSERVATORY.

REPORT TO THE BOARD OF VISITORS.

GENTLEMEN,

I do myself the honor to lay before you the following report, on the progress of the Magnetical, Nautical, and Meteorological Observatory; and would beg to suggest, at the same time, a few particulars that appear to me to be necessary, in order to secure to this institution a standing adequate to the importance of the sciences for the advancement of which it has been established, and to the prominent position of this colony, in the southern hemisphere.

Introductory remarks.

Such a short time has elapsed since the foundation of the Observatory, that a minute description of its history would be superfluous; suffice it to say, that the repairs of the old buildings of the Flagstaff Hill signal station, and the erection of some new ones, were completed about June or July, 1858, that the expenses incurred amounted to £950, to defray which, the sum of £500 was supplied out of the revenue of the colony, and £450 raised by private subscription.

Expenses of erection.

The systematic registration of Meteorological and Nautical facts commenced on the 1st of March, 1858; the observations on atmospheric electricity, and those on the hourly changes in the magnetic elements, on the 15th of April and 1st of May, respectively, in the same year. Since these dates, hourly registrations in all the above-named branches of physical science, have been carried on uninterruptedly, holidays not excepted.

Commencement of registrations.

All instruments in use at this Observatory, before the 1st of March, 1859, were private property, and no expenses were incurred by the Government of the colony, in the purchase of any instruments whatever; but since the above date, some of the English standard meteorological instruments, formerly in use at the Crown Lands Office, have been substituted for those used in 1858.

Instruments.

The execution of the work of the Observatory according to such an extensive system, would, under ordinary circumstances, require a considerable staff of observers; but as the grant of money for the year 1858 was only £600, I could not afford to engage more than two assistants at £180 per annum each; my own services being rendered gratuitously.

Assistants and salaries.

From the commencement of the year 1859 the institution was placed on a better footing, the grant for that year being £1750; out of which three assistants and a messenger were paid, as well as a salary to myself of £400.

On the 1st March, 1859, as above-mentioned, the management of the meteorological branch of the Crown Lands department was transferred to this institution, thereby adding considerably, both to the labors and expenses, because of the necessity of providing the country stations with instruments, forms of registration, &c., &c. I may here mention, that a uniform system of five-day means has been introduced, throughout the observations, for the purpose of making the meteorological facts collected in this country immediately comparable with those collected in other parts of the world.

Transfer of the Meteorological branch from the Crown Lands Office.

System of five-day means.

Before leaving this part of my report, I have to make mention of two other branches connected with the Observatory under my charge. I allude to the magnetic survey of this colony and the investigations for the advancement of ocean navigation. With reference to the former, I may state that it is in a fair state of progress; the magnetic elements and the latitude, as well as the altitude, above the sea, have been ascertained at upwards of thirty stations. During the frequent journeys that I have to make in the interior, no opportunity is lost of checking the instruments used at the meteorological out-stations, thereby making the observations at those stations much more reliable than they would otherwise be.

Magnetic Survey

The investigations, in connection with ocean navigation, have also been carried on successfully; nearly 200 logs have been carefully examined and valuable facts extracted therefrom. Instruments belonging to nautical men have been corrected, and it may be safely asserted that, as an institution, for collecting information on questions of nautical interest, this Observatory may be ranked with the best institutions of a similar nature in other parts of the world. Consistently with the original objects of this institution, I have actively endeavored to organize a system of meteorological observations at sea, but I am sorry to say, that my efforts have not been crowned with the success that I could have desired, owing to a want of instruments suitable for the purpose. Many logs have been distributed, together with such instruments as could be spared from my private collection; but as, in an undertaking of such

Ocean Navigation.

System of Meteorology at sea.

magnitude, my private resources soon became exhausted, and no funds were voted for the purpose, the development of the system was necessarily checked. These remarks apply partly also to the meteorological stations distributed over the colony.

Want of funds for instruments.

It may not be out of place here to observe that the estimates of the Observatory for the present year were framed with a view to remedy the above defect, and for that purpose the sum of £150 was proposed, in addition to the amount voted for 1859; but I am sorry to say that the Government have thought proper to strike it out.*

Delay of the annual report.

Owing to the additional amount of work, caused by the transfer of the Meteorological branch from the Crown Lands Office to this institution, the general report for 1858 was considerably delayed, because it was absolutely necessary to reduce the observations made at the out-stations, which had not been under my control during that year, to a form, similar to that in which the registers at this Observatory were arranged. This task was, however, satisfactorily accomplished, and since November last, a voluminous report has been in the hands of the Government Printer, but on account of the pressure of other business, its publication has not proceeded with the rapidity that might have been desired; this report includes the period from 2nd March, 1858, to 2nd March, 1859; the chief features of its contents are as follows:—

Contents of the annual report.

