

1968/2

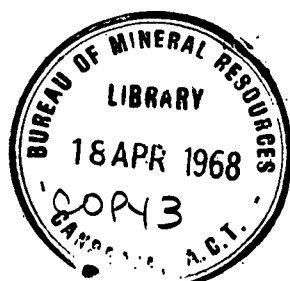
COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

RECORDS:

RECORD NO. 1968/2

016187



REGIONAL MAGNETIC SURVEYS IN
AUSTRALIA, AUSTRALIAN ANTARCTICA,
AND ON SOME ISLANDS IN THE
PACIFIC AND INDIAN OCEANS
DURING 1964

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by

J. van der LINDEN

The information contained in this report has been obtained by the Department of National Development, as part of the policy of the Commonwealth Government, to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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SUMMARY

This record describes all regional magnetic work done by the Bureau of Mineral Resources, Geology and Geophysics, during 1964. The surveys are part of the Bureau's regional magnetic programme. Repeat readings of three elements of the Earth's magnetic field were made on islands in the Pacific and Indian Oceans and at Davis and station S-2 near Wilkes in Australian Antarctica. The locations of the magnetic stations and the measured values of the magnetic field are presented in tabular form.

Detailed magnetic declination surveys were made in Tasmania, the eastern part of New South Wales, and the central western part of Queensland. These areas are magnetically anomalous and presented problems in the compilation of the isogonic map of Australia. The contour maps resulting from these surveys indicate that in all the surveyed areas changes are required to the smooth pattern of contours on the isogonic map of Australia.

Detailed magnetic declination surveys are classified as third-order magnetic surveys. This type of survey has been proven successful and covers a large area in a short time.

A systematic third-order survey of Australia, adding a QHM and a proton magnetometer to the survey equipment, is recommended. This would result in more accurate and detailed magnetic maps of Australia.

1. INTRODUCTION

This record describes all regional magnetic work carried out by the Bureau of Mineral Resources, Geology and Geophysics (BMR) during 1964.

Surveys conducted were:

1. Re-occupation of regional magnetic stations on some islands in the Pacific and Indian Ocean.
2. The re-occupation of the magnetic station at Davis and at S-2 near Wilkes, and measurement of vertical intensity near Wilkes, all in Australian Antarctica.
3. Detailed magnetic declination surveys in Tasmania, New South Wales, and Queensland.

The surveys are a continuation of a series of surveys made as part of the BMR regional magnetic programme. The results are included in the compilation of up to date maps showing values and the rate of secular variation of the components of the Earth's magnetic field. These maps are published at regular intervals. Previous work has been described by Pinn (1960), van der Linden (1961, 1964, 1965), and van der Linden and Parkinson (1963).

Observations of three components, viz declination (D), horizontal intensity (H), and vertical intensity (Z) were made during exact re-occupations of six magnetic stations in the Pacific and Indian Oceans, and the stations Davis and S-2 in Australian Antarctica. At 14 field magnetic stations near Wilkes, Z was measured.

Declination measurements were made at 131 stations in Tasmania, 143 stations in New South Wales, and at 284 stations in Queensland. The stations were generally about five miles apart along road traverses, but along a traverse from Condamine to Winton in Queensland the stations were twenty-five miles apart. Locations of the magnetic stations on the islands and of the declination traverses are shown in Plate 1. The locations of the magnetic stations in Antarctica are shown in Plate 2.

2. ACCOUNT OF SURVEYS

Pacific and Indian Oceans

The re-occupation survey was made from June to September 1964 by the author. Re-occupations were made at Willis Island, Nauru, and Ocean Island in the Pacific Ocean and at West Island, Direction Island, and Christmas Island in the Indian Ocean.

General conditions and station locations have not altered since the previous surveys (van der Linden, 1964). Recently an irregular air service to Nauru from Sydney has been established by QANTAS Airways.

Antarctica

I. Black, a BMR geophysicist returning from the geophysical observatory at Mawson, occupied exactly the magnetic station at Davis for several days in March 1964. R. Whitworth, who was engaged in seismic and gravity surveys near Wilkes, made repeat readings of D, H, and Z at station S-2 and measured Z at 14 magnetic stations east of Wilkes.

Declination surveys

The author conducted the survey in Tasmania during February 1964 and the surveys in New South Wales and Queensland during May and June 1964. The areas are magnetically disturbed and presented problems in the compilation of the isogonic map of Australia. The declination was measured with an Askania Declinometer, the bearing of the sun being measured using the black glass mirror on the Askania base circle. The geographic coordinates were scaled from 4-mile military maps. The same survey procedure was followed as in the 1962 declination survey (van der Linden, 1965a), but only one vehicle was used. An average of 15 stations was read each working day.

Tasmania

Traverses were along about 800 miles of principal roads, which resulted in a fair coverage of Tasmania with the exception of the uninhabited south-western part.

The greater part of Tasmania is composed of igneous rock formations (mainly dolerites and basalts) which are very magnetic. As far as possible no readings were made near outcrops of such formations to avoid random local anomalies having no bearing on the regional pattern of magnetic declination.

New South Wales

Part of the area had been surveyed in 1963 (van der Linden 1965b) and the results indicated that the survey had to be extended towards the east. In 1964 readings were made along the Princes Highway from Orbost to Port Macquarie, where the 1963 traverse was joined. Other connections to the 1963 survey were made through traverses from Batemans Bay via Canberra to Wagga and from Sydney to Bathurst. The road traverses in 1964 totalled 1000 miles.

Queensland

Declination measurements were made about 25 miles apart along 600 miles of road from Condamine to Winton. From Winton measurements were made about 5 miles apart along 1500 miles of roads connecting Winton via Cloncurry to Camooweal, Camooweal via Urandangi and Glenormiston to Boulia, Boulia to Winton, Boulia via Dajarra to Cloncurry, Dajarra to Urandangi, Cloncurry via Wurung to Julia Creek, and Julia Creek to Cloncurry.

3.

3. INSTRUMENTS

The following instruments were used on the surveys:

Survey	Instruments					
	D	Correction (minutes)	H	Correction (gammas/ gauss)	Z	Correction (gammas)
Pacific and Indian Oceans	Ask 320	-1.3	QHM306	-26	BMZ211	+161
Declination Surveys	Ask 320	-1.3	-	-	-	-
Davis, Antarc- tic	Ask 329	-0.3	QHM172	-170	BMZ115	-90 (Nov 64- Jan 65)
Near Wilkes, Antarctica	QHM 493	?	QHM493	-1 at Wilkes	BMZ121	-90 (Nov 64- Jan 65) -120 (March 65- April 65)

All instruments were compared at Toolangi Magnetic Observatory before and after the surveys. The instrument corrections were derived by van der Waal (1966).

4. REDUCTIONS AND RESULTS

Pacific and Indian Oceans and Antarctica

For the 'Ocean' stations, diurnal variation corrections were made using data from Port Moresby Magnetic Observatory. These data differ from those of Vestine et al (1947), but may be more accurate considering the large difference between geographic and magnetic latitude in this area.

4.

No corrections for diurnal variation were applied to the Antarctic observations. However, R. Whitworth made observations of the diurnal variation of Z at the ice dome station at a distance of 75 miles from Wilkes Observatory. The results of these (Plate 3) show a close relation to the variations of Z at Wilkes. Instrument corrections were applied to all observations.

The results are shown in Table 1, with preliminary values at BMR magnetic observatories in Antarctica.

Declination surveys

Because the noise caused by very local anomalies and inaccuracies of the 4-mile maps is larger than the diurnal variation (van der Linden, 1965a) no correction for it was applied. The results for each area are presented as follows:

1. By charts showing smoothed contours of the declination. The contour lines are smoothed to exclude random magnetic anomalies that are smaller than the distance between stations. Each chart has an inset of the same area as shown on the Isogonic Map of Australia 1965.0 (van der Linden, 1965c).
2. By graphs showing the observed values along the traverses. The graphs are separated in blocks, each block covering a section of the traverse that has a more or less constant direction. Included are values at previous magnetic stations. All values are adjusted for secular variation to the epoch 1965.0. Dotted lines are cross-sections of the contour charts and indicate the amount of smoothing applied.

Contour charts and graphs for Tasmania are shown in Plates 4 and 5. For New South Wales the results are shown in Plates 6 and 7, where the 1963 results are also included. For Queensland the results are shown in Plates 8 and 9. In Plate 10, the traverse from Condamine to Winton, results are shown together with a cross-section taken from the values of the Isogonic Map of Australia 1965.0.

5. DISCUSSION OF RESULTS

Islands survey and Antarctica

The results of the repeat stations will be used in assessing the rate of secular variation in combination with previous and future work.

The diurnal variation observations of Z at the ice dome station in Antarctica are interesting. Plate 3 shows that they were almost identical to the variations of Z at Wilkes Observatory, indicating that Wilkes data can be used during magnetically quiet days to reduce observed values in the field up to a distance of at least 80 miles from the observatory.

Detailed declination surveys

The insets taken from the 1965 Isogonic Map of Australia show that in each area, the isogonics have to be altered to conform to the results of the more detailed surveys. This is not surprising as the 1965 isogonic map was produced from values of stations 60 miles or more apart, and therefore showed a very generalised picture.

In Queensland some of the local anomalies such as the one between Mount Isa and Cloncurry are remarkably well defined. They could be caused by deep rock bodies apparently polarised to form a large magnetic dipole.

