A

COMMONWEALTH OF AUSTRALIA
MINISTRY OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORD 1951, No. 44

A PROVISIONAL ISOGONIC MAP OF AUSTRALIA AND NEW GUINEA FOR THE EPOCH 1950.5

by

W.M. HOLMES

Geophysicist

COMMONWEALTH OF AUSTRALIA
MINISTRY OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORD 1951, No. 44

A PROVISIONAL ISOGONIC MAP OF AUSTRALIA AND NEW GUINEA FOR THE EPOCH 1950.5

by

W.M. HOLMES

Geophysicist

ISSUED UNDER THE AUTHORITY OF THE HON. W.H. SPOONER
MINISTER FOR NATIONAL DEVELOPMENT

A PROVISIONAL ISOGONIC MAP OF AUSTRALIA AND NEW GUINEA FOR THE EPOCH 1950.5

ABSTRACT

A provisional Isogonic Map of Australia and New Guinea for the epoch 1950.5 has been prepared by revising the observational material used in the Isogonic Map for 1942.5, and including observations made at various parts of Australia since 1942. The extensions of the Isogonic Lines beyond the coast line of Australia depend almost entirely on extrapolation from the earlier work.

I. INTRODUCTION

In order to comply with numerous requests for up-to-date information on Magnetic Declination at various parts of Australia and adjacent regions, a revision of the map for 1942.5, which was produced by the Mineral Resources Survey, has been made. This revision in the first instance, was limited to the mainland of Australia and Tasmania, but before it was issued a request was received to extend the map to include certain ocean areas, also part of New Guinea and island groups to the north and east of it. The project is thus divided into two parts, for which different modes of treatment have been necessary. For the land areas which were considered during the first stages of the work, a certain amount of new observational material was available, whereas the extensions over the ocean areas and islands depend almost entirely on extrapolation from earlier maps. The resulting map, therefore, must be regarded as provisional; a more authoritative edition must await an extensive campaign of re-occupation of stations over the whole area.

II. REVISION OF MAP FOR THE AUSTRALIAN MAINLAND

The 1942.5 map was based on observations made at some 450 stations throughout Australia; most of these were occupied by observers of the Carnegie Institution of Washington between 1911 and 1914, some were re-occupied and some new stations were established in 1922 and the same procedure was followed in 1936. The South Australian Magnetic Survey occupied a number of stations at various dates. Since 1936 about 45 field stations have been re-occupied, and as these were fairly well distributed, it was expected that the values of secular variation would be known with sufficient accuracy for carrying forward the values of declination as given for 1942.5, to the epoch 1950.5. It became obvious, however, that some measure of re-treatment of the older material was required for a number of stations. The procedure is described below.

Since the revised map has to supply information in the form of terrestrial lines for the epoch 1950.5, and all the observations (other than those made at Toolangi and Watheroo) upon which this is based were made at various dates and at different times of day, it is necessary to apply corrections to these observations, (a) to obtain the mean-of-day value for the day of observation and, (b) to allow for the secular variation between that date and the selected epoch. For the first, curves of diurnal variation for the equinoxes and solstices and for various phases of the sun-spot cycle are required. For the second, secular variation curves for the respective stations are needed. Complete information is available only for the two observatories where continuous recordings of magnetic elements are made but, in general, reliance has to be placed on observations made at certain occupied stations at intervals very much longer than is desirable.

III. ADDITIONAL DATA USED IN REVISION.

The observational material in addition to that embodied in the earlier map, used in the preparation for the 1950.5 map, is as follows :-

(i) Continuous records of declination made at the Toolangi and Watheroo Magnetic Observatories. These are the only two stations at which the diurnal variation is completely known. It has been necessary to assume that the curves are applicable to stations even at great distances from the observatories.

(ii) Frequent re-occupation of stations at Blacktown, N.S.W. These observations extend a lengthy series at the Red Hill Observatory, so that the curves of secular variation over a long period could be drawn. From time to time frequent determinations of declination throughout the course of a day were made, so that diurnal variations were fairly well known.