1. Meteorological and Electrical Elements, given in daily means and extremes, all being derived from hourly observations.
2. Horary variations, in Meteorological, Magnetical, and Electrical Elements.
3. Value of the Meteorological and Electrical Elements, with reference to wind.
4. Complete register of Shooting Stars, containing 321 single meteors.
5. Observations on positions of the Zodiacal Light, and the frequency of Solar Spots.
6. Report on the Meteorology of the country, including twelve country stations; the facts have been arranged in periods of five days, with comparative tables.
7. The second part of the report, contains the Nautical facts; comparison of different routes, observations on the Wind, and on the Currents of the Ocean.
8. The Magnetic report contains a series of absolute measurements of the magnetic elements, their horary variations, &c., &c.; to this is added a complete register of Magnetic Storms and Auroral Discharges. It has not been considered advisable to include in this report, any of the magnetic observations made in the interior, but rather to publish the results in one volume, as soon as the Magnetic Survey of the colony has been completed; as this course would evidently be more advantageous to the scientific world, and at the same time more creditable to the colony, which has undertaken a work so important for the development both of theoretical and practical science.

Magnetic Survey not included in annual report.

Second annual report.

As it forms an essential part of the system adopted at this Observatory that all observations should be immediately reduced, I need hardly mention that I am now prepared to publish a second yearly report, embracing the period from 2nd March, 1859, to 2nd March, 1860; and whereas the first report was only a short extract from the registers of the Observatory, this one should be a complete copy of the same; but I will not at this time urge the desirability of adopting such a course, as I hope to have the honor of explaining personally to the Board the reasons that guide me in this matter.

Having given a short sketch of the history of this institution, and of the progress of the labors undertaken, during the two years of its existence, I shall now proceed with an enumeration of the buildings which form the Observatory:—

Enumeration of buildings.

1. The dwelling-house, containing the offices, quarters for the directory and messenger, mechanical workshop, anemometer and electrometer room.
2. Barometer and photometer rooms.
3. The meteorological stands; one for the standard dry and wet bulb thermometers and Regnault hygrometer, and the other for self-registering thermometers.
4. *The Absolute House*, for ascertaining the absolute values of the elements of terrestrial magnetism.
5. *The Horary House*, for registering the hourly changes in the magnetic elements.
6. *The Universal Room*, which is at present used for photographing the sun, with the view of investigating more closely into the periodicity of the solar spots and their connection with magnetism.
7. *Stable*.

Most of these buildings are of a temporary nature, and leave much to be desired.

Description of buildings.

1. This building is in a very unsatisfactory state, and it would be only wasting money to attempt to repair it; it is also by far too small for the requirements of the institution, and being of wood it is a very unsafe depository for the valuable documents and registers of the Observatory. It was for these reasons that I proposed to the Government that a sum of money should be placed on the Estimates for the erection of a brick cottage to replace the present wooden one.

* This sum appears now on the Supplementary Estimates for 1860.

2. This place is also out of repair; the rain enters the building in all directions, doing considerable damage to the instruments and interfering with the observations; besides which, the rooms are quite unsuited for the purposes for which they have to be used, namely, for a place in which to compare the instruments brought to this Observatory, for correction, from the out-stations, ships, &c. I proposed to make provision for a barometer room in the above-mentioned brick cottage.
3. The meteorological stands are in good condition.
4. This house is in a tolerable state, and the necessary repairs can easily be completed.
5. This house is in good repair, a few unimportant alterations have to be attended to.
6. The same may be said of No. 6.
7. The stable is a very temporary affair, and requires a thorough overhauling to make it what it should be.

It appears to me unnecessary to add to this statement a catalogue of the instruments in use; and I shall only remark, that the instruments required on the magnetic survey, as well as most of those in use at the Observatory, are in perfect working order; nevertheless, I shall, in another part of this report, have to propose some improvements and additions, in accordance with the progress of this branch of science. Instruments.

A circumstance deeply affecting the working of this Observatory must not be passed over in silence; and I feel myself obliged to bring the matter fully under the notice of the Board. Disturbances.

The magnetic observations were carried on satisfactorily until the middle of June, 1859, when considerable disturbances were observed in the magnets, from the effects of an iron shed, sawmill, and engine, which were erected in the immediate vicinity of the Observatory at that time. The fact was mentioned verbally to the Honorable the Chief Secretary, who communicated with the Honorable the Commissioner of Lands and Survey on the subject, in a letter dated 13th August, 1859, requesting him to take such steps as he might deem necessary, in order to prevent further inconvenience. A communication from the Deputy Surveyor-General, dated 31st August, informed me that it was a matter of impossibility to protect the Observatory against the interference above referred to, and that by taking such steps there would be a loss of more than £30,000 to the revenue of the colony. In a subsequent letter the Deputy Surveyor-General again expressed his doubts as to the possibility of preventing interferences, and suggested the removal of the Observatory to a more suitable and quiet place, and where the magnets would not be subjected to such disturbances. Deputy Surveyor-General's opinion.

This last opinion was expressed in answer to a statement I had made to the effect that during the month of October last, the constant alterations on the Flagstaff Hill, in the vicinity of the Observatory, and the necessary work connected therewith, as blasting, carting, &c., &c., rendered it almost impossible to proceed with the observations on terrestrial magnetism.

Being fully aware of the immense trouble and inconvenience that would be involved in the removal of such an observatory, I should have felt considerable hesitation in advising the Government to grant a place for its re-erection, had I not been convinced that the branch of science that I have the honor to represent would be considerably benefited thereby, because it was evident that, if the alterations in the neighborhood of this Observatory could not be put a stop to, it would be utterly useless to proceed with the magnetic part of our observations.