6. RECOMMENDATIONS

Regional magnetic surveys in Australia are classified as follows:

1. First-order surveys. These were initiated in 1962, when a network of 25 stations about 500 miles apart was made. By the end of 1966 the spacing was decreased to 300 miles and 47 stations were established, this included the reoccupation of 30 stations read during 1962 and 1963.

A high accuracy is aimed at, observations being extended over two days or more. In future surveys a portable magnetograph will be set up near the first-order station to record the daily variation.

The purpose of the first-order surveys is to provide accurate data on the secular variation. These will be used to adjust the values of second and third-order stations to a given epoch.

2. Second-order surveys. The beginning was made in 1911 by the Department of Terrestrial Magnetism (D.T.M.) of the Carnegie Institute, Washington, USA. By the end of 1917 the country had been covered by over 500 stations. Apart from a repeat survey in 1936-38, the last survey in Australia by the D.T.M. was made in 1923.

Some work was done by the Adelaide Observatory (1914-1939) mainly in the area around the St Vincent's Gulf in South Australia.

The North Australia Survey and the Mineral Resources Survey did limited work from 1936.

Its successor, the BMR, carried out work at an increasing rate since 1952, resulting in a network of about 1000 stations fairly regularly spaced about 60 miles apart. The occupation of each station takes generally one day.

The second-order stations have formed the basis of all published regional magnetic maps of Australia.

3. Third-order surveys. These were introduced in 1962 and in such surveys stations were read 5 miles apart along road traverses. A quick method of observing is used (so far for declination only) and an average of 15 stations is read per day. About 1000 third-order stations have been measured in areas where a better assessment of the position of the isogonics was required.

The present situation is:

- a. The basis of the regional magnetic maps are second-order data, many of them derived from old observations (50% pre-1917), made with comparatively inaccurate instruments and extrapolated to the present using uncertain secular variation values.
- b. The first-order stations will provide good secular variation control.
- c. The third-order stations have already shown that results based on wider spaced (second-order) stations can be misleading (Plate 4 is an excellent example).

Therefore instead of continuing to use the second-order data for compilation of regional magnetic maps of Australia a re-survey of Australia is recommended. This survey should be classified as a third-order survey. Using rapidly read, accurate instruments such as the QHM for horizontal intensity, a portable proton precession magnetometer for total intensity, and a Wilde compass theodolite for declination, ten stations can be read a day at distances of ten miles along traverses not more than fifty miles apart.

The result of such a project would be accurate, recent, and more detailed magnetic maps of Australia. The continuing first-order surveys will provide the data to adjust these maps to the required epochs.

To achieve the total coverage of Australia, 180 survey-weeks will be necessary for a field party consisting of two to three men. This means a survey lasting up to nine years for one field party working during the normal field season. The time, of course, can be reduced by employing more small field parties.

All field results can be computed using E.D.P. methods, which can also be applied for the final contouring.

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TABLE 1

STATION LOCATIONS AND MAGNETIC VALUESA: PACIFIC AND INDIAN OCEANS 1964

Station	Elev- ation (metres)	South Lati- tude	East Longi- tude	Date 1964	D	H (gammas)	Z (gammas)	I	F (gammas)
Nauru (R)		0° 33.3'	166° 55.2'	26 July	+9° 25.8'	35284	-6885	-11° 02.5'	35950
Ocean Island	5	0° 50.9'	169° 32.0'	29 July	+9° 25.1'	35689	-5879	-9° 21.3'	36170
Christmas Island	15	10° 25.1'	105° 40.6'	2 Sept	+0° 40.1'	35013	-30120	-40° 42.2'	46185
Direction Island	3	12° 06.1'	96° 52.5'	24, 25 Sept	-2° 45.2'	33323	-33473	-45° 07.6'	47235
West Island	2	12° 12.2'	96° 49.6'	22, 23 Sept	-2° 53.7'	33005	-33326	-45° 16.6'	46900
Willis Island	3	16° 17.8'	149° 58.5'	15 June	+7° 30.8'	34401	-32202	-43° 06.5'	47120

B. AUSTRALIAN ANTARCTICA

Station	Elev- ation (metres)	South Lati- ude	East Longi- tude	Date 1964	D	H (gammas)	Z (gammas)	I	F (gammas)
S-2 (R)	1156	66° 30'	112° 12'	17 March	104° 32.0'W*	8233	-64392	-82° 42.8'	64916
S-2 (R)	1156			3 Febr '65	92° 17.3'W*	8182	-64300	-82° 44.9'	64818
Icedome A	1370	66° 45.5'	112° 49'	6 Apr			-65226		
Ice dome A (M)	1370			26 Apr			-65190		
Ice dome B	1365	66° 46'	112° 51.5'	10 Apr			-65070		
Ice dome C	1360	66° 46.5'	112° 53'	6 Apr			-65050		
A 00	560	66° 30'	111° 06'	24 Nov			-65312		
A 10	460	66° 38'	111° 06'	26 Nov			-65032		
A 20	240	66° 47'	111° 06'	30 Nov			-65100		

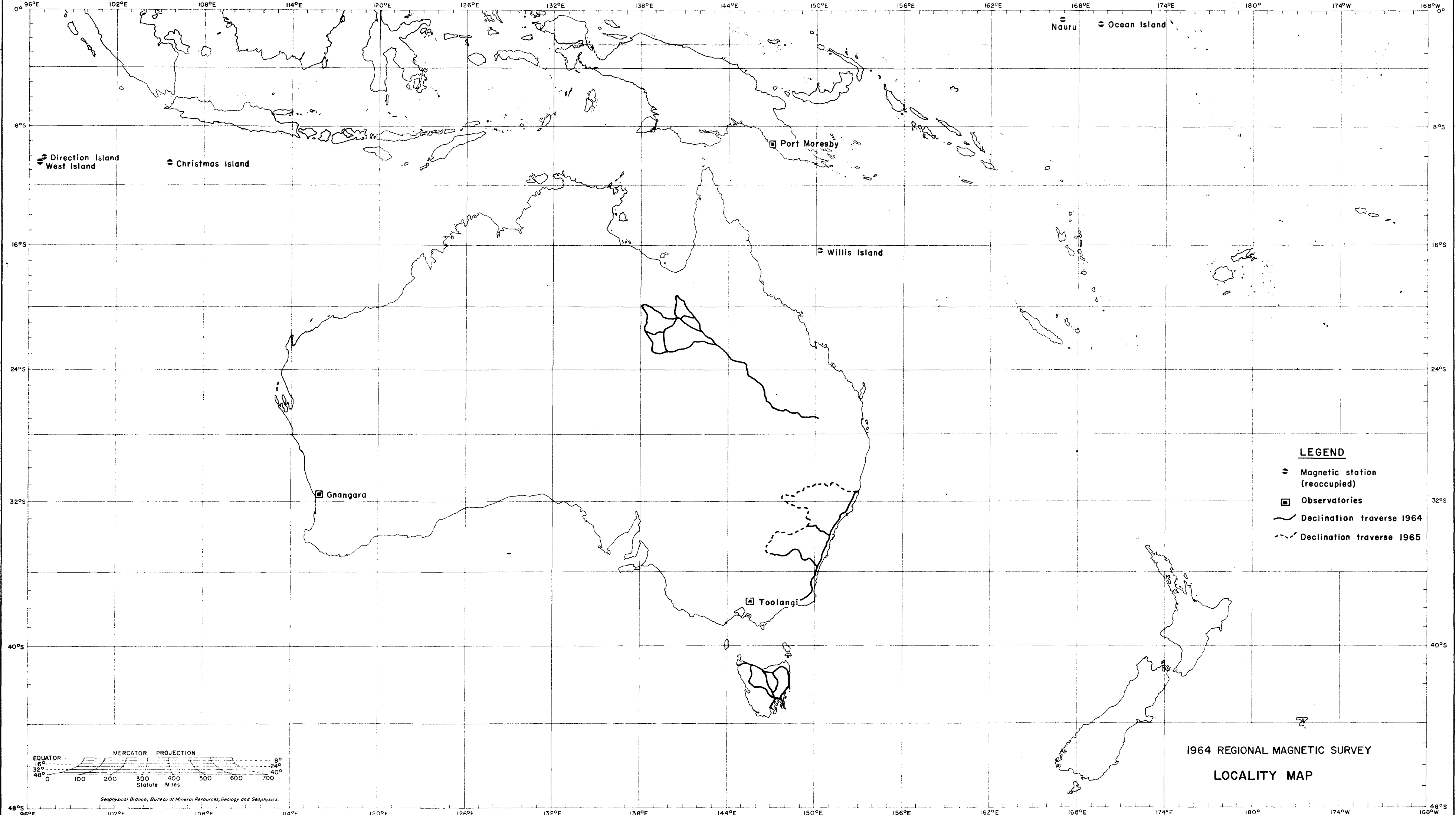
Station	Elev- ation (metres)	South Lati- tude	East Longi- tude	Date 1964	D	H (gammas)	Z (gammas)	I	F (gammas)
B 00	840	66° 30'	111° 28'	12 Dec			-65312		
B 10	730	66° 38'	111° 28'	5 Dec			-65040		
B 20	610	66° 47'	111° 28'	1 Dec			-64921		
B 30	560	66° 55'	111° 28'	3 Dec			-64909		
C 00	1010	66° 30'	111° 50'	15 Dec			-64451		
C 10	980	66° 38'	111° 50'	22 Dec			-64721		
C 20	950	66° 47'	111° 50'	24 Dec			-64665		
C31	900	66° 56'	111° 50'	13 Jan '65			-65168		
Davis (R,M)		68° 34.6'	77° 58'	29 Febr to 2 March	74° 42.5'W	16618	-54268	-72° 24.8'	56750 65750
Macquarie Island (O)	8	54° 30'	158° 57'	1964.0	26° 11.5'E	13183	-64298	-78° 24.8'	65636
Wilkes (O)	10	66° 15'	110° 35'	1964.0	85° 42.7'W	9230	-64827	-81° 53.8'	65481
Mawson (O)		67° 36'	62° 53'	1964.0	60° 51.7'W	18356	-48510	-69° 16.4'	51530

