COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

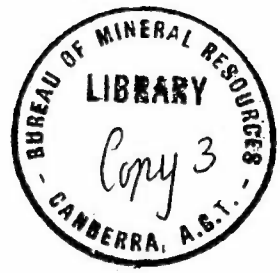
Record No. 1971/26

First-Order Regional Magnetic Survey of the Territory of Papua and New Guinea, 1969

by

D. M. Finlayson

Record No. 1971/26



FIRST-ORDER REGIONAL MAGNETIC SURVEY OF THE TERRITORY OF PAPUA & NEW GUINEA, 1969

by

D.M. Finlayson

CONTENTS

APPENDIX

TABLES

ILLUSTRATIONS

SUMMARY

The Bureau of Mineral Resources, Geology & Geophysics (BMR) has established a network of 72 first-order regional magnetic stations throughout Australia and its Territories, which is intended to provide precise information on the values of the geomagnetic field and its secular variation.

During April-June 1969, magnetic observations were made at nine stations in the Territory of Papua & New Guinea (TPNG) and at one station in the British Solomon Islands Protectorate. The observations were made over about a 60-hour period at each station with instruments, calibrated against the Australian standard, controlling a three-component fluxgate variograph. The horizontal intensity of the geomagnetic field was measured to within $\pm$ 5 gammas, declination to within $\pm$ 1 minutes of arc, and vertical intensity to within $\pm$ 6 gammas.

The occupation of all stations in the Australian network will be completed by early 1970 and the information will be used in the compilation of the 1970.0 series of isomagnetic maps.

1. INTRODUCTION

This Record describes the first-order regional magnetic survey work carried out during April-June 1969 in the Territory of Papua & New Guinea and in the British Solomon Islands Protectorate. The work was carried out by D. Finlayson from BMR's Canberra office, assisted by P. Rupa from the Port Moresby Geophysical Observatory staff.

The stations occupied were Honiara, Aropa, Rabaul, Wewak, Vanimo, Wabag, Lae, Momote, Daru, and Gurney (Plate 1). Magnetic observations had been made previously at all stations except Honiara and Vanimo (van der Linden 1965a, 1965b). On this survey new sites were chosen for various reasons at all stations except Wabag.

The survey was the second stage of the occupation of the Australian network of first-order regional magnetic stations (Finlayson, 1971). The object of the observational programme over this network is to provide high-quality data for the production of isomagnetic maps at epoch 1970.0 and to provide precise secular variation data.

Appendix 1 gives BMR classifications of regional magnetic stations.

2. METHODS AND EQUIPMENT

Logistics

The survey party and equipment travelled by commercial and charter airlines throughout the survey. The survey equipment was packed in steel and wooden cases and weighed about 270 kilograms. Provided prior warning was given to commercial airlines, this weight could be accommodated in the normal scheduled flights. Only one charter flight had to be arranged, from Wabag to Madang to connect with a scheduled flight. Transport and accommodation was arranged by the TPNG Administration, by the Department of Civil Aviation, and for the station at Honiara, by the Solomon Islands Geological Survey staff. These prior arrangements were essential to the success of the survey, and the co-operation and assistance of the local administrative personnel was much appreciated.

All stations were brought to the attention of the local administrative personnel so that wherever possible the station markers would not be disturbed or damaged.

Variograph

At each station the BMR three-component fluxgate variograph was operated from a tent near the magnetic station marker. The fluxgate detectors were temperature-sensitive and had to be insulated. For this survey the detectors were buried under about 15 centimetres of earth so that diurnal variations in temperature would be reduced (Plate 2). The fluxgate electronics were allowed about one hour to warm-up at each site.

Generally, the survey method was modelled on the 1968 first-order regional magnetic survey of eastern Australia, the Record for which contains details of the fluxgate variograph equipment (Finlayson, 1971). Modifications made for the TPNG survey were:

(a) Use of buried detectors for temperature control.

(b) Recording cable lengthened to 30 metres.

(c) Mercer chronometer replaced by a Bulova timer.

(d) Lead acid accumulators borrowed locally at each station.

Scale-value observations were made on the variograph records using a BMR fluxgate calibrating unit type MCR1.