To this was added, in a short time, another important consideration, which made it a still more urgent matter that the site of the Observatory should be changed. The extensive steps taken by the Government, in carrying out the Geodetic Survey, render it very desirable that the Astronomical Observatory at Williamstown, under the charge of Mr. Ellery, should be enlarged and improved, in accordance with the requirements of the General Survey of the colony, and its position in connection with commerce and navigation. But, as it appears from Mr. Ellery's reports, that the present site of the Williamstown Observatory becomes more and more untenable every day, and that it has been proposed to erect a new and enlarged Observatory on a more suitable site, I was, on being made acquainted with Mr. Ellery's opinions, immediately impressed with the necessity of having the Magnetic, Meteorological, and Nautical Observatory combined with the Astronomical in one and the same locality; and at a consultation which I had with Mr. Ellery on the subject, we decided on proposing the same to the Government. The great advantages of such an arrangement need no illustration, as they will be evident to every one conversant with the objects of Astronomical and Physical Science. Astronomical Observatory and Geodetic Survey.

There are, however, several difficulties in the way in carrying out this project; the chief of which is, the selection of a site suitable for both purposes. After a careful examination of different localities, we arrived at the opinions expressed in the Report attached hereto, which is written in our joint names. Another matter that would require particular attention is, that the requisite buildings should be so constructed, that the management of one institution should in no way interfere with that of the other, and that the labors of each should be quite distinct and separate from one another. I have thought it unnecessary to enter into details in a report like the present, and have, therefore, only given an outline of my views, hoping that the Board will allow me to explain, verbally, to them the particulars of the questions here alluded to. Proposal to remove the Observatory.

In conclusion, allow me to give a short summary of the foregoing suggestions. Considerations on the removal.

1. As the protection of the Magnetic Observatory, from certain disturbances which are liable to vitiate the observations, would cause a great loss to the public revenue, I would propose that a more suitable site be selected for an Observatory for the advancement of physical science. Summary of suggestions.

2. This site should be one suitable also for an Astronomical Observatory, and the two institutions should be removed to one and the same locality.
3. The building should be so constructed, that the working of the Magnetic, Nautical, and Meteorological Observatory might in no way interfere with the working of the Astronomical, and *vice versa*.
4. As success in the investigation of the meteorology of the adjacent seas, as well as in the organization of stations throughout the Colony of Victoria, depends, to a great extent, on the possession of instruments; I would therefore propose to take such steps, as may be deemed advisable, to provide excellent standard barometers, thermometers, &c., &c., as well as a first-rate anemometer.
5. As the importance of this Observatory, as a depository for nautical information, increases daily; and as nautical men look to it as a place for obtaining reliable information; I would suggest that a complete set of Admiralty charts be provided with as little delay as possible.

I have the honor to be, Gentlemen,
Your most obedient servant,

G. NEUMAYER.

Flagstaff Observatory,
March, 1860.

REPORT

TO

THE BOARD OF VISITORS TO THE OBSERVATORIES ON THE PROPOSED SITES FOR A NEW OBSERVATORY.

IN accordance with the request of the Board, I have made a careful examination of the proposed site for an Observatory in the Government Reserve, near the Botanical Museum,

The principal experiments were for *tremor of the ground*, and for atmospheric ebullition caused by smoke and heated air over the city and its suburbs. Tremor was tested for by observing magnified images reflected from quicksilver, with the following results:—A stone of about an ounce weight dropped on the ground anywhere within a range of 6 feet of the quicksilver *destroyed* the image, and a footfall within a radius of 150 feet very perceptibly *disturbed* the image. Trains passing on the St. Kilda, Sandridge, and Suburban Railways, caused no perceptible alteration of the image, nor was any disturbance discovered, when on several occasions a more than usual number of vehicles were passing the nearest to the site on the St. Kilda road.

Tests for atmospheric tremor or ebullition were made by observing objects on and a little above the horizontal line over Melbourne, but no ebullition more than usual at similar altitudes could be perceived; the wind was generally S.S.E. and S. at the time. A N. or N.W. wind might make a difference, but I am of opinion that with the exception of the directions over, and in the vicinity of the founderies and furnace chimneys, atmospheric disturbance need not be feared, as an obstruction to observation. The geological formation is *tertiary*; good for foundations and a bad conductor of tremors. The locality is well secluded and partially protected by trees. The dust storms are to be feared, as they must be, in any locality near Melbourne, but their effects may be much modified by planting trees.

The horizon generally is open; the N. and S. horizons lie respectively over the Eastern Hill and Brighton; and I am of opinion that if no encroachments of any large buildings or public highways take place, the site is in most respects well adapted for the erection of an Observatory.

The Royal Park I examined nearly two years ago. As far as tremor is concerned, a large portion of the park seems to be quite as good as the Botanical Gardens, and I think there would be less disturbance in light N. and N.W. winds, from atmospheric ebullition, and the trees form a good shelter from the dust storms. The formation is much the same as the Botanic Garden site, and I consider there are several positions in the Royal Park admirably fitted for an Astronomical Observatory.

