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SERIES C

VOLUME I

**TERRESTRIAL
MAGNETISM**

**Magnetic Observations at Heard,
Kerguelen and Macquarie Islands,
1947-1951**

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PREFATORY NOTE

The geomagnetic work of the Australian National Antarctic Research Expedition is planned and carried out by officers of the Bureau of Mineral Resources, Geology and Geophysics of the Ministry of National Development. This report has been compiled from individual reports submitted by these officers on their return to Australia and presents an account of their work during the period December 1947 to April 1951. A report on part of this work from which sections of the present report have been extracted, has already been published (Chamberlain 1952).

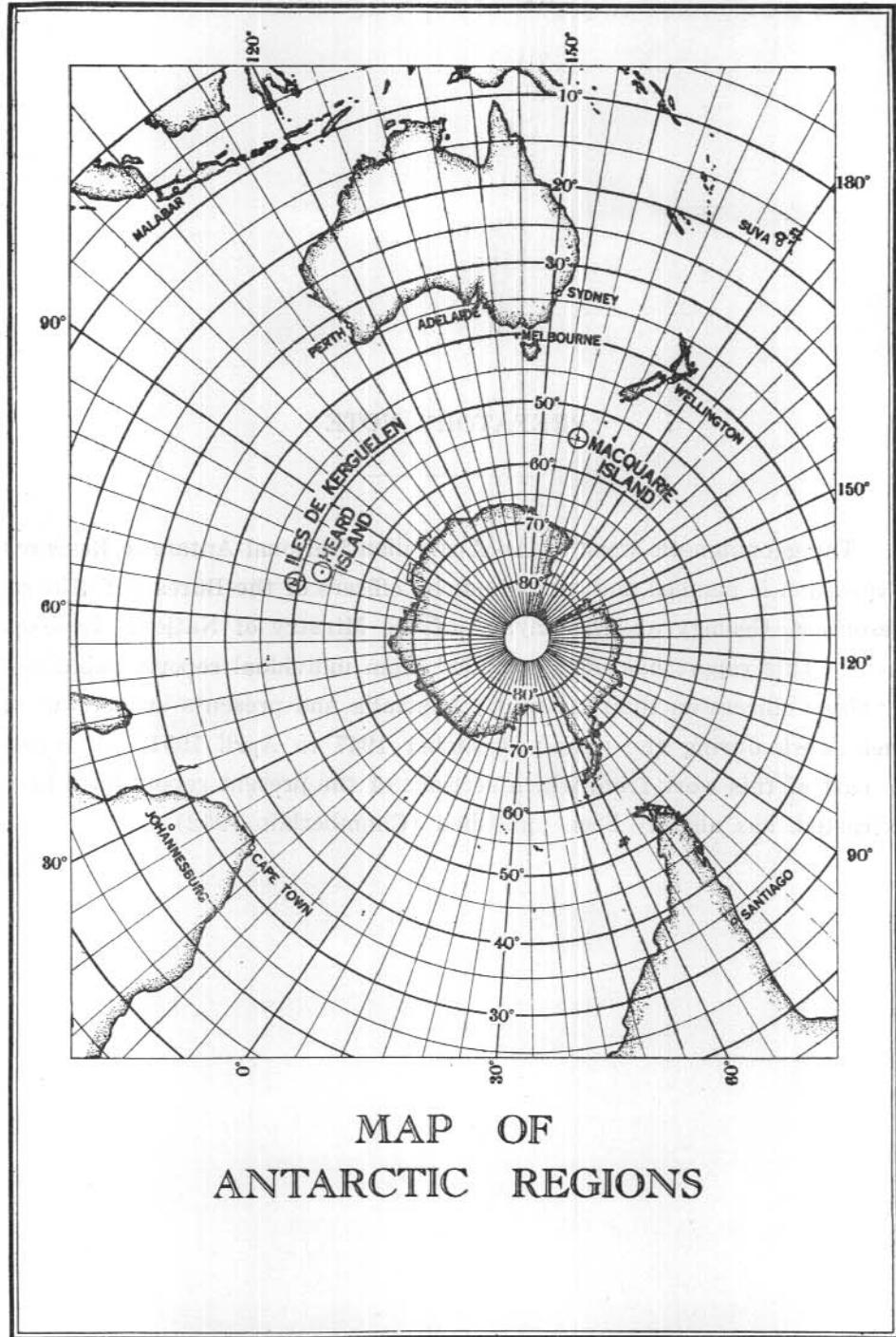


FIG. 1

INTRODUCTION

Terrestrial magnetic observations at Iles de Kerguelen and Macquarie Island (Fig. 1) have been made in the past by the following expeditions:—

Deutsche Südpolar Expedition (1901-03) — Iles de Kerguelen c.f. Luyken (1924).

Australasian Antarctic Expedition (1911-14) — Macquarie Island c.f. Webb (1925).

British Australian New Zealand Antarctic Research Expedition (1929-1931) — Iles de Kerguelen and Macquarie Island. c.f. Farr (1944).

The establishment in 1947-48 of permanent research stations at Heard Island and Macquarie Island by the Australian National Antarctic Research Expedition has enabled more frequent observations to be made. Where possible the magnetic stations of previous expeditions have been reoccupied. At Heard Island where no previous magnetic observations have been made a site has been selected about $1\frac{1}{2}$ miles from the main A.N.A.R.E. Station. At Iles de Kerguelen the station of the Deutsche Südpolar Expedition has not been reoccupied but observations have been made at a point corresponding as closely as could be ascertained to Station 2 of the B.A.N.Z.A.R. Expedition. At Macquarie Island observations have been made at Station A of the A.A. Expedition which was subsequently reoccupied by the B.A.N.Z.A.R. Expedition.

Throughout this paper East declination and North inclination are counted positive.

