

## CENTENARY OF MELBOURNE-TOOLANGI MAGNETIC OBSERVATORY

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## ABSTRACT

A brief history of the Melbourne-Toolangi Magnetic Observatory is given, on the occasion of its hundredth year of continuous operation.

In 1858, hourly magnetic observations began at a site in the Flagstaff Gardens in Melbourne. Since that date, magnetic observations or recordings have been maintained continuously at Melbourne and later at Toolangi with few interruptions. Actually, this was not the first magnetic observatory in Australia. One had previously been established in 1846 at Hobarton (now Hobart) in Tasmania, as part of the British Colonial Observatories scheme under Edward Sabine, but this was closed down in 1850. Thus, 1958 marks the attainment of 100 years of continuous magnetic work in Victoria.

Dr. Georg Neumayer, of Bavaria, had worked in terrestrial magnetism with Lamont at Munich. He had become convinced of the need for further magnetic recordings in the southern hemisphere, and in a visit to Australia in 1852-53 was impressed by the "rapid and enlightened progress" of the Colony of Victoria. He decided to return as soon as possible to establish a meteorological, nautical, and magnetic observatory. He returned in 1857, and after preliminary surveys in Melbourne and surrounding areas, recommended to the Government a site on a hill near the Botanical Gardens. However, the Government did not grant this site; instead, the observatory was set up using the buildings of an old signal-station on Flagstaff Hill, near the margin of the city proper. This site was not so suitable magnetically, being on basaltic rocks.

Regular magnetic observations began on May 1, 1858. The three elements—declination, horizontal intensity, and inclination—were observed visually every hour of the day and night for five years, on variometers designed by Lamont. In the event of disturbances or aurorae, observations were made every few minutes. Absolute measurements were made monthly from October 1857 to January 1858; they were then interrupted until the completion of a new building in October 1858.

The early staff included W. J. Wills, a surveyor, who undertook training in magnetic work so that he could include magnetic observations as part of the programme of an expedition led by Burke, which attempted to cross Australia from south to north. The now famous Burke and Wills expedition came to a tragic end, and both of the principals perished in 1861.

The operations were hampered by building and blasting activities in the vicinity, and after a further survey, Neumayer confirmed his recommendation of

the Botanical Gardens site. Eventually, the Government agreed to grant this site, and after a period of overlapping absolute observations, the variometers were transferred to the new site in 1862.

In 1863, photographic recording magnetographs and new absolute instruments were ordered; these were similar to those in use at the Kew (London) Observatory. Hourly observations were discontinued in 1863, but absolute measurements were continued.

In addition to establishing the Observatory, Neumayer conducted a magnetic survey of Victoria, and established 230 stations at intervals of about 30 miles. He completed this work in 1864, and returned to Germany, where he spent some years preparing the results for publication under the auspices of the Royal Society of London.

The absolute instruments arrived in 1866. They comprised unifilar *H* and *D* apparatus and a dip circle. The magnetographs were set in operation during 1867, under the direction of Mr. R. L. J. Ellery, Government Astronomer. Absolute observations were made monthly. The positions of the variometer spots were observed twice daily on telescopic scales, and the spots were recentered if necessary. The records were not scaled, however, as the primary interests of the observatory were in meteorology and astronomy, and staff was not available for magnetic reductions.

At one stage, it was seriously discussed whether the recordings should be discontinued in view of the lack of opportunity for reduction and the need for a new variograph building. However, in 1877, the magnetographs were transferred to a new building, and were set up on stone piers in the basement of a masonry hut. (This is still in use as a seismic observatory.) The move occasioned loss of records for three months. Alterations were made to the absolute hut in 1888. Electric lighting was connected to the observatory in 1891, but gaslight was still used in the magnetographs.

In 1892, Pietro Baracchi took over the direction of the observatory. In 1896, the first issue of "Terrestrial Magnetism" appeared, and Professor Schuster in a letter to the editor pointed out the paucity of magnetic observations in the southern hemisphere and emphasized the necessity of "resumption" of recordings at Melbourne. This prompted Baracchi to reply, outlining the history of the observatory, and stating that 29 years of records were accumulated. These records had been examined cursorily on the occasion of remarkable disturbances, and occasionally scaled to reduce absolute observations, but no further work had been carried out owing to lack of finance and staff. He had hopes that the position might soon improve.

In 1898, the Australasian Association for the Advancement of Science met in Sydney and appointed a committee to investigate terrestrial magnetism in the Australasian colonies. This committee recommended that the Victorian Government take steps to reduce the magnetic records. As a result, a grant of £100 was made for this purpose, and two computers were engaged.

During the next 15 years, a considerable amount of work was done on the records, and apparently all the records from 1868 to 1912 were scaled. In the material inherited by the Bureau of Mineral Resources, we have no record of indi-

vidual hourly scalings, except for temperature from 1899–1913. We have, however, manuscript tables of daily means, monthly mean scalings for each hour, and monthly mean variations for each hour, for all three elements from 1868 to 1912. This, of course, implies that hourly scalings must have been done for all records in that period. The tables referred to give values in inches, to three decimal places. We have also tabulations of base-line and scale-value determinations, and hourly scalings of the magnetograph records for the days on which absolute measurements were made; also the complete set of original photographic records from 1868–1919.