R = Repeat station

O = Magnetic observatory

* doubtful value

M= mean of day



- LEGEND**
- Magnetic station (reoccupied)
 - Observatories
 - Declination traverse 1964
 - - - Declination traverse 1965

1964 REGIONAL MAGNETIC SURVEY
LOCALITY MAP

EQUATOR
16°
32°
48°
0 100 200 300 400 500 600 700
Statute Miles
MERCATOR PROJECTION
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

(Based on 6265-96)

TO ACCOMPANY RECORD No. 1968/2

G96-161



LEGEND

- Field Magnetic Observation 1959-1963
- Field Magnetic Observation 1964
- Magnetic Observatory
- ▲ Field Magnetic Station reoccupied 1964

**AUSTRALIAN OBSERVATORIES AND
FIELD MAGNETIC STATIONS IN ANTARCTICA
1964**

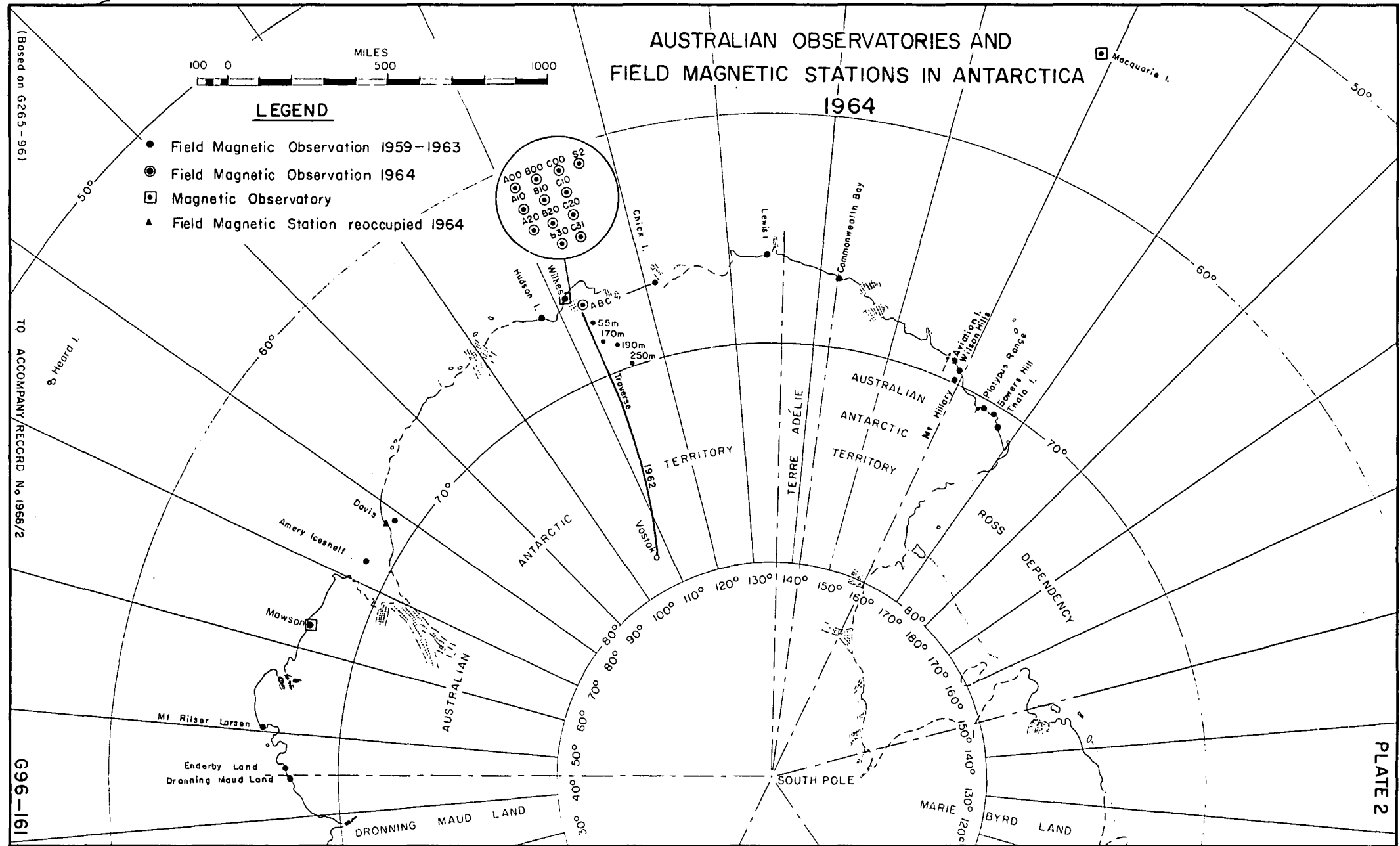
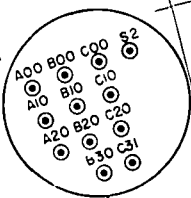
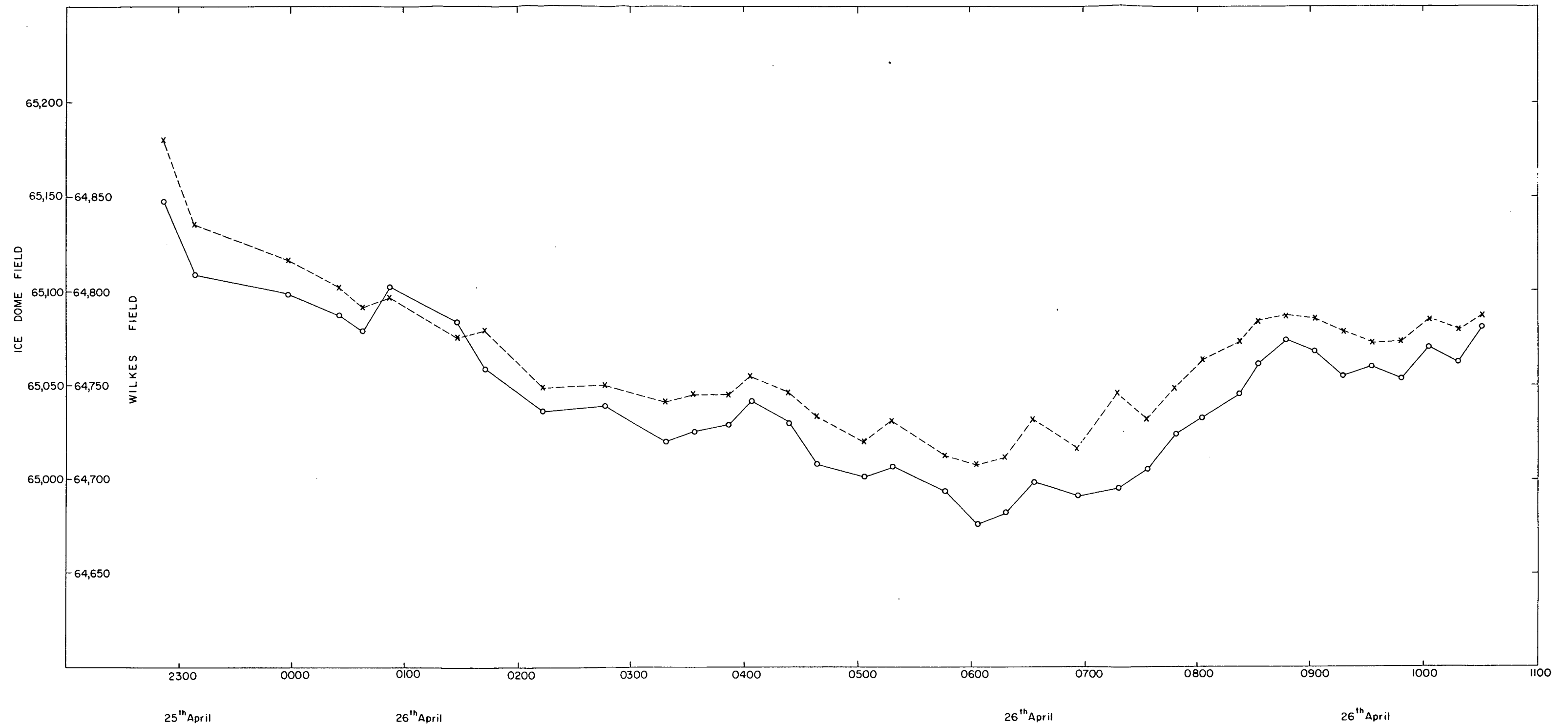


