COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 5

Regional Magnetic Surveys in Australia, 1965 and 1966

by

J. van der Linden

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ILLUSTRATION

SUMMARY

During 1965 and 1966 re-occupations were made of some of the stations of the Australian first-order regional magnetic network. The density of the stations within the network was increased by establishing new stations so that the maximum distance between stations is now 600 kilometres.

The results will be used in the compilation of secular variation charts of Australia.

The 1965 survey is classified as a first-order survey, and the 1966 survey as a second-order survey because during this survey readings were taken over one day instead of the usual two days at a first-order station.

The use of a chartered light aircraft on the second-order survey decreased the survey time considerably.

1. INTRODUCTION

This record describes first and second-order magnetic surveys made by the Bureau of Mineral Resources, Geology and Geophysics (BMR) during 1965 and 1966. BMR definitions of regional magnetic stations are given in the Appendix.

The aim of the surveys was to re-occupy the first-order magnetic stations that form a network over Australia. This network was established during 1962 and 1963 (van der Linden, 1965a and 1965b). In the original network the magnetic stations were about 1000 kilometres apart. During the 1965 and 1966 surveys additional magnetic stations were occupied to decrease the distance between stations to about 600 kilometres. Most of the additional stations were re-occupations of recent second-order stations. The station locations are shown in Plate 1.

The results of these surveys are used for the compilation of secular variation charts of Australia. Data extracted from the secular variation charts form the basis for up-dating all Australian magnetic data to the epochs required when compiling magnetic maps.

2. ACCOUNT OF SURVEYS

First-order survey 1965

This survey was made by the author from 15th September to 24th November 1965. Nine of the first-order stations established in the eastern part of Australia in 1962 were re-occupied and five new first-order stations were established to increase the density of stations in the first-order network. The stations were selected at a maximum distance of 600 kilometres apart. At each station, measurements of declination (D), horizontal intensity (H), and vertical intensity (Z) were made more or less continuously over the daylight period of two days. Observations were made in the sequence H, D, H, Z, H ..... to provide close control of diurnal variation in H. It is in H that variability of diurnal variation is greatest.

Towards the end of October and during November the weather in northwest Queensland became uncomfortably hot; temperatures often exceeded the upper limit temperature of the QHM thermometer (42°C).

The party consisted of the author and a field-hand. For transport a Holden station sedan and a Holden panel van were used. Both vehicles managed the country roads (many of which were rough) very well; no mechanical attention was required and no tyres were repaired. The panel van however was not suitable for the dusty roads as too much dust penetrated inside the van.

Second-order survey 1966

This survey was also made by the author from 6th September to 31st October 1966. It was originally planned as a first-order survey, using a three-component fluxgate variograph developed by BMR for control of duirnal variation. However, this variograph had too high a temperature sensitivity and was not suitable for fieldwork at that stage.

Testing of the variograph took considerable time off the planned field season, and it was decided therefore to make measurements in the same manner as at a first-order station, but to spend only one day at the station. Hence the classification as a second-order survey, even though more readings were taken than at a normal second-order station.

Re-occupations were made at 32 stations (Table 2); 21 were re-occupations of first-order stations and 11 were re-occupations of recent second-order stations.

Measurements of D, H, and F (total intensity) were made. F was measured with an Elsec proton precession magnetometer. This was the first time the Elsec was used for regional magnetic work. It proved to be a rugged, reliable instrument of high accuracy and easy operation.

For transport a chartered twin-engine aircraft (Piper Apache) was used. A total of 18,000 miles was flown at a charter cost of $7,985.51. This works out to 44 cents per mile.

Part of the charter agreement was that the pilot would assist with the magnetic observations, which obviated the engagement of a field-hand.

The author acted as navigator, and after becoming experienced the party often flew to the next station on the same day that work was completed at a station. In this way virtually no time was lost in travelling, but lack of ground transport at outback places was a nuisance in most cases because the stations were some distance from the airstrips. Perhaps the carrying of a midget motor cycle in the aircraft could have solved this problem.