The fluxgate detector coil constants used in determining scale values are listed below:

Detector	H	D	Z
Coil constant	2.40	2.41	2.37 gammas per microamp

Magnetometers

Throughout the operating period, control observations were made at the marker located permanently at each station. Generally, three sets of control observations were made each day using a QHM for horizontal intensity (H), and Elsec proton magnetometer for total intensity (F), and an Askania declinometer for declination (D). Vertical intensity (Z) was derived from the H and F data. The azimuth control for the declination measurements was obtained by making hour angle observations of the sun at each site, using a Watts theodolite.

The instruments used for variograph control were the same at all stations and are listed below together with their instrumental corrections.

Horizontal intensity (H). Instrument - QHM 189, normally used at Port Moresby geophysical observatory. Correction adopted after inter-comparison with BMR standard = -67 gamma/gauss (van der Waal, 1966).

Total intensity (F). Instrument - Elsec proton magnetometer No. 422. No correction. Instrument crystal frequency checked and found to be correct.

Declination (D). Instrument - Askania declinometer No. 509320. Correction adopted from BMR standard instrument = + 0.3 minutes (van der Waal, 1966).

Throughout the survey, information was gathered from local maps and DCA airport plans to obtain latitude and longitude values, which were required for azimuth computations.

3. RESULTS

Derivation

The reduction procedure applied to the results is the same as that applied to the results from the 1968 first-order regional magnetic survey of eastern Australia. The procedure is summarized below:

(a) Compute all control observations with relevant corrections.

(b) Compute and adopt all scale values.

(c) Scale ordinates and compute and adopt baselines.

(d) Scale mean hourly values for a 24-hour period at each station.

A summary of the work done at each station is given in Table 1. Details of the adopted variograph scale values and adopted baseline values are given in Tables 2 and 3 respectively.

Because of the mineralization at Aropa B site, which produced large magnetic gradients, no sensible Elsec readings could be made and hence no Z baselines are available. At Gurney the variograph equipment was not operating satisfactorily because of the extremely wet conditions, so no reliable variograph records were available. However, good baseline values were obtained using the magnetograms from Port Moresby magnetic observatory and these have been used to estimate mean values for Gurney and Samarai.

The mean values of H, D, and Z for the adopted 24-hour period at each station are given in Table 4. The value of Z quoted for Aropa B is only approximate and is included to give a measure of the anomalous nature of the region. Plots of the hourly values of H, D, and Z for the various stations are given in Plates 3 and 4.

Subsidiary sites

At all stations except Honiara and Wabag, subsidiary sites were reoccupied. All subsidiary sites had been occupied previously, and it was because of this that reoccupations were made during the 1969 survey. The reoccupations enabled site differences and secular variation to be measured. The corrections to be applied to H, D, and Z observations at subsidiary sites to reduce them to the main site values are given in Table 5. The values of H, D, and Z at the subsidiary sites derived using the corrections in Table 5 are given in Table 6.

No Elsec proton magnetometer readings were possible at sites Rabaul A, Lae A, and Samarai because of instrumental noise induced from nearby power lines.

Precision

Systematic errors resulting from the survey methods can be estimated from the standard deviations of the observed values from the adopted values given in Tables 2 and 3. For declination measurements a further error is introduced from the azimuth determinations, where the standard deviation about the mean was + 0.3 minutes. Summation of the systematic errors indicates that the majority of survey results are within the limits aimed at, viz + 5 gammas for H, + 1.0 minutes for D, and + 6 gammas for Z. The Z results from Aropa A and B sites are outside these limits. The results from Gurney and Samarai are probably within the limits because the measurements were made during a magnetically quiet period and the diurnal variation at Port Moresby would not be appreciably different from that at Gurney.

The degree of magnetic disturbance during the adopted 24-hour recording period at each station is indicated in Table 7, where the K-index sum, the C-index, and magnetic phenomena as recorded at Port Moresby Observatory are listed. A measure of the effects of magnetic disturbance of H, D, and Z is given in Table 8, where the differences between the mean for the 5 International Quiet Days and the daily mean are listed for the various components at Port Moresby Observatory. It is seen from Table 8 that H is the only component appreciably distorted. In the Record of the 1968 first-order

regional magnetic survey of eastern Australia (Finlayson, 1971) a value of 15 gammas was arbitrarily taken as the limit above which the conditions were described as disturbed magnetically. If this criterion is applied to the TPNG observations then the results from Rabaul, Wewak, Lae, Momote, and Gurney must be classified as disturbed. However, only the Rabaul and Lae results are greatly affected by magnetic storms.