PLATE 2

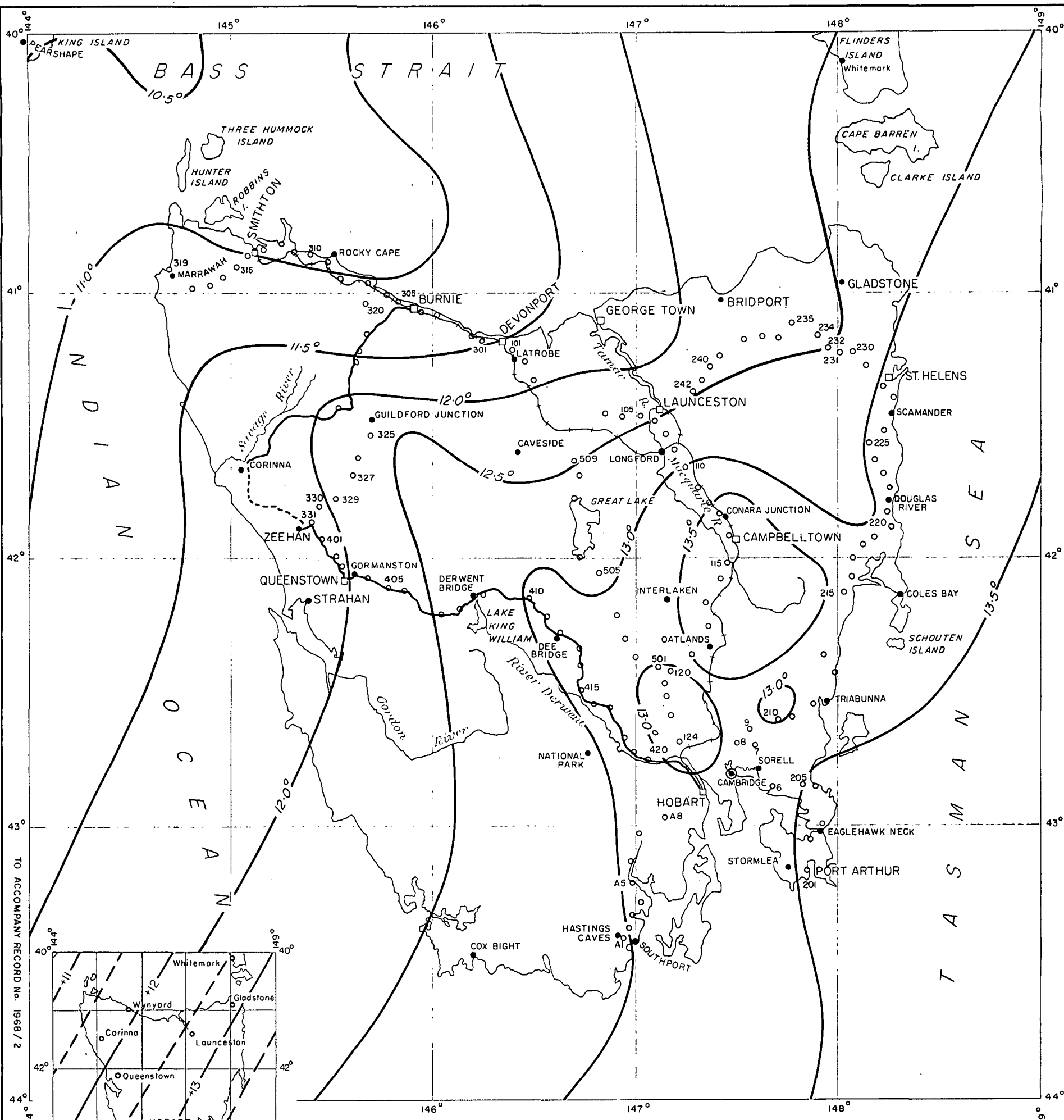


DIURNAL VARIATION OBSERVATIONS OF Z AT ICE DOME COMPARED WITH WILKES OBSERVATORY

AUTUMN TRAVERSE 1964

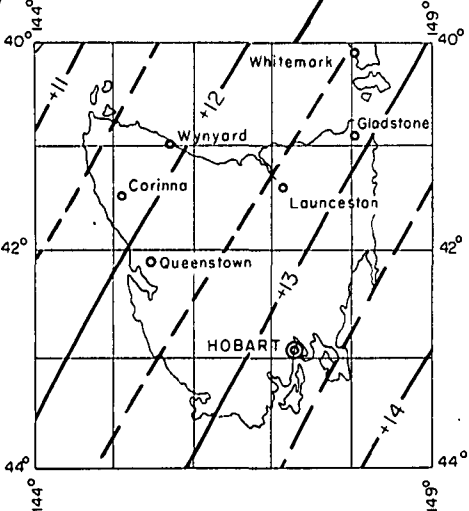
Distance, Wilkes to ice dome is approx. 75 miles

- ICE DOME OBSERVATIONS, NO INSTRUMENT CORRECTIONS APPLIED
- WILKES OBSERVATORY VALUES AT THE SAME INSTANT



TO ACCOMPANY RECORD No. 1968/2

G 96-143



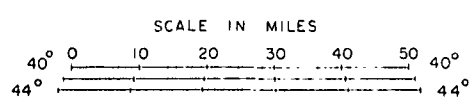
INSET FROM 1965.0 ISOGONIC MAP OF AUSTRALIA

