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**PRELIMINARY ISOGONIC MAP OF THE  
AUSTRALIAN REGION FOR EPOCH 1970.0**



by

*D.M. Finlayson*

**BMR  
Record  
1970/90  
c.4**

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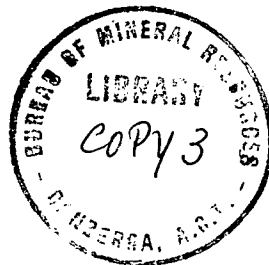
Note: Owing to unforeseen delays in the preparation of this Record, a black and white version of the final isogonic map was ready before the Record was issued. This has been included at the end of this Record for comparison; it will be published in colour in a BMR Report at some future date along with the other isomagnetic maps for the 1970.0 epoch

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Plate 1 Preliminary map of magnetic declination ( or variation)  
in degrees, epoch 1970.0.

## SUMMARY

The Bureau of Mineral Resources, Geology and Geophysics is responsible for mapping the geomagnetic field in the Australian region. For this purpose a network of 72 first order regional magnetic stations has been established throughout Australia and its territories. Data from these stations and from third order and other magnetic surveys in the Australian region have been used in the compilation of the declination map.

The preliminary map of magnetic declination (or variation) for the epoch 1970.0 has been produced in response to numerous enquiries. A final declination map will be prepared during 1970 as part of a series mapping all geomagnetic components in the Australian region.

Third order magnetic surveys in various regions of Australia indicate that there are many regional anomalies and it is estimated that, on average, these lead to an uncertainty of  $\pm 0.2$  degrees in the values of declination derived from the 1970.0 isogonic map.

## 1. INTRODUCTION

This record describes the compilation of the preliminary 1970.0 isogonic map. Since the publication of the 1965.0 map (Van der Linden, 1965c) a considerable amount of survey work has been carried out by the Regional Magnetic Survey Group and this has produced magnetic data at many new stations as well as adding to the time series of magnetic information observed at many of the Bureau's first order magnetic stations.

The author was responsible for the work carried out at the first order stations in eastern Australia during 1968 (Finlayson, 1970a) and in the Territory of Papua and New Guinea during 1969 (Finlayson, 1970b). J. van der Linden completed third order magnetic surveys in southern Queensland in 1967 (Van der Linden, in prep.), northern New South Wales in 1968 (Van der Linden, in prep.) and southern New South Wales and Victoria in 1969 (Van der Linden, in prep.). These provided valuable information on regional magnetic anomalies. Van der Linden also made a second order re-occupation survey of many of the existing first order magnetic stations during 1966 (Van der Linden, 1969).

Qantas Airlines have for some time been conducting a 'heading improvement programme' in order to increase the accuracy of aircraft navigation (Qantas Airlines, 1968). This has produced statistical data on the errors in the world 1965 isogonic map produced by the staff of the Royal Greenwich Observatory, United Kingdom. This information has been important in determining the isogonic trends in the ocean areas surrounding Australia, especially in the Tasman and Arafura-Banda Sea regions.

## 2. MAP COMPILATION

The preliminary 1970.0 isogonic map has been compiled mainly from the results of magnetic surveys carried out by the Bureau of Mineral Resources, Geology and Geophysics, the New Zealand Department of Scientific and Industrial Research, and Qantas Airlines.

The Bureau has now carried out extensive surveys over all but the most inaccessible areas of Australia. These surveys are of three different types, 1st, 2nd, and 3rd order surveys.

1st order surveys are conducted at a network of 72 permanent magnetic stations throughout Australia and the Territory of Papua and New Guinea. These stations are re-occupied at approximately 5-year intervals in order to provide an accurate time series of data on the secular variation of the geomagnetic field. Some form of magnetic variograph control is maintained at each station during the observation period so that corrections can be made for the diurnal variation of the field, magnetic storms, and other magnetic phenomena. Daily mean values of declination (D) are measured within the limits  $\pm 1.0$  min.

2nd order surveys are those in which magnetic observations are made over a period of one or two days during daylight hours but which have no variograph control.

3rd order surveys are those conducted over a network of roads and in which one set of magnetic observations is made at 15 km intervals. Victoria, N.S.W., and Queensland south of latitude  $20^{\circ}$ S have now been surveyed by this method.

The secular variation data derived graphically from 1st order stations have enabled a computer programme to be compiled which up-dates magnetic results to 1970.0 by assuming a constant secular change over ten year periods centred on 1940.0, 1950.0 etc. This has been done for all 2nd and 3rd order survey results since 1955.

Using the magnetic results from the 1st order station network as a basis, isogonic lines have been drawn using a spline, and corrections have been made to allow for regional anomalies highlighted by 2nd and 3rd order survey results. Some 3000 2nd and 3rd order magnetic observations have been made since 1955.

Over the mainland of Australia the isogonic lines have been constrained to pass through the mean of the 2nd and 3rd order survey results, but where survey data are less dense, considerable weight has been given to the results from 1st order stations.