ROBT. L. J. ELLERY.

REPORT

TO

THE BOARD OF VISITORS TO THE MAGNETIC, NAUTICAL, AND METEOROLOGICAL OBSERVATORY.

GENTLEMEN,

I do myself the honor to submit to the Board of Visitors the following report on my investigations, calculated to illustrate the questions as to the best site for an Observatory for Physical Science, and undertaken on the express desire of the Board. Before entering into details, I beg to state that the unfavorable weather, and some necessary repairs to the buildings of the Flagstaff Observatory greatly protracted the proceedings connected with this special Magnetic Survey of Melbourne and its suburbs, which I had to undertake to be fully prepared to answer the various questions.

Notwithstanding a complete set of observations on the values of the magnetic elements for various localities around Melbourne had been made by me some three years ago, and although the results then derived had been very decisive, I entered at once again into a thorough examination of Melbourne with regard to terrestrial magnetism, and I may state so much here that the results I arrived at do entirely correspond with those obtained on previous occasions; but I shall avoid referring to the latter, as the present set of observations suffice to decide the points in question.

The following contains the leading principles, according to which the task was accomplished:—

1. To obtain good observations on as many stations in and around Melbourne as time and season would permit.
2. To observe the three elements of terrestrial magnetism, declination, horizontal intensity and inclination in each station, inasmuch as each element taken only by itself could never afford the means of exact conclusions.
3. To reduce all observations made on the various stations to the *differential instruments* at the Flagstaff Observatory, as the diurnal changes in the elements might lead to erroneous conclusions.
4. To determine the absolute values of the magnetic elements in the absolute house of the Observatory, previously and subsequently to the observations in the field. (This was thought advisable in order to keep the instruments used in perfect check. These original observations have not been attached to this Report, as they are of a technical nature, and not immediately pertaining to the question).
5. To select the stations in such a way as to secure the best guarantee to the reliability of the results; and here was particular attention paid that the stations should be, as nearly as circumstances would permit, equally distributed all around the compass, and that no *disturbing causes* should influence the readings (as the vicinity of iron and buildings, &c.), wishing these to be distinguished from *local influences* depending upon the geological formations.
6. To determine the astronomical meridian for each station by means of the universal instrument placed in the round tower of the Flagstaff Observatory. For this purpose all stations were chosen with a view to have a sight of the tower, and heliotrop signals were used to facilitate the operation of transferring the meridian.
7. To attach the original reading of the instruments in the out-stations, to show the manner in which the observations have been carried out.

The accompanying sketch of Melbourne and its suburbs contains the various stations selected, and here may also follow a short description of the localities. The geological remarks being taken from the lately published Map of the Geological Survey of the Colony.

No. 1. The ABSOLUTE HOUSE of the Flagstaff Observatory.

No. 2. SANDRIDGE, near the battery, and nearly on the magnetic meridian of the Flagstaff Observatory and close to the beach. The stand of the instrument was fixed in sand.

Azimuths	{	Flagstaff Observatory ...	... N. 7° 17' 95" E.
		Trig. Signal, Batman's Hill ...	... N. 8° 20' 40" E.
		Wesleyan Chapel ...	... N. 23° 56' 41" E.

No. 3. BOTANICAL GARDEN RESERVE.—Hundred yards towards the west of the newly erected Botanical Museum. Geological formation: newer and older Pliocene with cappings and outliers of tertiary on old rocks. First rate foundations; admitting of a free sight around the horizon with the exception of those points between E. and N.E.

Azimuths	{	Flagstaff Observatory ...	...	N. 40° 33·55' W.
		Williamstown Lighthouse ...	...	S. 53° 22·15' W.
		Wesleyan Chapel ...	...	N. 14° 41·55' W.

No. 4. TOORAK—HAWTHORN.—Seventy yards from the Glenferry Road on the eastern side. Geological formation: upper silurian.

Azimuths	{	Flagstaff Observatory ...	...	N. 72° 2·91' W.
		Ross Church ...	...	N. 72° 13·39' W.
		Chalmer's Church ...	...	N. 63° 49·31' W.

No. 5. UNIVERSITY.—Between the yard of the University and the New Cemetery, some 120 yards from Madeline street towards the west. Geological formation: upper silurian.

Azimuths	{	Flagstaff Observatory ...	...	S. 25° 53·07' W.
		Wesleyan Chapel ...	...	S. 11° 41·02' E.

No. 6. ROYAL PARK.—On an open place some 207 yards towards the west of the late Observatory of the Geodetic Survey. Free sight around the horizon with the exception of from S.E. to N.E. Geological formation: near the line of boundary between basalt, and the upper silurian on the latter.

Azimuths	{	Flagstaff Observatory ...	...	S. 14° 18·0' E.
		Williamstown Lighthouse ...	...	S. 17° 57·27' W.
		Tree on Mount Macedon ...	...	N. 56° 34·83' W.

No. 7. MOONEE PONDS.—Some 200 feet from the road towards east, near the late Observatory of the Geodetic Survey. Geological formation: upper silurian, with cappings and outliers of tertiary and older rocks, to both sides however layers of basalt. This station was observed on the 7th of October, 1858, but the values have been reduced for annual change.