DECLINATION CONTOUR MAP 1965.0

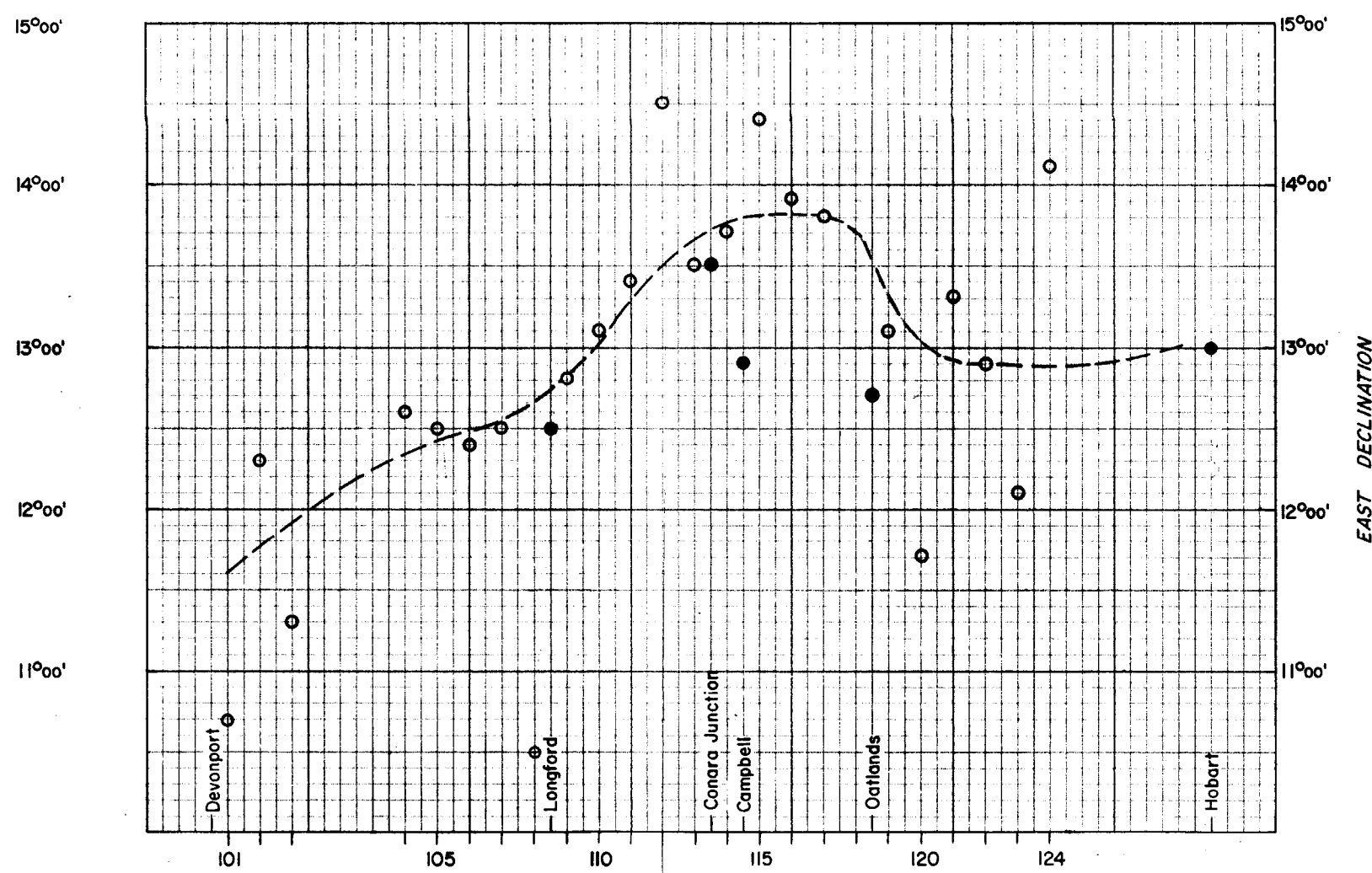
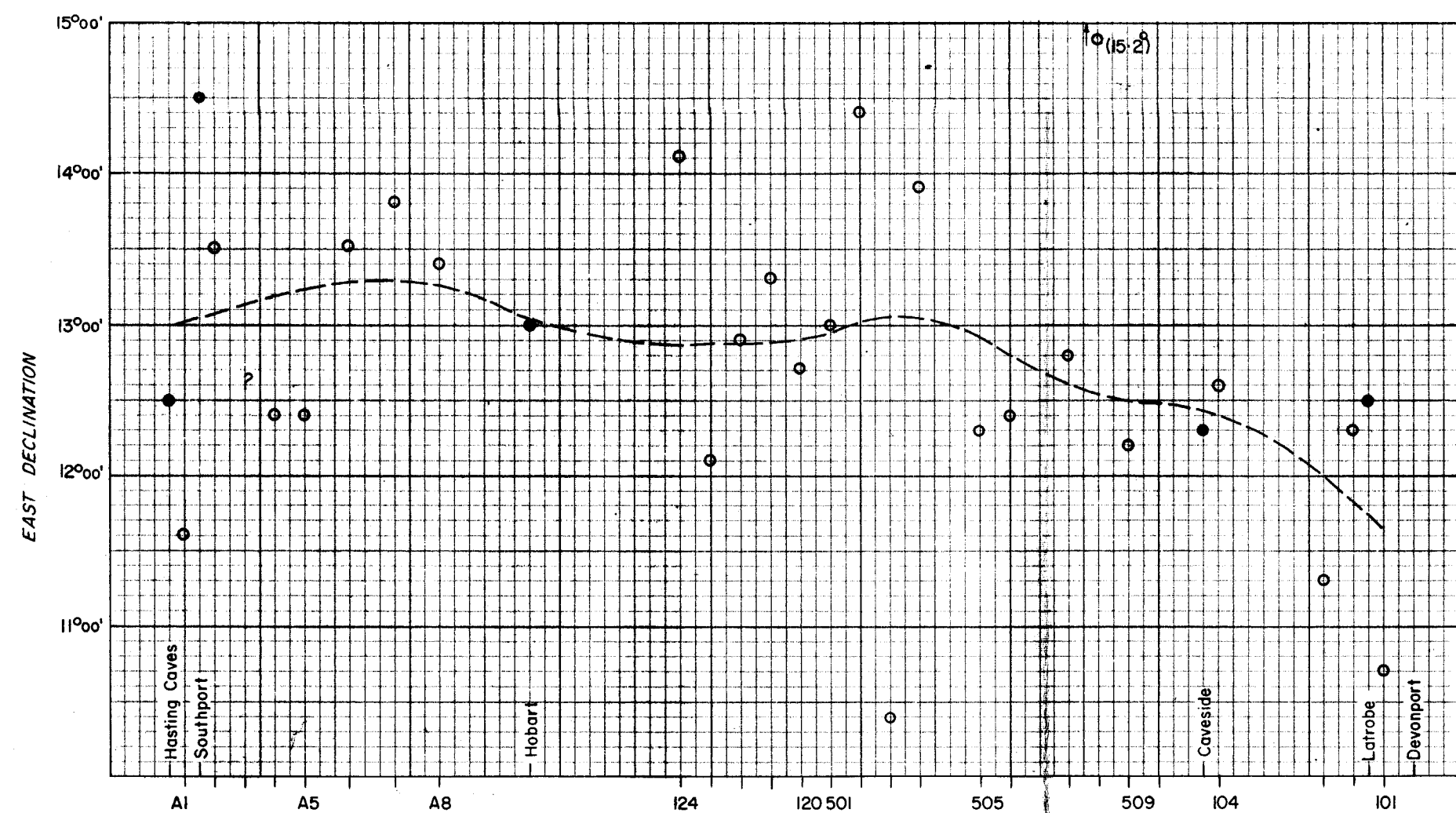
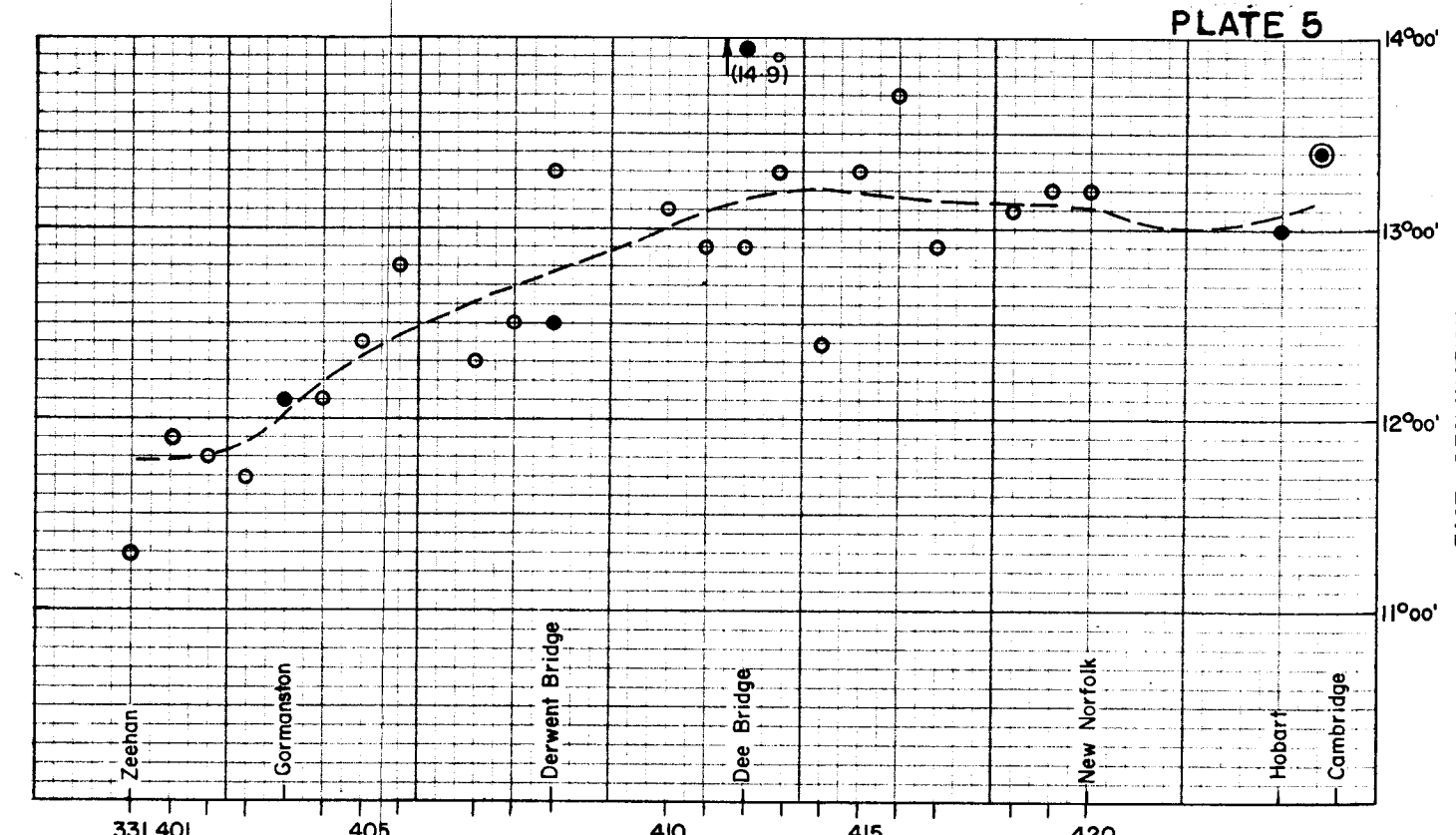