3rd order survey work in eastern Australia has demonstrated the variability of declination due to regional geological conditions. The accuracy of the smoothed isogonic lines based on these results is estimated to be  $\pm 0.2$  degrees and this error has been quoted as that applying over land areas within the 1st order survey network. However, it may well be greatly exceeded in regions where there are magnetic anomalies caused by local geological conditions.

In the Territory of Papua and New Guinea the results of surveys carried out during 1962-63 and during 1969 have contributed greatly towards the time series of data from that region, but geological structures must again be taken into account when considering the reliability of the isogonic lines. The results from Honiara in the British Solomon Islands Protectorate were obtained in conjunction with the resident Geological Survey staff.

The trend in the isogonic lines in the oceans surrounding Australia has been obtained from results of the New Zealand DSIR geophysical office (Burrows, 1967), Qantas Airlines (Qantas Airlines, 1968), and the published results from Tangarang, Hollandia, and Guam geophysical observatories (Royal Greenwich Observatory, 1967).

The New Zealand DSIR geophysical office provided results from Amberley and Apia observatories and the most recent results from surveys carried out on various Pacific islands.

Qantas Airlines have for a number of years been collecting statistical data on the errors in their compass headings and this has been used to make corrections to the 1965.0 isogonic map published by the British Royal Greenwich Observatory. In particular, the errors in the Tasman and Arafura-Banda Sea areas were quite large (+0.7 and -0.5 degrees respectively). These have been taken into consideration in the compilation of this preliminary 1970.0 map.

### 3. COMMENTS

The 1970.0 preliminary isogonic map gives an indication of average declination (or variation) in the Australian region and a considerable amount of recent survey work has been accommodated in the compilation. The map has been derived empirically and no attempt has been made to make it self-consistent with other magnetic components. An error of + 0.2 degrees is estimated for the isogonic lines based on regional anomalies highlighted by recent 3rd order magnetic survey work.

The declination secular variation is small over most of continental Australia and thus the isogonic lines have changed little since the 1965.0 declination map was published. However there has been an improvement in the quality of the observed data and in particular the secular variation data in recent years. The error in secular variation values is estimated to be  $\pm 0.3$  min/year.

The present map has been compiled in response to public requests but it must be regarded as preliminary since a complete series of 1970.0 iso-magnetic maps will be compiled during 1970. Small alterations to the preliminary isogonic lines may be necessary since the latest 1st order survey of northern and western Australia is not expected to be completed until January 1971 and the results of this survey will be included in the final map compilation.

### 4. ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance rendered by all those who have contributed towards the BMR regional magnetic survey programme. In particular he would like to acknowledge the extensive magnetic survey work carried out by J. Van der Linden of BMR. Organizations who have assisted by providing magnetic data are Qantas Airlines, New Zealand Department of Scientific and Industrial Research, the U.K. Royal Greenwich Observatory, and the British Solomon Island Protectorate Geological Survey.



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D

**LEGEND**

Magnetic declination in degrees  
Red — East declination    Blue — West declination  
The wider stippled line indicates approximate annual change of magnetic declination in minutes of arc  
Red — Increasing easterly    Blue — Increasing westerly

These contours in eastern Australia show the departures from the smoothed contours caused by regional magnetic anomalies; similar departures may be expected in other areas. Local anomalies may cause greater departures at any given location.

Geraldton • First-order regional magnetic station  
Karrakegin • Second-order regional magnetic station  
ADELAIDE • City  
Mount Isa • Town

AUSTRALIA AND SURROUNDING AREAS

## MAGNETIC DECLINATION OR VARIATION

EPOCH 1970.0

COMPILED BY GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY &amp; GEOPHYSICS, CANBERRA