The apparent high cost of air charter was offset by the much shorter time in conducting the survey. This survey by road would have taken $2\frac{1}{2}$ times longer and the total cost would have been only slightly less than the air charter cost.

Instruments

The following table shows the instruments used and their corrections:

Instrument	Correction to BMR Standard	
	1965	1966
QHM 306	-29 gammas/gauss	-67 gammas/gauss
BMZ 211	+150 gammas	(not used)
Ask. Decl. 320	-0.1 minute	+0.4 minute
Elsec 271/592	(not used)	zero

Instrument corrections were derived by van der Waal (1966)

3. REDUCTIONS AND RESULTS

All observations were corrected to BMR standard, and for diurnal variation. Diurnal variation (Sq) corrections were obtained from the tables of Vestine et al (1948). The values thus derived were averaged for the day of the observations, to take account of observational errors and the departure of ambient and mean Sq values.

The corrected mean values and station coordinates for the 1965 survey are shown in Table 1. Only the first day of the observations is entered. Included here are the twelve-monthly preliminary mean values for 1965.0 and 1966.0 at the Australian magnetic observatories.

Similar data for the 1966 survey are shown in Table 2.

4. DISCUSSION OF RESULTS

Graphs showing long-term variation of the magnetic elements at the first-order stations to 1965 were published by van der Linden (1966). These graphs were brought up to date by adding the 1965 and 1966 results, and new graphs were drawn for the additional stations in the first-order network.

All data from the 1965 re-occupations fell into the expected places on the graphs. Of the 1966 second-order data those obtained at Ingham and at Maryborough did not fall into place. No explanation for these discrepancies can be given until other re-occupations of these two stations have been made.

The fact that the results obtained from the other 30 second-order stations yielded useful results for obtaining secular variation values is very gratifying, considering the shorter observing period involved in this type of survey.

The main problem is obtaining good daily mean values for second-order surveys is the determination of the diurnal variation corrections. A project to study the morphology of the Sq over Australia is now on the BMR programme and it should result in minimising this problem.

5. REFERENCES

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VESTINE, E.H., LAPORTE, L., LANGE, I., COOPER, C., AND HENDRIX, W.C. 1948 Description of the Earth's main magnetic field and its secular changes, 1905-1945. Publ. Carneg. Instn. 578

APPENDIX

NOTES ON REGIONAL MAGNETIC STATIONS

First-order station

A first-order station is a place at which the geomagnetic field has been observed (or recorded with 'absolute' control) more or less continuously for two or three days, with an accuracy of 5 gammas or better in the absence of magnetic storms, and which is sufficiently well marked and located that re-occupation within three to five years will be possible.

Second-order station

A second-order station is a place at which the field has been observed several times during one day with an accuracy of 5 gammas and which is marked so that re-occupation may be possible in the future.

Third-order station

A third-order station is one at which the field, or one of its components, has been observed once with an accuracy of about 20 gammas (or the equivalent angle) and which is located only by a map.