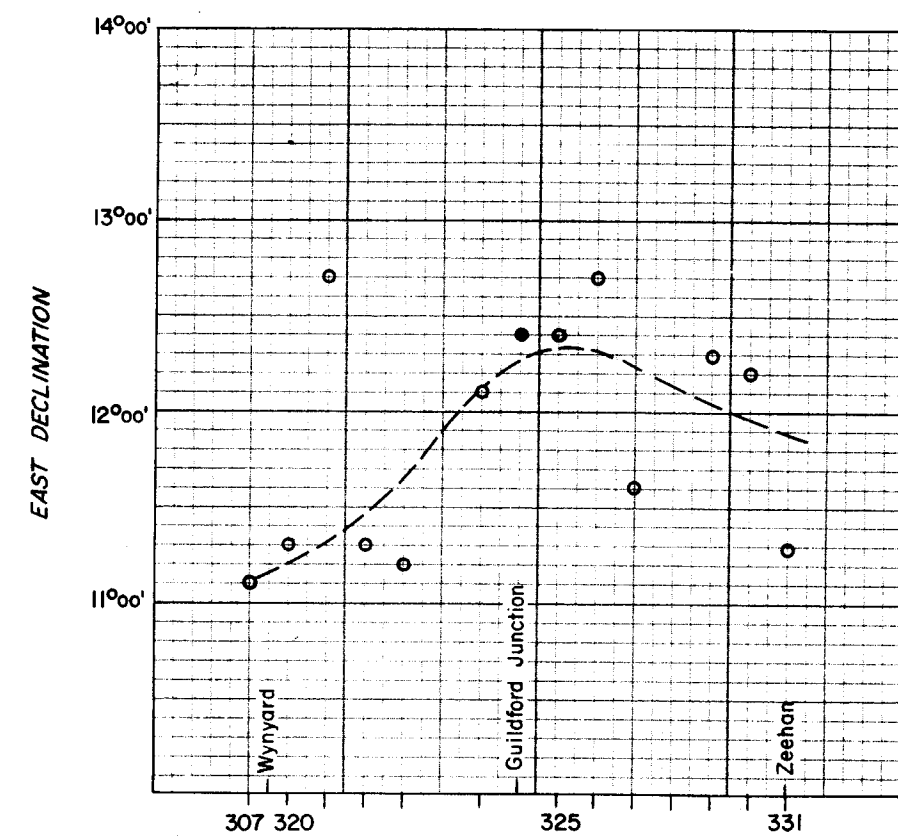
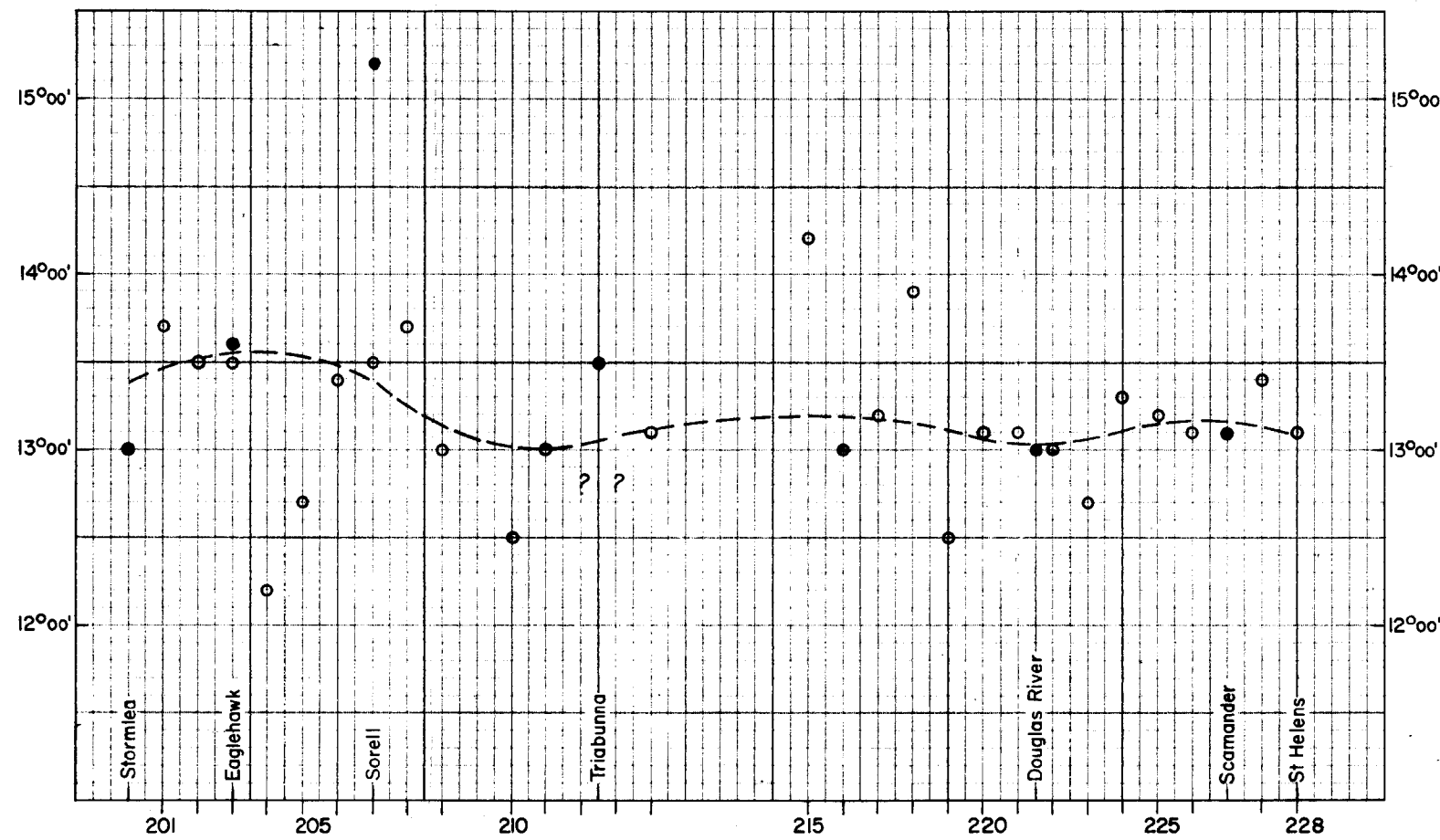
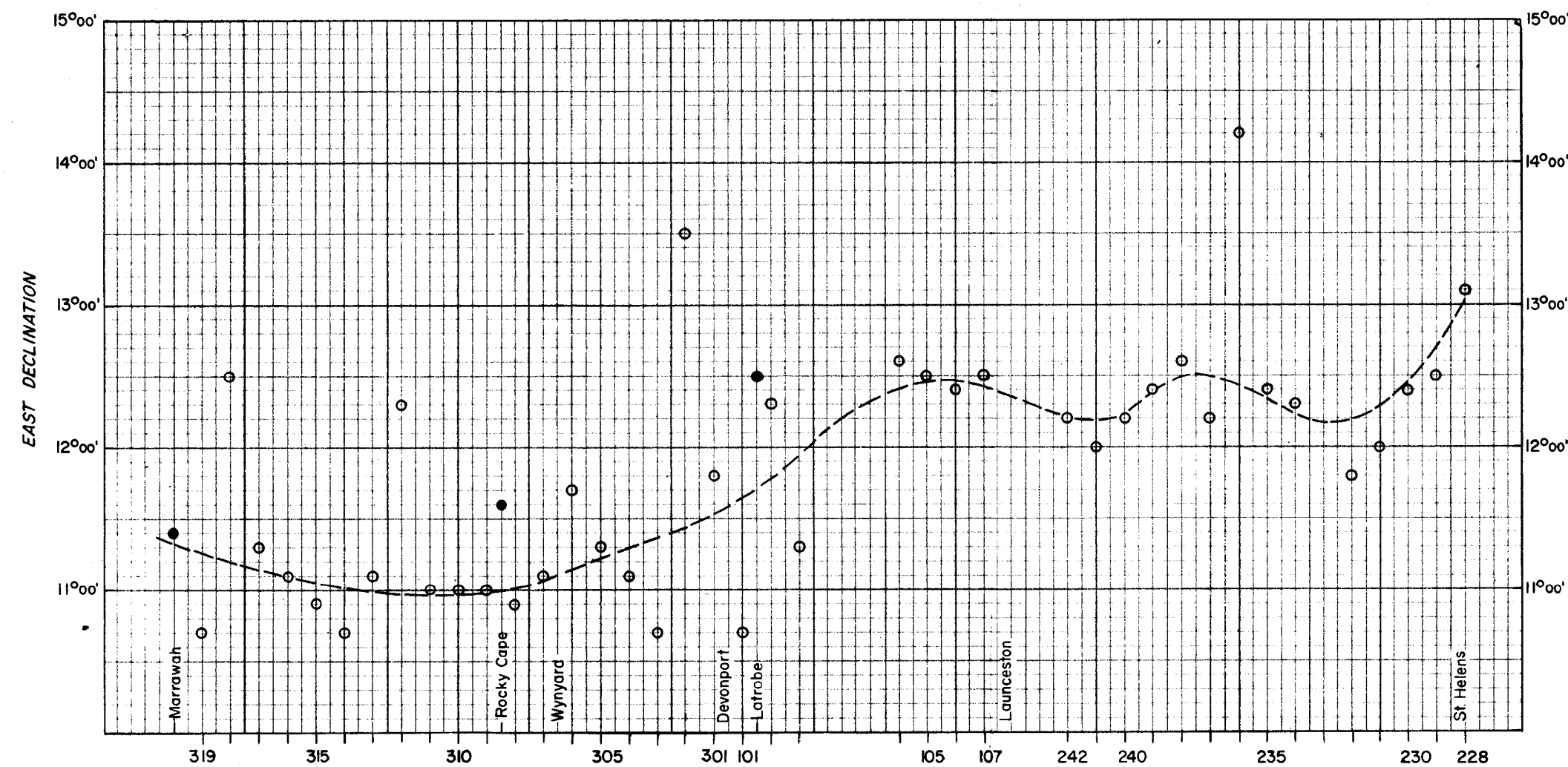
TASMANIA