4. DISCUSSION

Examination of the results in relation to BMR and international isomagnetic maps previously produced for the area suggests that a number of sites are of little value owing to magnetic anomalies. Although secular variation data can be obtained from these sites, the absolute values of the geomagnetic field are not representative of the region, and it is suggested that alternative sites be used in future.

The Aropa station has a subsurface of mineralized sand containing magnetite, and the Rabaul station is situated in a volcanic caldera; it is recommended that they be abandoned and the stations at Buka and Kavieng respectively be used instead.

It is recommended that Samarai also be abandoned because of the anomalous results obtained, and that the station at Gurney be used instead.

It is recommended that the stations Wewak C, Lugos and Daru A be abandoned because of the awkward relation of the sites to buildings etc. Alternative sites have been occupied at Wewak D, Momote, and Daru B respectively.

It is recommended that Lae A site be abandoned because of the proximity to power lines, steel fixtures, etc, and the alternative Lae B site be used.

5. ACKNOWLEDGEMENTS

The author would like to express his appreciation of the assistance rendered by the staff of the BMR Geophysical Observatory at Port Moresby, the Geological Survey of the British Solomon Islands Protectorate, the Territory of Papua & New Guinea Administration, and the Department of Civil Aviation during the course of the survey.

6. REFERENCES

FINLAYSON, D.M., - First-order regional magnetic survey of eastern Australia, 1968. Bur. Min. Resour. Aust. Rec. 1971/24 (unpubl.).

VAN DER LINDEN, J., 1965a - Regional magnetic surveys in Australia, Australian Antarctica and the Territory of Papua & New Guinea, 1962. Bur. Min. Resour. Aust., Rec. 1965/20 (unpubl.).

VAN DER LINDEN, J., 1965b - Regional magnetic surveys in Australia, Australian Antarctica and the Territory of Papua & New Guinea during 1963. Bur. Min. Resour. Aust., Rec. 1965/218 (unpubl.).

VAN DER WAAL, C.A., 1966 - Corrections for absolute and semi-absolute magnetic instruments. Bur. Min. Resour. Aust., Rec. 1966/207 (unpubl.).

APPENDIX

CLASSIFICATION OF 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 reoccupation 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 reoccupation 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 1

SUMMARY OF WORK CARRIED OUT AT STATIONS

Station	Date 1969	No. of hours	No. of control observations	Remarks
Honiara	19-21/4	53	9	New station on Henderson airfield.
Aropa	24-26/4	70	6	New site on Aropa airfield very disturbed. Old site in Aropa plantation reoccupied. Whole area anomalous.
Rabaul	29/4-1/5	51	8	New site on airfield very disturbed. Old site in Centennial Park reoccupied. Whole area anomalous.
Wewak	3-5/5	68	7	New site on airfield occupied. Old site in District Commissioner's residence reoccupied.
Vanimo	7-9/5	52	6	New station on airfield near ionospheric installation.
Wabag	10-13/5	69	6	Old site near seismic hut end of airstrip reoccupied.
Lae	15-18/5	66	8	New site on airfield occupied. Old airfield site reoccupied.
Momote	19-21/5	63	5	New site on airfield occupied. Old site at Lugos mission reoccupied.
Daru	26-28/5	68	8	New site on airfield occupied. Old site just outside airfield reoccupied.
Gurney	31/5-3/6	0	6	Fluxgate instrument failure. New site at Gurney airfield occupied. Old site at Samarai reoccupied. Samarai area anomalous.