TABLE I

STATION POSITIONS AND MAGNETIC VALUES
FIRST ORDER SURVEY 1965

STATION		LAT DEG	LAT MIN	LONG DEG	LONG MIN	DATE	D DEG	D MIN	I DEG	I MIN	H	Z	F	EL METRES
PT MORESBY OBS		-9	24.0	147	9.0	65	6	7.9	32	18.0	36348	-22978	43001	70
		-9	24.0	147	9.0	66	6	9.0	32	21.0	36328	-23008	42998	70
GNANGARA OBS		-31	47.0	115	57.0	65	-2	51.6	65	55.0	23911	-53501	58601	60
		-31	47.0	115	57.0	66	-2	52.0	65	55.8	23898	-53498	58600	60
TOOLANGI OBS		-37	32.0	145	28.0	65	10	30.4	68	11.7	22554	-56374	60719	517
		-37	32.0	145	28.0	66	10	33.0	68	13.0	22526	-56369	60700	517
COOKTOWN B	R	-15	28.6	145	14.8	29 10 65	6	24.2	42	45.8	34688	-32080	47248	6
INGHAM		-18	39.5	146	9.0	3 11 65	6	49.0	47	35.7	33186	-36336	49210	15
MACKAY B	R	-21	9.5	149	10.8	6 11 65	8	18.6	50	22.4	32408	-39139	50814	5
WINTON	R	-22	23.9	143	3.2	22 10 65	65	9.6	52	37.8	31548	-41307	51976	215
MARYBOROUGH	R	-25	31.3	152	43.7	10 11 65	10	20.6	55	9.4	30284	-43502	53005	10
ROMA B	R	-26	33.7	148	46.7	16 10 65	8	50.4	56	46.0	29689	-45312	54172	335
QUILPIE		-26	36.5	144	15.2	19 10 65	7	41.4	57	32.9	29340	-46139	54678	215
MOREE A2	R	-29	28.3	149	49.8	28 9 65	9	58.2	60	8.6	27860	-48536	55964	235
MOREE A3		-29	30.0	149	50.0	13 10 65	9	57.6	60	15.6	27748	-48569	55937	230
GRAFTON		-29	46.0	153	1.2	17 11 65	10	46.4	59	43.7	27968	-47916	55481	31
BOURKE C	R	-30	3.1	145	57.5	24 9 65	9	0.2	61	8.1	27296	-49519	56544	117
NEWCASTLE		-32	48.0	151	53.0	22 11 65	11	21.8	63	7.1	26066	-51421	57650	8
CONDOBOLIN A1	R	-33	6.0	147	8.7	21 9 65	9	37.1	63	57.8	25572	-52347	58259	217
MORUYA B	R	-35	53.6	150	8.4	14 9 65	12	11.4	65	59.5	24176	-54279	59420	5