LEGEND

- 1st order station 1962
- 2nd order stations 1952 and 1958
- 3rd order stations 1964
- Towns, Cities.
- 12.5° Declination contours 1965.0



MERCATOR PROJECTION



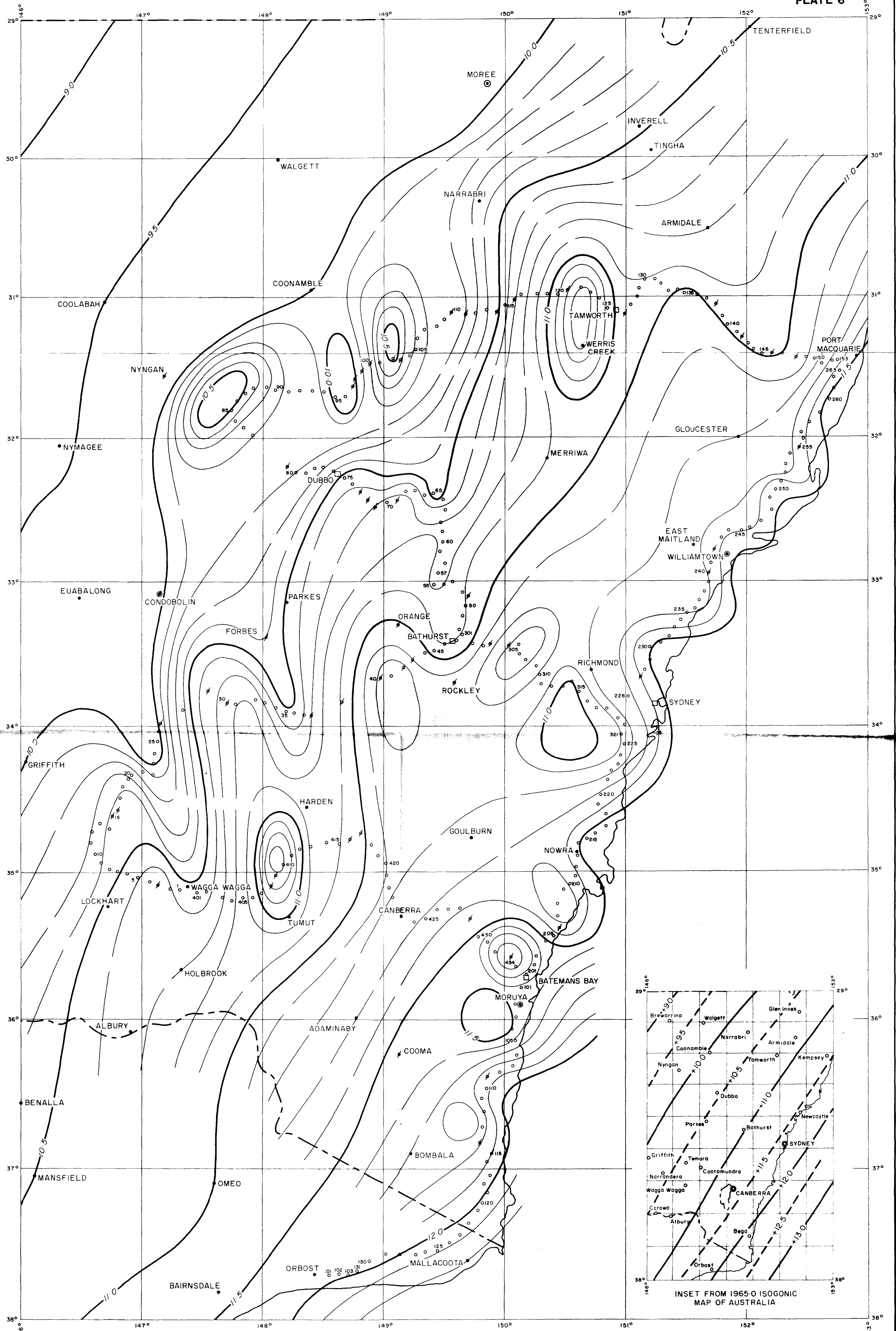
DECLINATION SURVEY TASMANIA 1964

**VALUES OF MAGNETIC DECLINATION FOR
1965 AS MEASURED ALONG ROAD TRAVERSES**

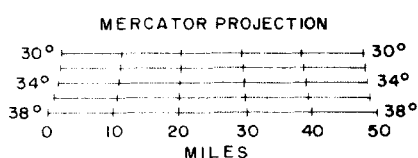
Note: Distances between stations are not to scale

LEGEND

- — — profile taken from Plate 4
 - 3rd order station
 - 2nd order station 1955 and 1958
 - 1st order station
 - 110 Station Number
- } Values adjusted to 1965.0

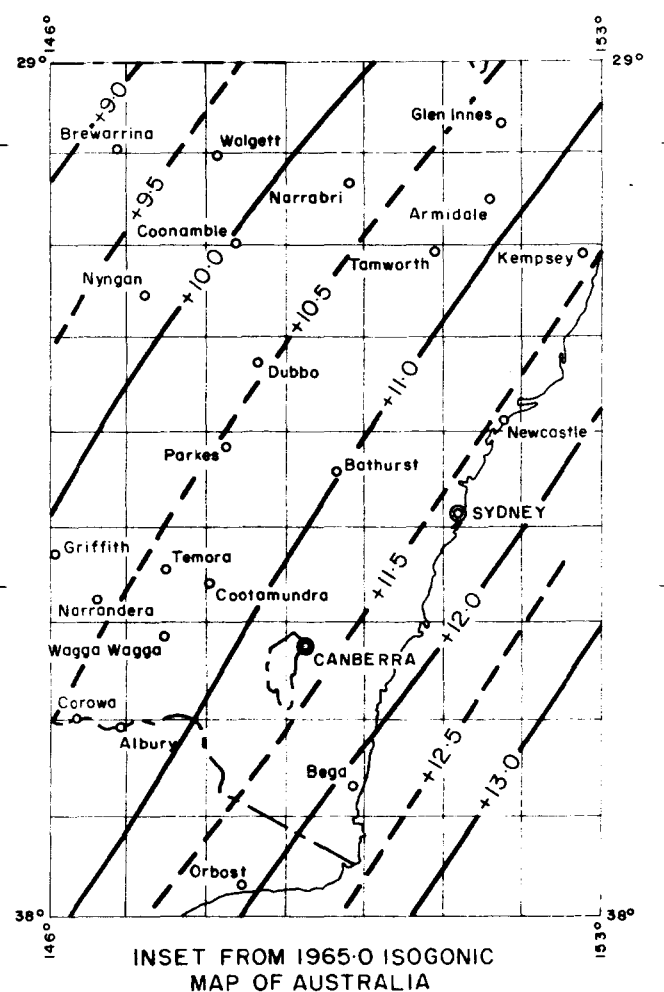


- 1st order station
- 2nd order station
- 3rd order station
- ✱ Anomalous station (value differs more than $\pm 0.2^\circ$ from contour)
- Towns, cities
- 10.0— Declination contours (1965.0 value)