In the case of declination, the work was carried further, and we have the tables of daily means and monthly mean hourly variations converted to arc. There is also a set of manuscript tables giving "number and aggregate amount in thousandths of an inch of hourly readings in declination differing from monthly hourly mean by 0.100 inch or more." East and west deviations are listed separately for each month from 1868 to 1912. There are also two "sample sheets for publication," giving the complete hourly values for  $D$  for January and February 1868, in degrees and minutes, the means of days and hours, maximum and minimum values with times, range, and class.

The observatory cooperated with a number of international expeditions over this period, a British and foreign hydrographic survey in 1891, and an expedition from the "Bureau des Longitudes" in Paris in 1896–97. In 1901, an arrangement with the British Antarctic Expedition led to modification of the recorders to enable quick-run recordings to be made at prearranged times. In 1902, trouble with fluctuating gas pressures was overcome by installation of a regulator. In 1904, Dr. Hecker, of the Prussian Geodetic Institute, visited Melbourne and compared his instruments. As a result of his visit, Baracchi ordered an earth inductor to replace the dip circle.

For reasons unknown, absolute observations were reduced to two sets in November of each year 1904–05–06, and then were suspended altogether until 1911, although the magnetographs were maintained in operation. Very few observations were made from 1911 to 1915. From 1916, observations were made twice per month.

In 1911–13, the observatory acted as a base-station for the Carnegie Institution of Washington magnetic survey of Australia.

From 1913 onwards, the records became very disturbed during the daytime, owing to the introduction of electric trams. In 1915, Baracchi retired and was succeeded by Dr. J. Baldwin, who conducted extensive surveys for an alternative site free from artificial disturbance, and eventually chose the present site at Toolangi, about 50 miles northeast of Melbourne.

In August 1919, the Toolangi installation was completed. (Watheroo Magnetic Observatory was also started in 1919 by the Carnegie Institution of Washington.) The plan was similar to the United States Coast and Geodetic Survey observatories. An Eschenhagen magnetograph was installed in an insulated wooden hut. Absolute observations were still carried out at Melbourne, and the old magnetograph was kept running for a few months. In 1922, a station difference was determined in conjunction with Coleman, of the Carnegie Institution of Washington.

Arrangements were made for a local resident to change the records daily, and

visits were made monthly for scale-value determinations. No staff was available for scaling the records, or money for printing them. In 1923, a meeting of the Pan-Pacific Science Congress strongly urged "that adequate provision be made by the Government of Victoria for the prompt reduction of the observations and publication of the results" from Toolangi. In 1925, the Government provided a temporary assistant to scale the records. Dr. Baldwin in a letter to the "Journal of Terrestrial Magnetism" announced his intention to start with the recent records, and as opportunity permitted to work off the earlier years. A special board was designed to facilitate the scaling of the magnetograms (Baldwin and Holmes, 1926).

As a result of this, hourly values for  $D$ ,  $H$ , and  $Z$  were published from 1924-33. The records for 1934-38 were also scaled and converted (except for  $Z$  in 1937-38), but these results have not been published. Apparently, the opportunity for the reduction of the earlier years (1919-24) never arose.

In January 1939, the magnetograph hut and instruments were destroyed in bushfires which raged throughout Victoria, but the absolute hut escaped damage. The building was replaced by an underground concrete vault, and a set of La Cour instruments was obtained on loan from the International Polar Commission and installed. Recording recommenced in January 1940. Regular absolute observations were maintained during the interruption to the recordings.

During World War II, operation was reduced to a minimum, absolute observations being made only once a month or less, and no records were scaled. However, continuous recording was maintained.

In 1943, the operation of the Melbourne Observatory, including Toolangi, was taken over by the Commonwealth from the Victorian Government, and the station was administered by the Commonwealth Solar Observatory, Mount Stromlo, under Dr. R. v. d. R. Woolley, now Astronomer Royal. In 1946, the Bureau of Mineral Resources, Geology and Geophysics took over both Toolangi and Watheroo observatories, and has operated them since that time. In addition, magnetic observatories have been established by the Bureau at Heard Island (1952), Macquarie Island (1952), Mawson (1955), Gngangara (1957), Darwin (1957), and Port Moresby (1958). With the exception of Heard Island, which closed down in 1954, these observatories are still operating. It is likely that Darwin and Watheroo will close down after the end of the International Geophysical Year; Gngangara will replace Watheroo.

Under the Bureau's jurisdiction, several improvements have been made in the equipment and methods used at Toolangi. Absolute observations were made fortnightly from 1949, and weekly from 1951. The old Kew magnetometer was replaced by an Askania field model in 1952, and by a Ruska observatory-type magnetometer in 1954. This has been supplemented by Q.H.M.'s and a B.M.Z. I.M.S. corrections have been determined from international Q.H.M. comparisons, as well as from the constants determined for the new instruments before delivery. The I.M.S. corrections are now known within one or two gammas. Frequent intercomparisons are conducted between the Bureau's observatories.

The Geophysical Observatory Report, published monthly since October 1952, gives  $K$ -indices, provisional monthly mean values, and details of disturbances for the Bureau's observatories.

Hourly values for Toolangi for 1949-54 have now been finalized, and will be published shortly. Little has been done yet to reduce the great amount of back data. However, semi-automatic trace-reading equipment has been purchased, and it is hoped that this, in conjunction with automatic computing machines, will reduce the time necessary for routine scaling and reduction of records, and enable a start to be made on the records for 1938-48.

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