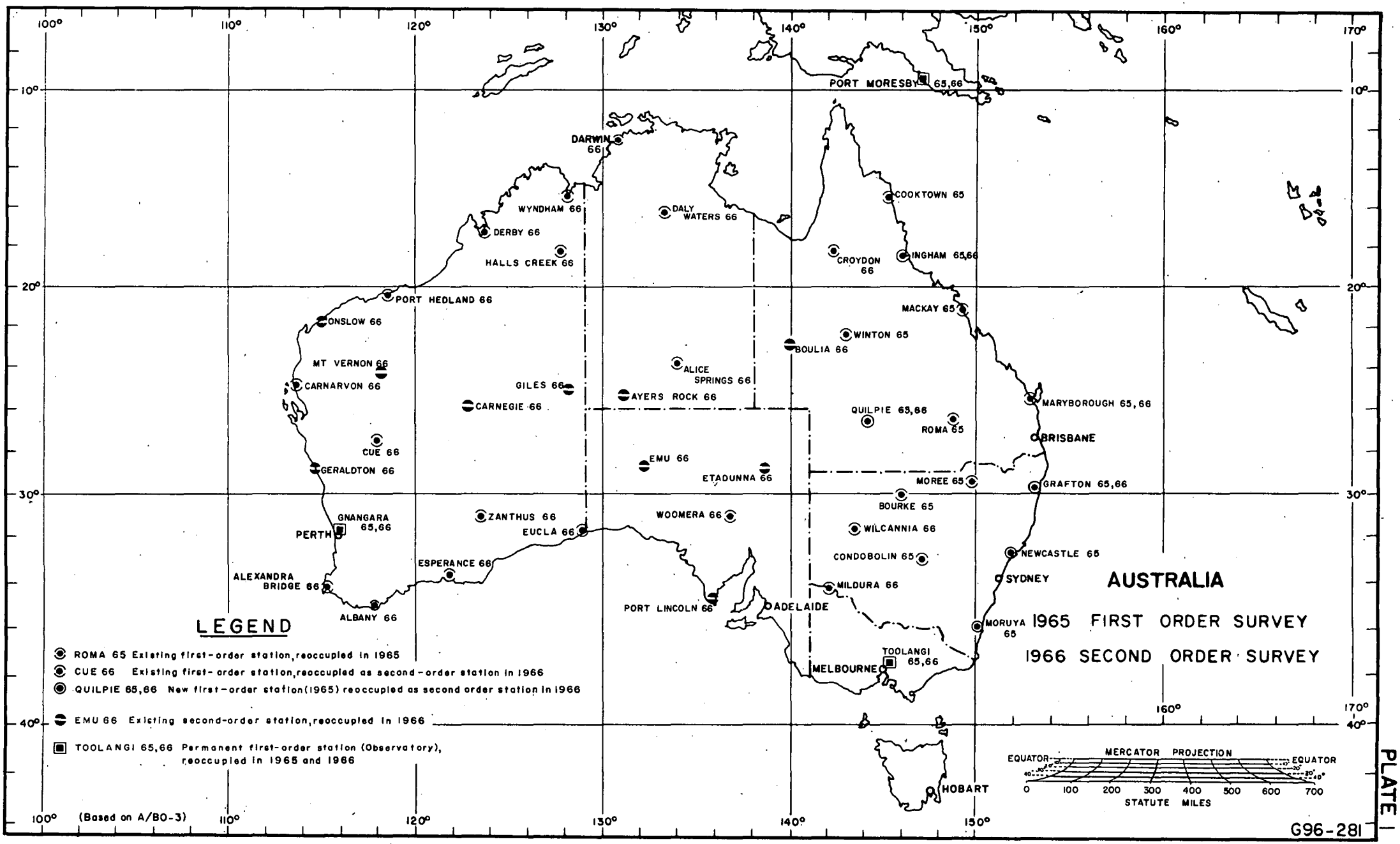
R = REOCCUPIED

TABLE 2

STATION POSITIONS AND MAGNETIC VALUES
SECOND ORDER SURVEY 1966

STATION		LAT DEG MIN	LONG DEG MIN	DATE	D DEG MIN	I DEG MIN	H	Z	F	EL METRES
DARWIN D	R	-12 26,7	130 49,9	6 9 66	3 40,6	39 46,8	35666	-29695	46410	30
WYNDHAM C	R	-15 30,9	128 8,6	7 9 66	3 19,6	45 8,6	34324	-34496	48663	5
DALY WATERS B	R	-16 17,4	133 22,8	10 9 66	4 21,7	45 18,5	34368	-34740	48867	230
DERBY B	R	-17 22,2	123 39,6	8 9 66	2 43,1	48 5,5	33390	-37203	49989	5
CROYDON	R	-18 12,7	142 13,3	14 9 66	6 9,7	47 7,9	33610	-36210	49405	120
HALLS CREEK B	R	-18 14,6	127 40,8	9 9 66	2 42,4	48 46,9	33249	-37956	50459	440
INGHAM	R	-18 39,5	146 9,0	15 9 66	7 15,1	47 27,7	33194	-36175	49096	15
PORT HEDLAND B	R	-20 18,9	118 37,0	6 10 66	1 14,1	52 52,4	31399	-41476	52021	10
ONSLOW	R	-21 38,7	115 6,2	7 10 66	0 25,9	55 24,5	30121	-43676	53055	5
BOULIA	R	-22 54,7	139 56,0	11 9 66	6 22,8	53 30,5	31192	-42176	52450	170
ALICE SPRINGS CR		-23 48,4	133 53,9	28 9 66	4 45,3	55 28,7	30471	-44300	53768	590
MOUNT VERNON	R	-24 14,4	118 14,2	4 10 66	0 40,2	57 43,5	28982	-45890	54276	400
CARNARVON C	R	-24 52,5	113 39,3	8 10 66	-1 6,0	59 19,5	28027	-47249	54936	5
GILES	R	-25 2,0	128 18,0	30 9 66	3 25,5	57 44,4	29219	-46292	54742	635
AYERS ROCK	R	-25 20,6	131 2,0	29 9 66	4 24,8	57 49,6	29279	-46542	54986	560
MARYBOROUGH C	R	-25 31,3	152 43,2	21 69 66	10 9,6	54 47,8	30691	-43501	53238	10
CARNEGIE	R	-25 49,3	122 55,9	2 10 66	1 55,3	59 4,5	28450	-47488	55358	500
QUILPIE	R	-26 36,5	144 15,2	24 9 66	7 46,3	57 35,6	29299	-46156	54670	215
CUE	R	-27 25,6	117 53,0	3 10 66	-0 9,9	61 25,0	26834	-49256	56091	480
EMU	R	-28 38,9	132 13,2	26 10 66	4 33,2	61 11,4	27270	-49582	56586	300
ETADUNNA	R	-28 43,1	138 38,0	25 9 66	6 40,6	60 30,2	27779	-49107	56420	20
GERALDTON C	R	-28 48,6	114 42,1	9 10 66	-1 53,2	63 9,7	25704	-50801	56934	35
GRAFTON	R	-29 46,0	153 1,2	22 9 66	10 50,7	59 47,3	27901	-47918	55449	30
ZANTHUS	R	-31 3,4	123 33,4	21 10 66	1 7,1	64 27,4	25162	-52652	58355	295
WOOMERA	R	-31 6,0	136 46,0	29 10 66	6 4,2	63 16,8	26034	-51716	57899	195
WILCANNIA	R	-31 30,9	143 23,0	30 10 66	8 32,0	62 56,6	26230	-51355	57666	85
EUCLA	R	-31 43,0	128 53,0	22 10 66	3 29,0	64 27,9	25215	-52781	58495	5
ESPERANCE	R	-33 41,0	121 49,0	20 10 66	-0 6,4	67 14,8	23253	-55444	60123	150
ALEXANDRA BR.	R	-34 9,8	115 12,3	16 10 66	-4 9,7	68 20,3	22089	-55617	59843	85
MILDURA	R	-34 13,9	142 3,0	31 10 66	7 29,3	65 40,5	24448	-54084	59353	55
PORT LINGOLN B	R	-34 43,7	142 51,3	25 10 66	5 4,0	66 47,6	23677	-55222	60084	5
ALBANY	R	-34 56,9	117 48,3	19 10 66	-2 51,8	68 25,4	22158	-56028	60250	75