No. 8. STANLEY STREET west, North Melbourne.—On a small hill. Geological formation: lower volcanic, with cappings and outliers of tertiary.

Azimuths	{	Williamstown Lighthouse ...	...	S. 24° 48·5' W.
		Trig. Signal, Batman's Hill ...	...	S. 22° 14·6' E.

No. 9. FOOTSCRAY.—Near the road from Melbourne to Williamstown, towards east Geological formation: upper volcanic.

Azimuths	{	Flagstaff Observatory ...	...	S. 71° 16·0' E.
		Williamstown Lighthouse ...	...	S. 7° 27·89' E.
		Tree on Mount Macedon ...	...	N. 32° 27·59' W.

No. 10. WILLIAMSTOWN.—Near the newly erected Mechanics' Institute, some 400 yards from the railroad towards N.E. Geological formation: upper volcanic.

Azimuths	{	Flagstaff Observatory ...	...	N. 40° 13·81' E.
		Lighthouse ...	...	S. 74° 41·07' E.

No. 11. RED BLUFF. Near the Trigonometrical Signal. Geological formation:—newer and older Pliocene with cappings and outliers of tertiary on older rocks.

Azimuths	{	Flagstaff Observatory ...	N 13° 45·14' W.
		Williamstown Lighthouse	N 73° 22·71' W.

N.B.—Whenever the Azimuth of the Flagstaff Observatory is given, it is understood that the centre of the round tower was observed.

[Here are subjoined, in the Original Report, copies of the complete sets of Observations, the reduction and discussion of which give the following results.]

The Stations, "Botanical Gardens" (3.) and "University" (5.) agree in every one of the three Magnetic elements exceedingly well, and so do the stations, "Toorak, Hawthorn," (4) and "Red Bluff" (11); while on the other hand, the remainder of the stations do not agree with those named before, nor do they agree so well amongst themselves, which fact makes it evident that local causes influence the result. I therefore thought myself justified in adopting the mean of the values of stations 3 and 5 as the standard with which to compare the others. In this view I was further supported by the unobjectionable geological formation in the first-named stations, and by the result of a discussion of the value of the single readings, which clearly showed their perfect reliability in every respect, (in stations 3 and 5).

Before I give the single results of comparison, I shall state the values for the magnetic elements for the adopted *standard stations*, as derived from the mean values for the period between the 20th of May and the 30th May, 1860.

MAGNETIC DECLINATION	...	...	8° 41' 69" East.
HORIZONTAL INTENSITY	...	...	2.36894 (Gauss's unit.)
MAGNETIC INCLINATION	...	...	67° 11' 17" South.

The differences of these standards and the out-stations are as follows, commencing with the smallest difference in each element:—

I. MAGNETIC DECLINATION.

1.	{ Botanical Gardens	(3)	...	...	...	— 0.02'
	{ University	(5)	...	...	...	+ 0.02'
2.	Sandridge	(2)	...	...	...	— 2.00'
3.	Toorak, Hawthorn	(4)	...	...	...	— 2.88'
4.	Red Bluff	(11)	...	...	...	— 2.87'
5.	Royal Park	(6)	...	...	...	— 3.69'
6.	Moonee Ponds	(7)	...	...	...	+ 4.11'
7.	Williamstown	(10)	...	...	...	— 9.77'
8.	Footscray	(9)	...	...	...	— 9.79'
9.	Flagstaff Observatory	(1)	...	...	...	— 10.99'
10.	Stanley street	(8)	...	...	...	— 11.89'

II. HORIZONTAL INTENSITY.

1.	{ Botanical Gardens	(3)	...	...	...	— 0.0002
	{ University	(5)	...	...	...	+ 0.0002
2.	Toorak, Hawthorn	(4)	...	...	...	+ 0.0023
3.	Footscray	(9)	...	...	...	— 0.0042
4.	Red Bluff	(11)	...	...	...	— 0.0050
5.	Royal Park	(6)	...	...	...	+ 0.0058
6.	Williamstown	(10)	...	...	...	— 0.0073
7.	Flagstaff Observatory	(1)	...	...	...	— 0.0073
8.	Sandridge	(2)	...	...	...	— 0.0077

III. MAGNETIC INCLINATION.

1.	Red Bluff	(11)	...	...	...	+ 0.40'
2.	{ Botanical Gardens	(3)	...	...	...	+ 1.05'
	{ University	(5)	...	...	...	— 1.05'
3.	Royal Park	(6)	...	...	...	— 3.43'
4.	Toorak, Hawthorn	(4)	...	...	...	— 3.83'
5.	Stanley street	(8)	...	...	...	— 4.92'
6.	Williamstown	(10)	...	...	...	— 5.08'
7.	Sandridge	(2)	...	...	...	+ 6.05'
8.	Flagstaff Observatory	(1)	...	...	...	+ 7.92'
9.	Moonee Ponds	(7)	...	...	...	— 10.66'

By examining the differences in Horizontal Intensity (II.) somewhat closer, we find that their greatest value is reached in "Royal Park" and "Sandridge," "Flagstaff Observatory," and "Red Bluff." These stations being nearly on a straight line, which bisects the Magnetic Meridian at an angle of 22° 30' from N. towards W., and which is nearly parallel to the axis of the basaltic layer extending from Emerald Hill towards the Royal Park and Moonee Ponds. The greatest disturbance in the values of the magnetic elements seem to prevail near station, "Stanley Street," (8) or rather more towards the swamps.