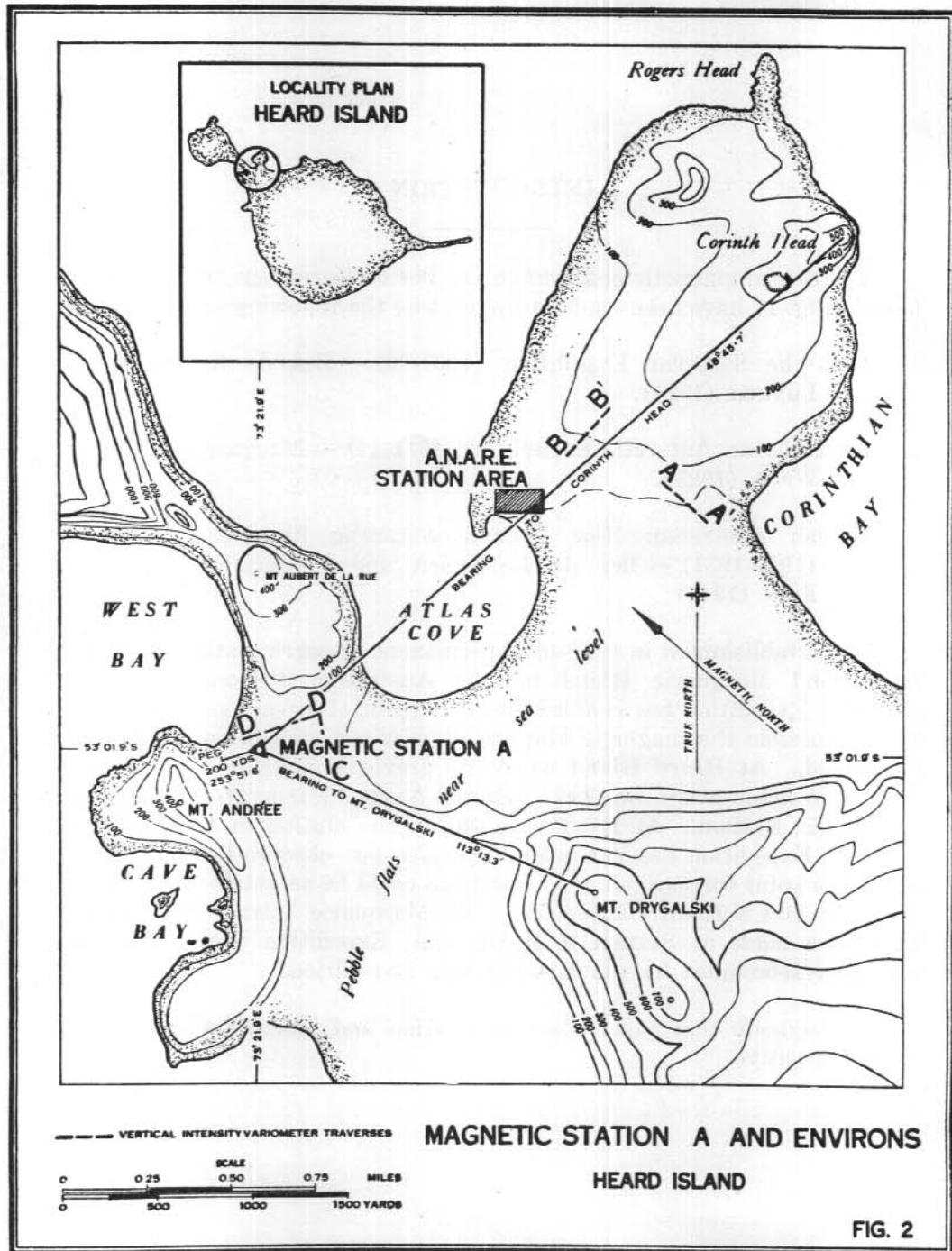


FIG. 2

MAGNETIC OBSERVATIONS — HEARD ISLAND

Variometer Survey. In December 1947 a series of vertical intensity variometer readings was made in the Atlas Cove area at 100 ft. intervals along the traverses A-A', B-B', D-C