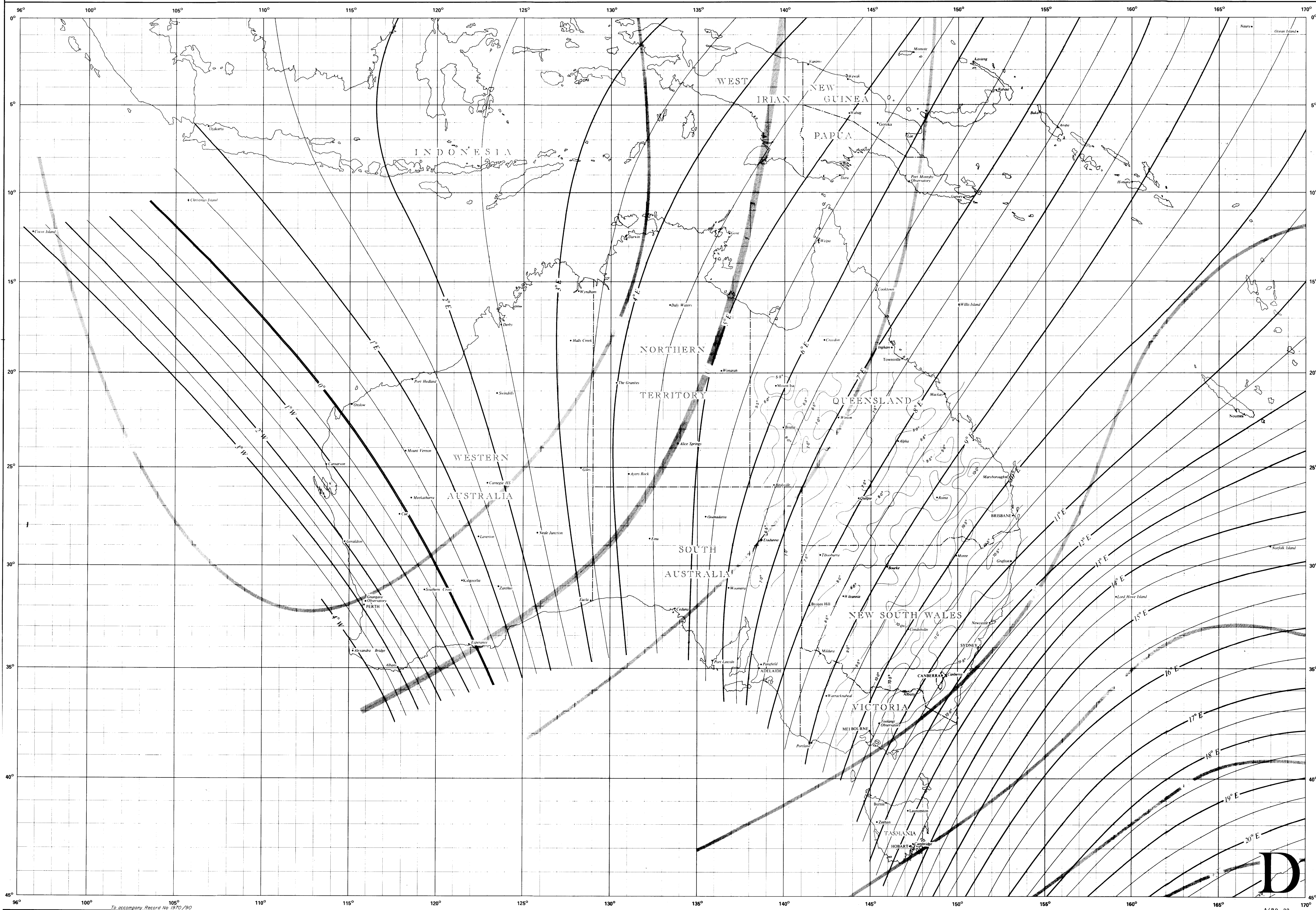
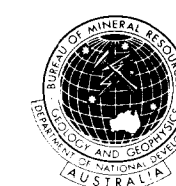
MERCATOR PROJECTION

0° 25° 50°

0 100 200 300 400 500

KILOMETRES

SCALE 1:10,000,000 AT EQUATOR



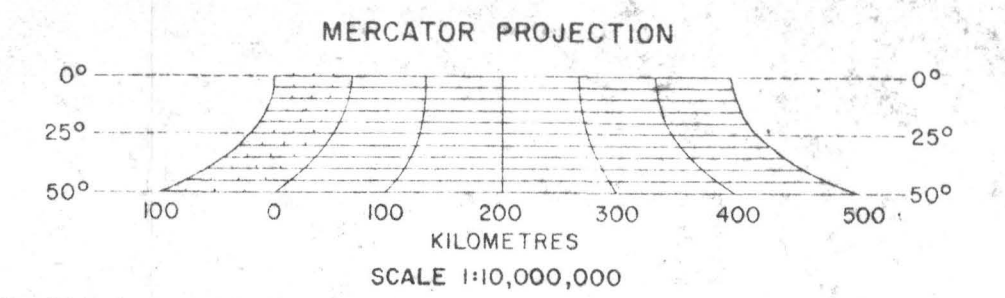
D



AUSTRALIA AND SURROUNDING AREAS  
PRELIMINARY  
MAP OF MAGNETIC DECLINATION (OR VARIATION) IN DEGREES  
EPOCH 1970.0

COMPILED AND DRAWN IN THE GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

LEGEND  
• TOOLANG Magnetic observatory  
○ DARWIN First Order magnetic station  
—+2— Line of equal Magnetic Declination in degrees  
—-1— Line of equal Annual Change in minutes  
The lines indicate the general trend of Magnetic Declination and Annual Change. No allowance has been made for local anomalies.  
To obtain true bearing from compass bearing:  
+ Means Declination or Annual Change is East and correction must be added.  
- Means Declination or Annual Change is West and correction must be subtracted.



NOTE: This is a preliminary chart.  
The accuracy of the isogonics over land areas is  $\pm 0.2$  degrees, without allowance for local anomalies.