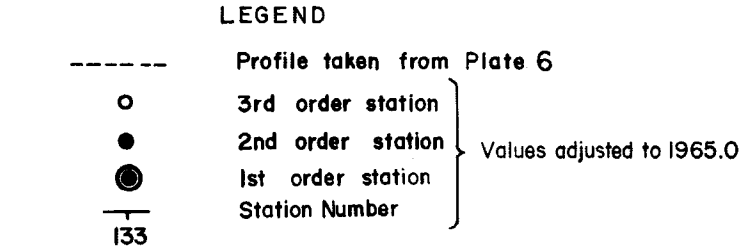


NSW-VICTORIA
DECLINATION CONTOURS, 1965.0

Results of detailed survey not included



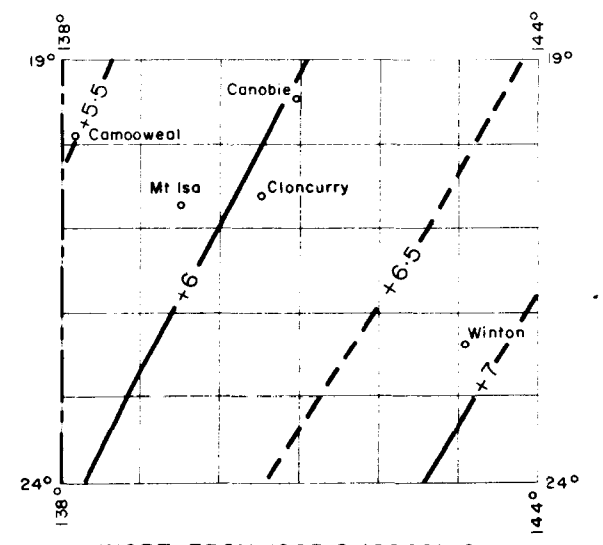
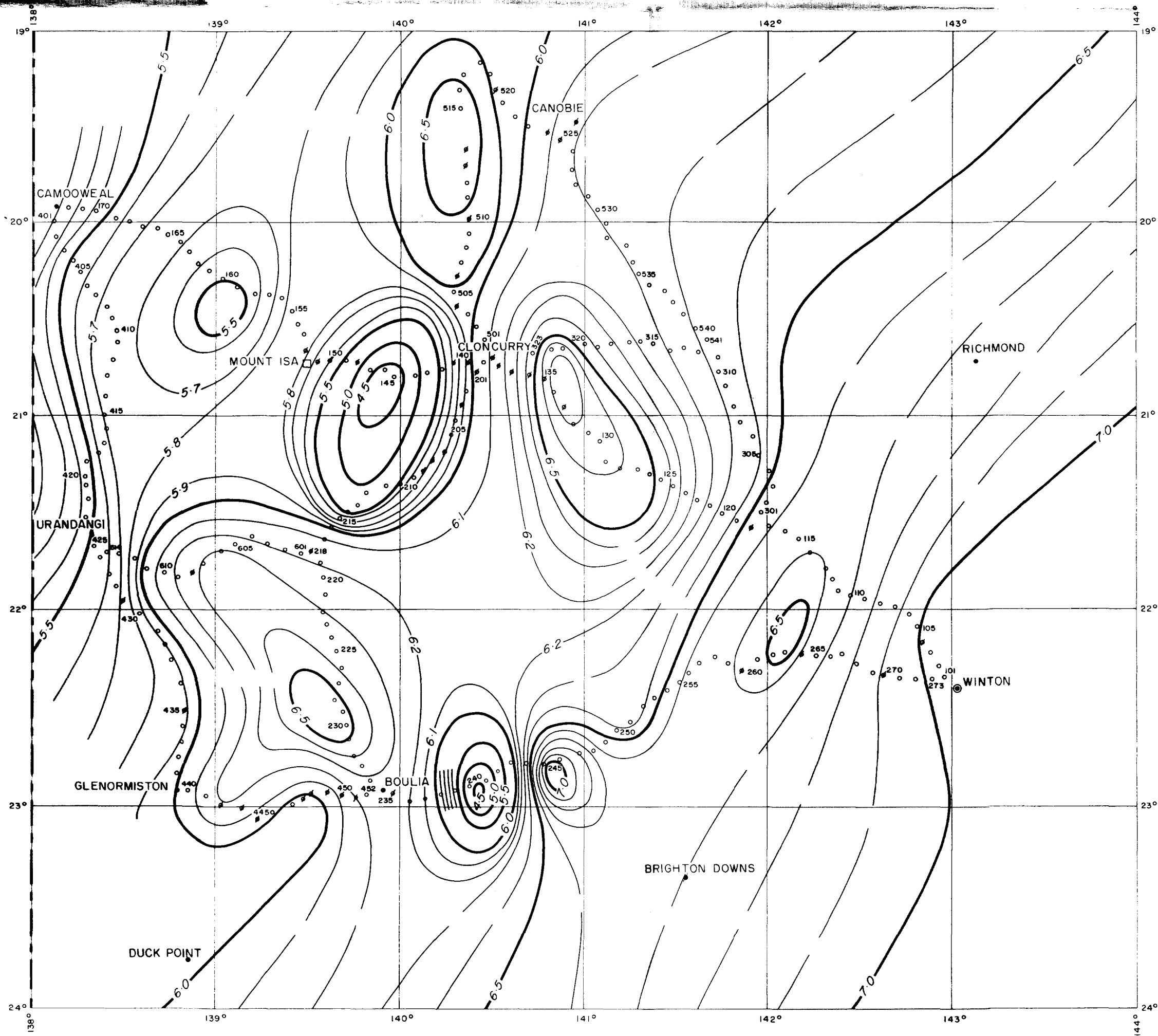
INSET FROM 1965.0 ISOGONIC
MAP OF AUSTRALIA



VALUES OF MAGNETIC DECLINATION AS MEASURED ALONG ROAD TRAVERSES

NOTE: Distances between stations are not to scale

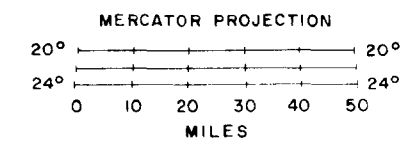
Declination profile from Plate 6

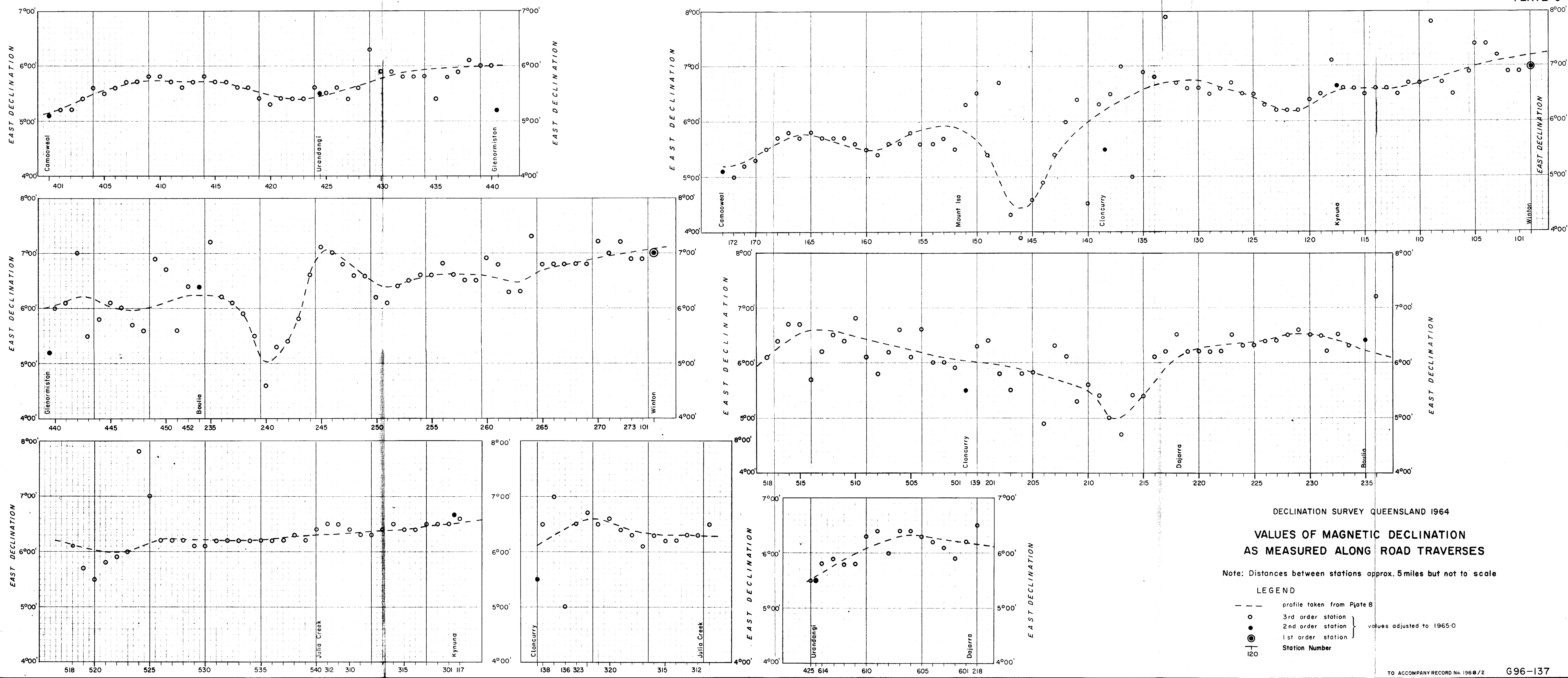


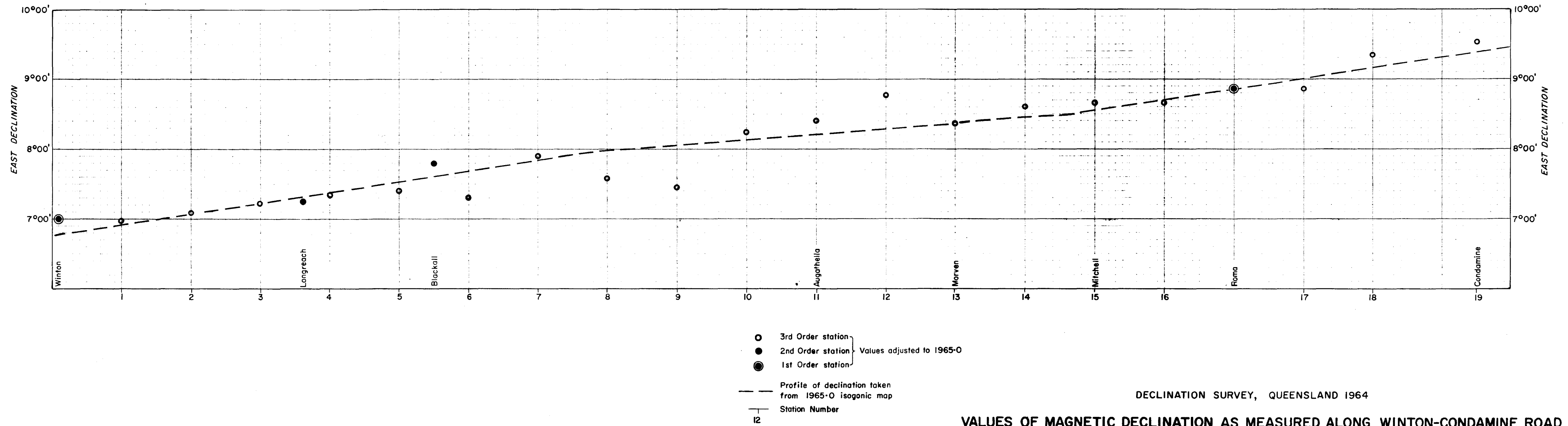
INSET FROM 1965-0 ISOGONIC
MAP OF AUSTRALIA

- 1st order station
- 2nd order station
- 3rd order station
- ⦿ Anomalous station (value differs more than $\pm 0.2^\circ$ from contour)
- 6.0 — Declination contour (1965-0 value)

QUEENSLAND
DECLINATION CONTOURS 1965-0







DECLINATION SURVEY, QUEENSLAND 1964

VALUES OF MAGNETIC DECLINATION AS MEASURED ALONG WINTON-CONDAMINE ROAD

NOTE: Distances between stations approximately 25 miles but not to scale