TABLE 2

ADOPTED SCALE VALUES

Station	H gammas/div	D gammas/div.	D mins/div.	Z gammas/div.
Honiara	5.16	5.33	0.51	4.98
Aropa	5.73	5.81	0.56	XXX
Rabaul	6.39	5.84	0.54	5.16
Wewak	5.01	5.37	0.50	5.05
Vanimo	5.02	5.38	0.50	4.99
Wabag	4.84	5.31	0.49	4.93
Lae	5.02	5.33	0.49	4.97
Momote	5.01	5.35	0.50	4.99
Daru	5.32	5.31	0.50	5.02
Gurney	XXX	XXX	XXX	XXX
SD of scale values from adopted values	±0.09	±0.02	±0.01	±0.02

1 div. = 1 mm in centre of recording chart

XXX indicates no variograph record available.

TABLE 3

ADOPTED BASELINE VALUES

Station	H gammas		D ° '	Z gammas
Honiara	35820-35877		8 56.0	20651
Aropa B	35333	to	5 27.8 5 29.9	XXX
Rabaul E	37467		6 58.5	14322-14338
Wewak D	37262	to	4 45.6 4 45.0	15616
Vanimo	37289	to	4 19.3 4 20.7	14496
Wabag	36884		5 01.9	18033
Lae B	36713		5 58.6	19355
Momote	37007		5 04.4	1860
Daru C	36500		5 17.6	23450
Gurney	36043*		6 33.2*	23854*
SD of observed values from adopted values	± 3		± 0.4	± 6

* values adopted using Port Moresby magnetograms

XXX indicates no control observations available.

TABLE 4

MEAN VALUES OF H, D, AND Z

Station	Lat. S. ° '	Long. E. ° '	Date 1969	D ° '	H gammas	Z gammas
Honiara	9 25.4	160 02.8	20/4	8 56.8	35819	20648
Aropa B	6 20.5	155 43.7	24/4	5 26.6	35294	18341**
Rabaul E	4 13.5	152 11.1	29/4	6 56.9	37459	14337
Wewak D	3 35.2	143 40.1	3/5	4 41.9	37228	15602
Vanimo	2 41.9	141 18.3	8/5	4 16.6	37242	14510
Wabag	5 29.5	163 43.6	11/5	5 01.2	36883	18053
Lae B	6 43.7	147 00.1	17/5	6 00.8	36761	19390
Momote	2 04.0	147 25.4	20/5	5 04.6	37017	1876
Daru C	9 05.2	143 12.3	27/5	5 17.5	36484	23471
Gurney	10 18.7	150 20.3	31/5	6 42.7*	36130*	23912*

* values determined using Port Moresby magnetograms
** estimated value only
*** declination easterly

TABLE 5

CORRECTIONS TO BE APPLIED TO SUBSIDIARY SITE OBSERVATIONS

Station	Lat. S. °	'	Long. E. °	'	Date 1969	D °	'	H gammas	Z gammas
Aropa A	6	19.2	155	43.2	24/4	-2	25.4	-718	+974**
Rabaul D	4	12.2	152	11.0	29/4	+2	17.2	+839	XXX
Wewak C	3	33.0	143	38.0	3/5	-	3.7	+ 10	- 26
Lae A	6	43.9	147	00.3	17/5	+	1.8	+ 52	XXX
Lugos	2	00.0	147	17.2	20/5	-	11.1	+ 60	+ 87
Daru B	9	05.1	143	12.4	27/5	-	1.0	+ 2	+ 40
Samarai F	10	35.0	150	36.0	31/5	-2	49.7*	-1018*	XXX

TABLE 6

MEAN VALUES OF H, D, AND Z AT SUBSIDIARY SITES

Station	Lat. S. °	'	Long. E. °	'	Date 1969	D easterly °	'	H gammas	Z gammas
Aropa A	6	19.2	155	43.2	24/4	7	52.0	36014	17367**
Rabaul D	4	12.2	152	11.0	29/4	4	39.7	36620	XXX
Wewak C	3	33.0	143	38.0	3/5	4	45.6	37218	15628
Lae A	6	43.9	147	00.3	17/5	5	59.0	36709	XXX
Lugos	2	00.0	147	17.2	20/5	5	15.7	36957	12789
Daru B	9	05.1	143	12.4	27/5	5	18.5	36482	23431
Samarai F	10	35.0	150	36.0	31/5	9	32.4*	37148*	XXX