and D-D' shown in Fig. 2. Profiles of the vertical intensity along these traverses are given in Figure 3.

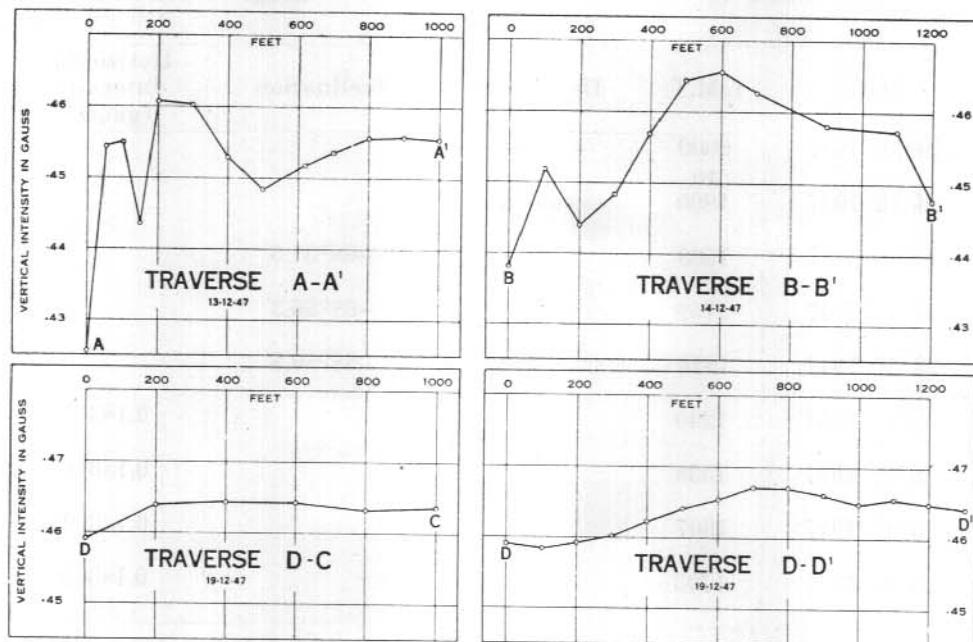


FIG. 3
Profiles of Vertical Intensity in the Atlas Cove area, Heard Island.
Observer: N. G. Chamberlain.