(iii) Several observations made at or near the Adelaide Observatory. These were combined with observations made at different sites in the park lands around the city, but the absence of well determined station differences from the older records has diminished their value when secular variation has to be computed.

(iv) Observations made at some 35 stations, occupied mostly in 1944 and 1945. Most of these had been occupied in 1936 (as well as at earlier dates), so that the secular variation curves drawn from them in the earlier work could be extended to the later dates, and extrapolated in the light of the secular variation curves for Toolangi and Watheroo. Further, about a dozen other stations, which had not been visited since 1922, were re-occupied. Secular variation curves were drawn for these in the light of information from the previous group of stations. This re-occupation programme was carried out by observers of the Carnegie Institution of Washington until its magnetic activities in Australia were taken over by this Bureau; later observations were made by officers of the Bureau.

Maps were drawn showing the lines of equal change in declination for successive five-year intervals (or others as required). The changes at stations lying between these lines were obtained by interpolation. Not all the stations used in the 1942.5 map were used in the revision. The observations made by the South Australian Magnetic Survey were used only to a very limited extent. Hardly any re-occupation has been done in South Australia, and the areas, particularly to the north and north-west of Adelaide were shown to be magnetically disturbed, thus the results add little to our knowledge of the terrestrial lines. Also, several West Australian stations were omitted; these were originally occupied during the search for a site suitable for a magnetic observatory, which culminated in the selection of Watheroo for that purpose.

IV. CALCULATION OF SECULAR VARIATION

The general trend of the secular variation curves since 1910 shows that the declination (easterly being reckoned positive) diminished for some time, reaching a minimum about 1922, after which it rose gradually. The maximum rate of increase occurred

during the interval 1930 to 1940 for Watheroo, after which the annual increases have become steadily smaller. The annual change may become zero before many years pass. For Toolangi, the rate of increase was not so steady, but an upward trend is still being maintained.

When the secular variation curves were drawn in connection with the preparation of the 1942.5 map, practically no observations later than 1936 were available except for the two observatories. It was therefore necessary to extend the curves for the stations mentioned in para. (iv) and the only available information indicated that the trends at 1936 would probably be maintained. Later observations at these stations, together with those made at Toolangi and Watheroo, showed that the rates of increase for the extrapolated portions had to be modified. It was therefore decided to work back (using the older secular variation values) from the 1942.5 values to 1935.5 for all stations last occupied prior to that date, before carrying the values forward to 1950.5 with the revised secular variation.

It is thought desirable to describe in some detail the method of computing the value of the declination at a station for an epoch subsequent to the date of observation. The starting point is the value observed in the field at a recorded local mean time, and corrected for instrumental errors to agree with the International Magnetic Standard. By referring to an appropriate diurnal variation curve, the correction to the mean-of-day can be obtained. Secular variation is now known exactly for every site, but curves can be drawn for a sufficient number of stations distributed over the continent. From the secular variation curves for the stations mentioned in para. (iv), increments in declination for the intervals 1910-15, 1915-20----- were read off. On a new map all these stations were marked, together with the increment for the interval 1910-15. Contours were then drawn showing the lines of zero, +5', +10'... increments for the interval. Other similar maps were drawn, one for each of the intervals under discussion. To obtain the total increment for any station, between the last date of observation of the declination and the epoch of the map, each of the "interval" maps is examined in turn, and the increment for the station calculated by interpolation. The sum of all these separate increments, added to the observed value, gives the value of declination at the station of the selected epoch.

As mentioned above, many of the secular variation curves made for the 1942.5 map had to be modified for the intervals from 1935 onwards. It was necessary to discover what increment had been used for the interval 1935-42, and deduct it from the accepted value for 1942.5, in order to recover the value as at 1935.5. A new map was constructed for 1935-40, also maps for 1940-45 and 1945-50, and by reading off appropriate increments the value of the declination for 1950.5 was computed.