XXX no control observation available
* values determined using Port Moresby magnetograms
** estimated value only

TABLE 7

MAGNETIC DISTURBANCE PARAMETERS

Station	Date 1969	K-index Sum (Port Moresby)	C-index (Port Moresby)	Reported magnetic phenomena (Port Moresby) UT	
Honiara	20/4	12	0	-	
Aropa	24/4	16	0	-	
Rabaul	29/4	21	1	28/4/69	02.51 storm ssc
Wewak	3/5	20	1	2/5/69	13.22 ssc
				"	18.11 si
Vanimo	8/5	11	0	-	
Wabag	11/5	8	0	-	
Lae	17/5	18	0	14/5/69	15.19 bp
				"	19.29 storm ssc
Momote	20/5	10	0	-	
Daru	27/5	10	0	-	
Gurney	31/5	18	0	30/5/69	16.09 bp

TABLE 8

DISTORTION OF H, D, AND Z AT PORT MORESBY

Station	Date 1969	dH gammas	dD minutes	dZ gammas
Honiara	20/4	1	-0.2	-2
Aropa	24/4	-10	0.2	2
Rabaul	29/4	32	-0.1	-1
Wewak	3/5	21	0.2	2
Vanimo	8/5	1	-0.2	5
Wabag	11/5	-2	-0.2	3
Lae	17/5	50	0.0	-4
Momote	20/5	17	-0.6	2
Daru	27/5	-5	0.1	-2
Gurney	31/5	16	-0.1	-4

d = (Numerical Monthly Mean for 5 Quiet Days) - (Numerical Daily Mean)

PLATE I

Direction Island
West Island
Christmas Island
Darwin
Yirrkala Mission
Weipa Mission
Wyndham
Derby
Daly Waters
Halls Creek
Cooktown
Willis Island
Croydon
Ingham
Wonarah
Port Hedland
Swindells
The Granites
Onslow
Mackay
Winton
Boulia
Alice Springs
Alpha
Mt Vernon
Carnarvon
Carnegie HS.
Giles
Ayers Rock
Birdsville
Quilpie
Roma
Maryborough
Cue
Oodnadatta
Geraldton
Laverton
Neale Junction
Emu
Etadunna
Tibooburra
Bourke
Moree
Grafton
Southern Cross
Zanthus
Eucla
Ceduna
Woomera
Wilcannia
Gnangara
Condoblin
Newcastle
Alexandra Bridge
Esperance
Albany
Port Lincoln
Parafield
Mildura
Canberra
Warracknabeal
Toolangi
Portland
Cambridge
Vanimo
Wewak
Wabag
Mamote
Rabaul
Lae
Daru
Port Moresby
Gurney
Arapa
Honiara
Nauru
Ocean Island
Lord Howe Island
Norfolk Island

MERCATOR PROJECTION
KILOMETRES
200 100 0 100 200 300 400 500 600 700 800

STATIONS OCCUPIED DURING APRIL – JUNE 1969

FIRST-ORDER REGIONAL MAGNETIC NETWORK

RADIUS OF CIRCLES = 250 km

TO ACCOMPANY RECORD NO 1971/26

(Based on G20-14)(G96-425)