Taking all three elements into account, it becomes evident by inspection of the respective tables (I., II., III.) that the most sudden changes in either element take place when proceeding from "University" (5) towards "Moonee Ponds," (7) although the distance is but very small.

	University.	Royal Park.	Moonee Ponds.
Declination	+0.02'	-3.69'	+4.11'
Horizontal Intensity	+0.0002	+0.0058	
Inclination	-1.05'	-3.43'	-10.66'

Such differences can only be due to some serious local influence, as one might have anticipated from the geological formation.

Let us now glance at the differences within the triangle, "University," "Botanical Gardens," and "Toorak—Hawthorn," the distances being by far greater than in the former case :—

	University.	Botanical Gardens.	Toorak—Hawthorn.
Declination	+0.02'	-0.02'	-2.88'
Horizontal Intensity	+0.0002	-0.0002	+0.0023
Inclination	-1.05'	+1.05'	-3.83'

I do not think there is any necessity for entering further into an examination of the character of various localities around Melbourne, and I may be permitted to conclude this enumeration of facts and these remarks by stating a truth which clearly follows from my investigations, namely,—*An Observatory for the advancement of the science of terrestrial magnetism in the vicinity of Melbourne should not be erected towards the west of the magnetic meridian of the station "University" (5). The slight and well corresponding differences in the values of the magnetic elements for so considerable distances as between Nos. 5, 4, 3, are calculated to illustrate the suitability of localities towards the east of the magnetic meridian of No. 5, for a site of a Magnetic Observatory.*

This result thoroughly corresponds with the views I have entertained since the first three months of my stay in this colony, and it is due to these views that I considered stations No. 5 and No. 3 as the standards, and that the absolute values have on several occasions been ascertained for these spots (on the 1st of April, 1857; 26th of September, 1857; 1st of April, 1859; and 3rd of May, 1859) and it was only after a considerable hesitation on my part that I consented to occupy the old buildings of the Flagstaff Signal Station, and then only because I had arrived at the conviction, after mature consideration, that by considerable additional calculations, and by establishing standards as those of No. 3 and 5, I would be enabled to answer all questions, at least the most important ones, according to the present state of the science of terrestrial magnetism.

It remains only to add that, *I am of the opinion that no place near Melbourne towards the east of the meridian of station No. 5, "University," appears to be equally well qualified to be selected for a site of a Magnetic Observatory as that on the hill near the Botanical Gardens, and I would, therefore, most humbly request the Board to give me their support in securing to scientific research so excellent a position.*

I do not hesitate a moment to state, with due regard to the interests of the sciences of navigation and meteorology and physical sciences in general, that not a finer spot can be found, and I still entertain the hope that the Board will acquire the conviction that it would be difficult to find a better spot even for the advancement of astronomy than that recommended by me as a site for an Observatory for Terrestrial Magnetism and physical sciences in general.

I have the honor to be, Gentlemen,
Most respectfully yours,

Flagstaff Observatory,
June 14th, 1860.

G. NEUMAYER.

TO THE SECRETARY OF THE BOARD OF VISITORS TO THE MAGNETIC,
NAUTICAL, AND METEOROLOGICAL OBSERVATORY.

Flagstaff Observatory,

Melbourne, June 27th, 1860.

SIR,

The perpetual alterations in the vicinity of the Flagstaff Observatory, whereby the magnetic instruments are severely affected make it incumbent upon me to represent to the Board the necessity of having the Observatory removed as soon as circumstances permit. Inasmuch as it is unlikely that a transfer of the whole institute can be effected within this year, I would most humbly advise to have the newly selected ground fenced off with as little delay as possible, the absolute house of this Observatory removed to the same, and an additional little building erected in which to put up a set of variation instruments, the expenses of the whole not exceeding two hundred pounds.

It is quite necessary that this should be executed as speedily as possible to prevent any interruptions in the series of observations and to secure the standard for the magnetic survey of this colony.

I venture to hope that the Board will support me in this important question, as it appears that there is no possibility to put an end to the alterations above alluded to.

I have the honor to be, Sir,

Your most obedient servant,

G. NEUMAYER.

TO THE BOARD OF VISITORS OF THE MAGNETICAL, NAUTICAL, AND
METEOROLOGICAL OBSERVATORY.

GENTLEMEN,

After having been made acquainted with the decision of the Board of Land and Works with regard to the site for an Observatory near the Botanical Gardens reserve, to the effect that the Board objects to grant a piece of land in that locality, and suggested the selection of a site in Studley Park; I proceeded at once to inquire into the suitability of the localities pointed out, by making observations during the 30th of July in order to arrive at a definite conclusion.

I may be permitted to give first of all a description of the site, or rather sites, suggested.

There are two places available for the purpose, both being situated on the left banks of the River Yarra; the one (A) to the right of Johnston's bridge-road, about seventy feet above the low water mark of the Yarra, the other (B) in that triangle formed by Johnston's and Studley Park, bridge-road, near the junction of both; the former station bearing N. $40^{\circ} 4' W.$ from the latter.