R = REOCCUPIED


100°
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PORT MORESBY 65,66
DARWIN 66
WYNDHAM 66
DERBY 66
HALLS CREEK 66
DALY WATERS 66
COOKTOWN 65
CROYDON 66
INGHAM 65,66
PORT HEDLAND 66
ONSLOW 66
MT VERNON 66
CARNARVON 66
GILES 66
CARNEGIE 66
ALICE SPRINGS 66
AYERS ROCK 66
MACKAY 65
WINTON 65
BOULIA 66
QUILPIE 65,66
ROMA 65
MARYBOROUGH 65,66
BRISBANE
CUE 66
GERALDTON 66
EMU 66
ETADUNNA 66
MOREE 65
GRAFTON 65,66
BOURKE 65
GNANGARA 65,66
PERTH
ZANTHUS 66
WOOMERA 66
EUCLA 66
WILCANNIA 66
CONDOBOLIN 65
NEWCASTLE 65
ESPERANCE 66
ALEXANDRA BRIDGE 66
ALBANY 66
PORT LINCOLN 66
ADELAIDE
MILDURA 66
SYDNEY
MORUYA 65
TOOLANGI 65,66
MELBOURNE
HOBART
AUSTRALIA
1965 FIRST ORDER SURVEY
1966 SECOND ORDER SURVEY
LEGEND
ROMA 65 Existing first-order station, reoccupied in 1965
CUE 66 Existing first-order station, reoccupied as second-order station in 1966
QUILPIE 65,66 New first-order station (1965) reoccupied as second order station in 1966
EMU 66 Existing second-order station, reoccupied in 1966
TOOLANGI 65,66 Permanent first-order station (Observatory), reoccupied in 1965 and 1966
(Based on A/BO-3)
MERCATOR PROJECTION
EQUATOR
EQUATOR
0 100 200 300 400 500 600 700
STATUTE MILES
G96-281
PLATE I
TO ACCOMPANY RECORD NO. 1969/5