G96-426

FLUXGATE VARIOGRAPH EQUIPMENT

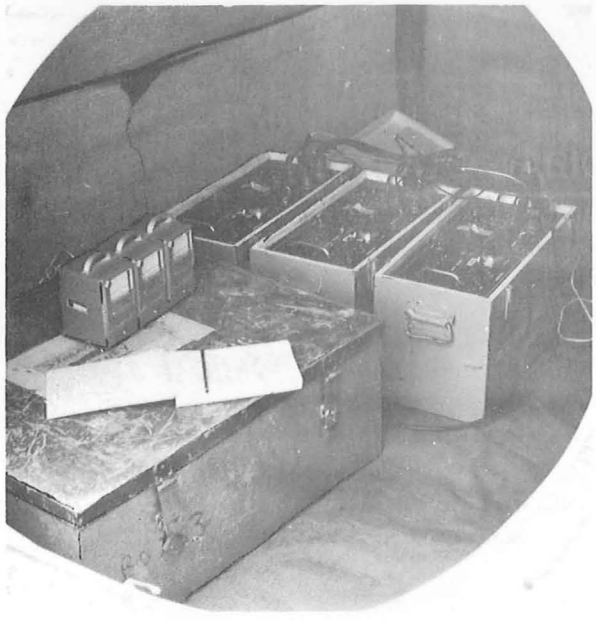
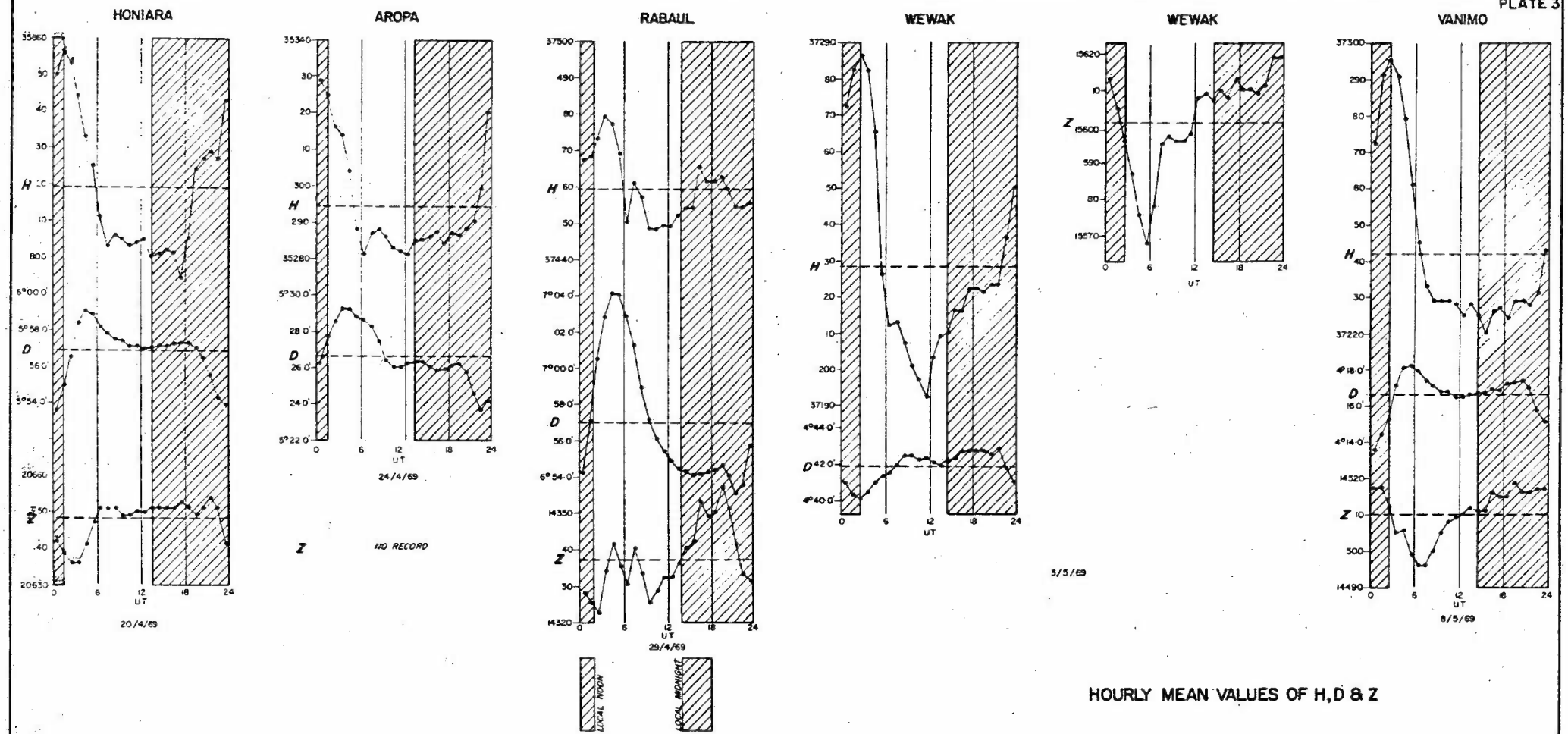