The geological formation in both localities is upper silurian, and is therefore not likely to cause any disturbances in the values of the magnetic elements, and would, I think, offer good foundations.

Station A is situated on a peninsula formed by the River Yarra, its greatest breadth (12 chains) being opposite the junction of the Merri Creek and the Yarra; on the highest portion, however, the breadth does not exceed 8 chains; and thus we see at once that the Observatory would have to be erected on a high wall, running East and West, the North side of which is exposed to the rays of the sun.

Station B is situated in the above-described triangle; in this case the Observatory would occupy the centre of a circle of 6 chains radius, with the two roads as tangents, as the gravel pit towards the South would not admit of a greater distance from the junction.

At each of these two stations a complete set of magnetic instruments were put up, and—although the observations were carried on quite independently—the results of both sets of observations corresponded very well with each other; for this reason I shall only speak of those derived from Station B, with the understanding that those in Station A are identical with them.

Although the view in the distance is very open nearly all round the compass, the buildings of the Flagstaff Observatory could not be seen from either of the two stations, and in order to determine the magnetic declination a different method from that on former occasions had to be adopted. The azimuths of several distant objects were ascertained by means of a sextant and a chronometer; the error of the latter having been carefully determined before and after the observations.

By means of distances of the sun's nearest and furthest limb from the *tree on Mount Macedon* the azimuth of the latter was found to be from Station B, N: $40^{\circ} 4' 5'' W.$, and that of the spire of the Wesleyan Chapel, W. $10^{\circ} 29' 7'' S.$

I refrain from subjoining the original observations from which these results have been derived, and proceed at once to the enumeration of facts, which are calculated to throw light on the question of suitability of the place with regard to magnetic observations.

The mean value of the magnetic declination for a period of ten days was found to be $8^{\circ} 39' 01''$ E., which value agrees well with the standard adopted in my former report (see that report), and the same may be said with regard to the magnetic inclination, the value of which is $67^{\circ} 8' 22''$ S.

The observations carried on with the view of determining the horizontal force do not give such satisfactory results, which may, however, be attributed to a sudden change in the magnetic momentum of the standard magnets, the value of which I could not determine as yet, the time allowed being too short.

With these facts I do not hesitate to say that neither of the sites suggested offer any serious objections with regard to their geological formation and magnetic qualities; but with regard to Station B I most humbly add that alterations on the adjoining roads, as the laying of water pipes, gas pipes, &c., would alter this state of things considerably, the distance being so very small; and I would on this ground alone hesitate to recommend to the Government the erection of an Observatory in this latter locality.

I may be allowed briefly to give my opinion as to the suitability of either spot for sites of an Observatory for physical science.

Station A, as it is at present, may be considered suitable for the objects of meteorology and terrestrial magnetism; but Station B is too near the roads, and objectionable on this account. But there is another point to be taken into consideration when about to erect an Observatory for the advancement of astronomical and physical science in a young and rising community, the welfare and position of which will greatly depend upon the development of ocean navigation; and this point is, to erect the Observatory in such a locality that nautical men and others interested in navigation, as chronometer makers, mechanical workmen, &c., may have easy access.

I should feel that I was insulting the Board of Visitors by entering into a discussion on the importance of such institutions in connection with navigation—the fact that such an influence could not be fairly exerted, were the Observatory, erected at a place so far removed from all shipping affairs, at a place from which the harbor cannot be seen, and consequently no corresponding simultaneous observations could be carried out—should suffice to prove the unsuitability of the localities suggested.

After having had the honor to superintend for nearly three years the Flagstaff Observatory, and having made some experience with regard to the difficulties connected with the collection of facts from logs of ships, with the correction of nautical instruments, and the supply of important information to masters of ships, I do not hesitate one moment to state that both places are entirely unsuitable for these purposes, and that I would not consider myself justified in proposing to have the Observatory erected in these localities. Nautical men would but seldom visit the Observatory to get the information they are so much in want of; they would never find an inducement to co-operate with the Observatory, not being personally acquainted with its scope and object; they would hesitate to carry their valuable instruments four or five miles land inward to have them adjusted or corrected, and simultaneous observations for this latter purpose could not be carried out, as the signals of light would not be visible.

My conviction on this point is so strong, that I believe should such a step as the one contemplated be carried out, it would at once destroy the greatest part of the good which hitherto has been done at the Flagstaff Observatory for the advancement of ocean navigation.

I again venture to impress the Board of Visitors with the importance of arriving soon at a final decision in this matter, as this state of suspense (the cause of which is given in my former report) cannot act otherwise than injuriously upon the labors of the Observatory.

Allow me to state, in conclusion, that I know of no other place near Melbourne equally well qualified for a site of the proposed Observatory than that near the Botanical Gardens reserve, and I again most humbly request the Board to give science their support in overcoming the difficulties to be encountered in securing so excellent a position for its promotion.

I have the honor to be, Gentlemen,
Your most obedient servant,

G. NEUMAYER.

Flagstaff Observatory,
August 7th, 1860.