When this work was completed for all stations, the values were plotted on a map as magnetic contours for each half degree. Mostly these were sinuous curves and in places it was almost impossible to draw continuous curves to represent observational results. No useful purpose would be served by publishing such curves, hence the attempt was made to draw in general trend lines (terrestrial lines) in the form of sweeping curves. Such procedure is justified by two considerations. The correction for diurnal variation is made on the assumption that the observation was made on a normal "quiet" day; many days are not normal, even though they would not be classed as much disturbed. Further, many stations occupied are now known to be more or less affected by the presence of magnetic rocks. Large areas disturbed in this manner are shown in the map by stippling, but it is certain that there are other areas similarly affected though their boundaries have not been surveyed.

It is obvious that some of the trend lines depend on very scanty evidence as to their position and form. There are large areas, mostly in West Australia, where no observations have ever been made. A large desert area between Kalgoorlie and Alice Springs, is one of these. Also, there are extensive regions which have not been revisited since 1936. The coastal stations in Queensland and the whole of Tasmania come within this category. Fortunately, it is known that the changes in declination in Queensland have been small, and extrapolation from the mainland to Tasmania, in regard to secular variation, introduces little uncertainty.

V. ISLAND AND OCEANIC REGIONS

The extension of the terrestrial lines over the ocean areas and islands is based on less certain information than the foregoing. Under the former Dutch regime, in Indonesia, the Royal Meteorological and Magnetic Observatory, Batavia, sent its observers to all parts of that territory and occupied about 15 stations in Dutch New Guinea. In the territory of Papua and North East New Guinea and in the islands, stations have been occupied by observers of the Carnegie Institution of Washington. All land observations were made not later than 1936. At sea, a few observations were made aboard the ship "Carnegie" which sailed through the eastern fringe of the ocean areas dealt with in the present map in 1915.

The procedure followed in the present work has been to re-compute the positions of the terrestrial lines as at 1950.0, using the material given in the 1942.5 map. These were taken as establishing the trends of the lines at this epoch but not necessarily the locations of those lines. New lines were drawn as extensions of the lines over the mainland in the directions indicated, and it is held that they represent the most probable values of declination over the areas concerned.