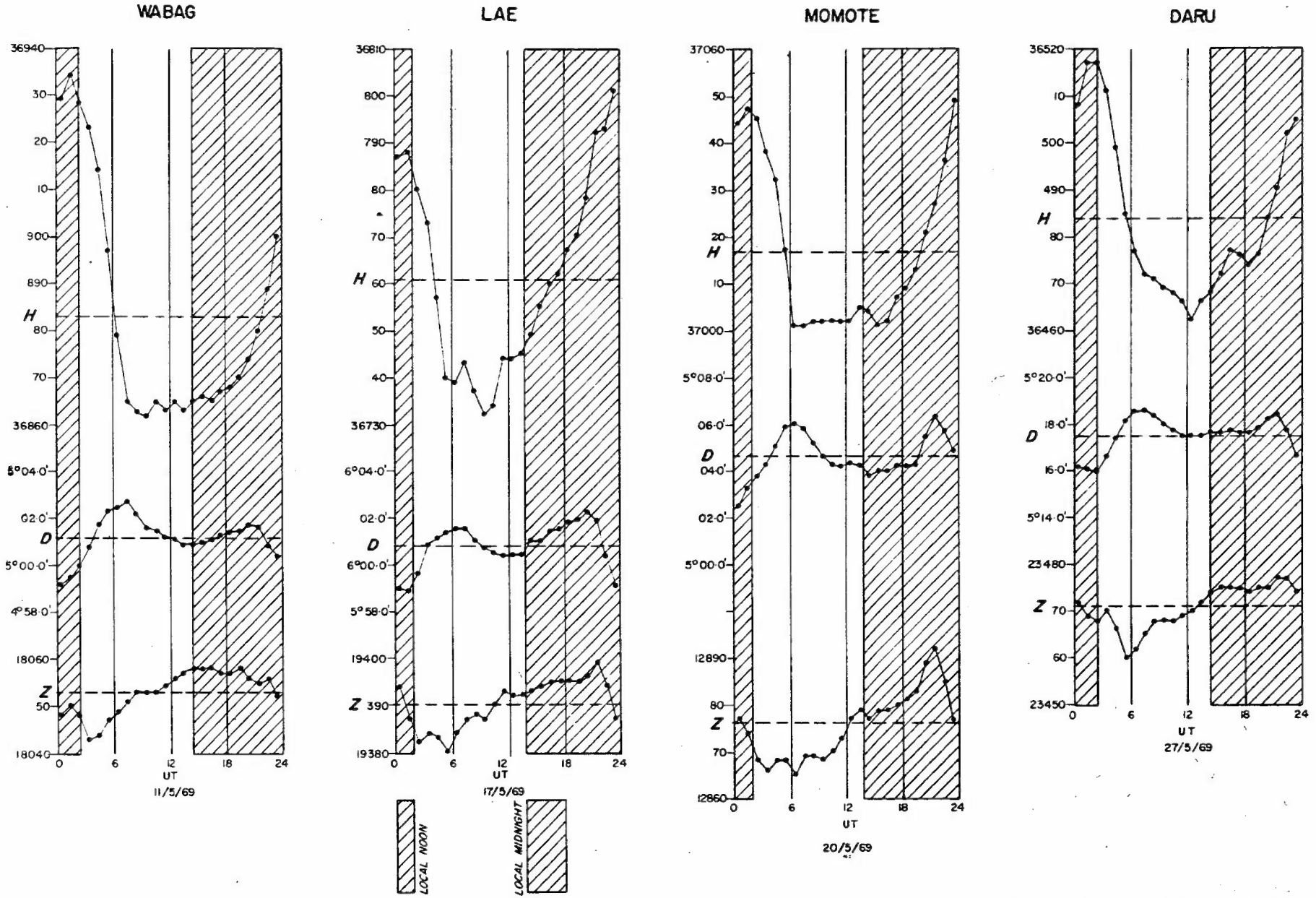
PLATE 3



HOURLY MEAN VALUES OF H, D & Z

G96-423

PLATE 4



HOURLY MEAN VALUES OF H, D & Z

TO ACCOMPANY RECORD NO 1971/26

G96—424