STATION AT KEW BETWEEN JOHNSTON-STREET AND STUDLEY PARK,
JULY THE 30TH, 1860.

Mount Macedon Tree	...	215°	26.1	25.9	32.8	...	32.2	29.25
Wesleyan Chapel	...	276°	50.0	59.2	49.9	...	58.7	54.45
							Decl.	Intens.
Declination 12h. 20m.	...	166°	2.2	3.5	2.85	...	50.0	27.7
Deflection 1	...	187°	49.05	53.25	51.15	...	50.0	27.5
" 2	...	188°	44.8	49.1	46.95	...	50.0	27.3
" 3	...	143°	45.9	46.1	46.0	14° 0	50.0	27.1
" 4	...	143°	45.2	45.3	45.25	...	50.0	26.9
Declination 12h. 35m.	...	166°	2.3	3.9	3.10	...	50.0	26.7
Deflection 4'	...	143°	45.2	45.9	45.55	...	50.2	26.7
" 3'	...	143°	45.2	45.8	45.50	...	50.5	26.6
" 2'	...	188°	45.8	50.2	48.00	14° 0	50.7	26.5
" 1'	...	187°	46.3	50.8	48.55	...	50.9	26.4
Declination 12h. 50m.	...	166°	0.7	2.5	1.60	...	51.0	26.4
Deflection 1	...	195°	9.2	14.0	11.60	...	51.4	26.5
" 2	...	196°	25.6	30.7	28.15	...	51.8	26.6
" 3	...	136°	4.2	3.95	4.08	15° 4	52.3	26.7
" 4	...	136°	7.9	7.6	7.78	...	52.6	26.8
Declination 1h. 3m.	...	166°	0.3	2.0	1.15	...	52.9	26.8
Deflection 4'	...	136°	9.0	8.9	8.95	...	52.8	26.2
" 3'	...	136°	4.4	4.0	4.20	...	52.7	25.6
" 2'	...	196°	28.8	33.4	31.10	14° 5	52.6	25.0
" 1'	...	195°	9.0	13.6	11.30	...	52.5	24.5
Declination 1h. 17m.	...	166°	1.0	2.2	1.60	...	52.4	24.3
Mount Macedon Tree	...	215°	26.2	32.7	26.2	...	34.3	29.35
Wesleyan Chapel	...	276°	50.05	59.2	...	...	...	54.63
Declination 1h. 20m.	...	166°	0.7	2.3	1.50	...	52.6	24.1
" 1h. 32m.	...	194°	39.0	43.2	41.10	...	53.0	
" 1h. 36m.	...	194°	59.9	64.9	62.40	...		
" 1h. 40m.	...	137°	36.9	37.2	37.05	13° 7		
" 1h. 44m.	...	137°	19.4	19.6	19.50			
" 1h. 48m.	...	136°	55.8	56.3	56.05			
" 1h. 52m.	...	137°	35.8	36.2	36.00			
" 1h. 56m.	...	194°	57.9	62.8	60.35			
" 2h. 0m.	...	194°	38.6	43.1	40.85			
			W.	E.	S.			
Inclination at the Ring	{	194°	0.35	0.43	0.18			
		137°	0.31	0.48	0.18			
Declination 2h. 5m.	...	165°	58.2	59.3	58.75	...	55.0	24.4
Mount Macedon Tree	...	215°	26.2	32.3	29.25			

REPORT

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THE BOARD OF VISITORS TO THE OBSERVATORIES ON THE EFFECT OF THE DISCHARGE OF ARTILLERY ON ASTRONOMICAL INSTRUMENTS AT THE PROPOSED SITE FOR THE OBSERVATORY, GOVERNMENT RESERVE.

In accordance with the request of the Board I made experiments at the proposed site for the Observatory, near the Botanical Museum, to ascertain if the firing of artillery, which frequently takes place there, would have any injurious effects on astronomical instruments. Having through Mr. Verdon obtained the co-operation of a body of the volunteer artillery with two twelve-pounder howitzers the following tests were made :—

A transit instrument with powers of 35 and 70 was set up on the stonework of the sill of one of the windows of the Botanical Museum, and adjusted so that the cross wires bisected a well-defined distant object.

- 1st. One gun was then fired within a distance of 10 chains of the instrument, when it was found that the wires had *dropped* 10 seconds from the bisection.
- 2nd. Three guns were fired consecutively, at a distance of 15 chains, and the instrument was disturbed about 7 seconds for each gun.
- 3rd. Three guns were fired consecutively at a distance of 25 chains, and the instrument was disturbed about one second for each gun.
- 4th. Several guns were fired at the nearest distance that the artillery ever approaches the proposed site, during ordinary practice, and no effect whatever was perceptible, although the guns were fired in salvo.

The results of these experiments show that no disturbance from the firing of the ordinary artillery on the usual practice ground need be apprehended, for it must be borne in mind that the guns *were all pointed at the instrument*. That the instrument was in the open air, and with no walls, or anything intervening. It may therefore be safely concluded that when the astronomical instruments are protected by the walls of the Observatory, that the firing of even heavier artillery from the parade ground will exercise no injurious influence.

ROBERT L. J. ELLERY,

Astronomer, and Superintendent Geodetic Survey.