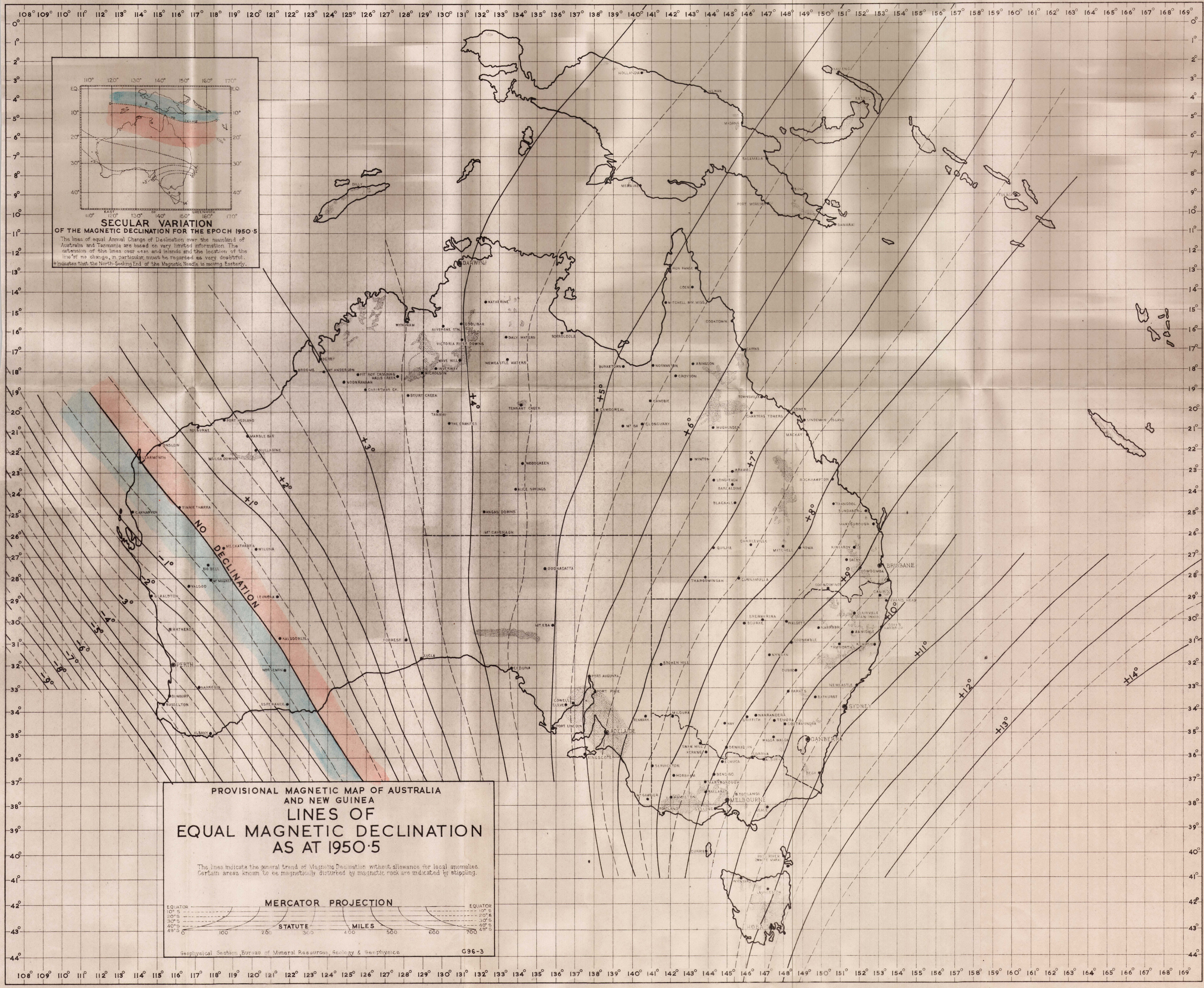
VI. INSET MAP

The lines of equal annual change of declination, shown in the inset map, are based on the same evidence as the isogonic lines, so far as the mainland is concerned. The line of no-change is inserted on very meagre evidence. It is known the declination changes at Djarkarta (Batavia) are now very small, possibly zero; the rates of change in the Northern Territory are known to be small, but no negative values have been recorded. The general west-east trend is in accord with the magnetic maps issued by the Admiralty (1947) and the U.S. Navy Hydrographic Department (1950) though the locations of this line on these two maps and the present map differ widely.

(W. M. Holmes)
GEOPHYSICIST.

August 21st, 1951.

Distribution :
Original - File 122G/3.
1. - Deputy Director, National Mapping.
2. - D.S.I.R., Wellington.
3. - Army Survey Directorate, Albert Park.
4. - Chief Geologist.
5. - Geophysical Library.
6. -


SECULAR VARIATION
OF THE MAGNETIC DECLINATION FOR THE EPOCH 1950·5
The lines of equal Annual Change of Declination over the mainland of Australia and Tasmania are based on very limited information. The extension of the lines over seas and islands and the location of the line of no change, in particular, must be regarded as very doubtful.
+ Indicates that the North-Seeking End of the Magnetic Needle is moving Easterly.
NO CHANGE
EAST OF GREENWICH
NO DECLINATION
DARWIN
BRISBANE
SYDNEY
CANBERRA
MELBOURNE
ADELAIDE
PERTH
PROVISIONAL MAGNETIC MAP OF AUSTRALIA
AND NEW GUINEA
LINES OF
EQUAL MAGNETIC DECLINATION
AS AT 1950·5
The lines indicate the general trend of Magnetic Declination without allowance for local anomalies. Certain areas known to be magnetically disturbed by magnetic rock are indicated by stippling.
MERCATOR PROJECTION
STATUTE MILES
Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics
G96-3