The instrument used for the measurements was Watts Vertical Intensity Variometer No. 15977. The profiles along A-A' and B-B' indicate intense local anomalies apparently associated with the basalt flows of the Corinth Head promontory. The profiles along D-D' and D-C show smaller anomalies associated with the predominantly trachytic nature of the rock in the vicinity but the vertical intensity gradient is still considerable.

Absolute Observations. The position of the site selected for absolute observations at Heard Island is shown in Fig 2 (designated Station A); it was marked by a brass plate 3 inches in diameter set in a concrete pillar left flush with the ground.

Observations were made at this Station in December 1947 and February 1950. The results are given in Tables 1 and 2 and Figures 4 and 5.

MAGNETIC OBSERVATIONS AT HEARD,

TABLE 1.

Terrestrial Magnetic Observations—Heard I., Station A.

Observer: N. G. Chamberlain.

Lat. $53^{\circ}01.9'$ S.Long. $73^{\circ}21.9'$ E.

Date	L.M.T.	Declination	Inclination	Horizontal Intensity (gauss)
24 12 1947	0000 to 1800	-48°43.5' (mean)		
23 12 1947	1509		-68°37.5'	
23 12 1947	1759		-68°36.3'	
23 12 1947	1816		-68°36.8'	
23 12 1947	1240			0.18361
23 12 1947	1338			0.18348
23 12 1947	1607			0.18349
23 12 1947	1703			0.18382

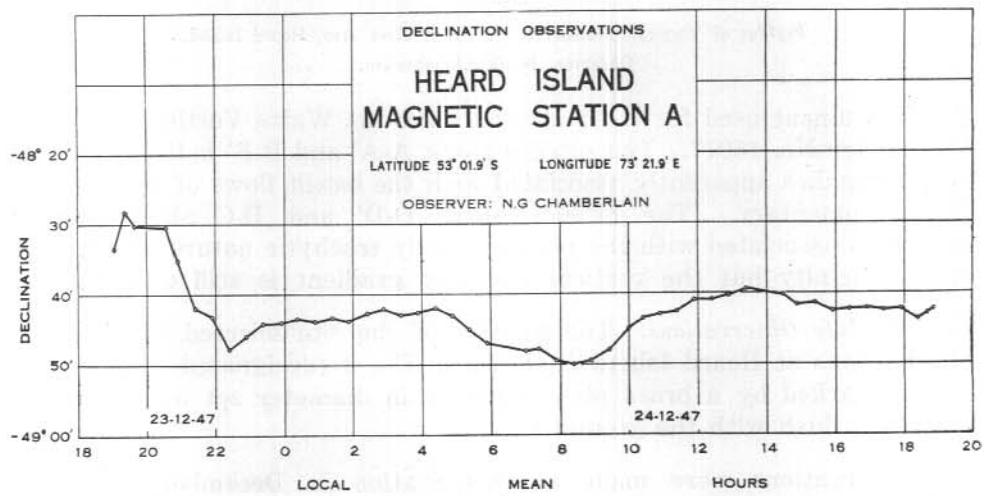


FIG. 4

TABLE 2.

Terrestrial Magnetic Observation—Heard I., Station A.

Observers: G. F. Schaeffler and H. Doyle.

Lat. $53^{\circ}01.9'$ S.Long. $73^{\circ}21.9'$ E.

Date	L.M.T.	Declination	Inclination	Horizontal Intensity (gauss)
22 2 1950	1027 to 1109	-49°20.0' (mean)		
15 2 1950	1646		-68°40.0'	
20 2 1950	0913		-68°35.3'	
20 2 1950	1534		-68°39.7'	
20 2 1950	1028			0.18412
20 2 1950	2020			0.18416

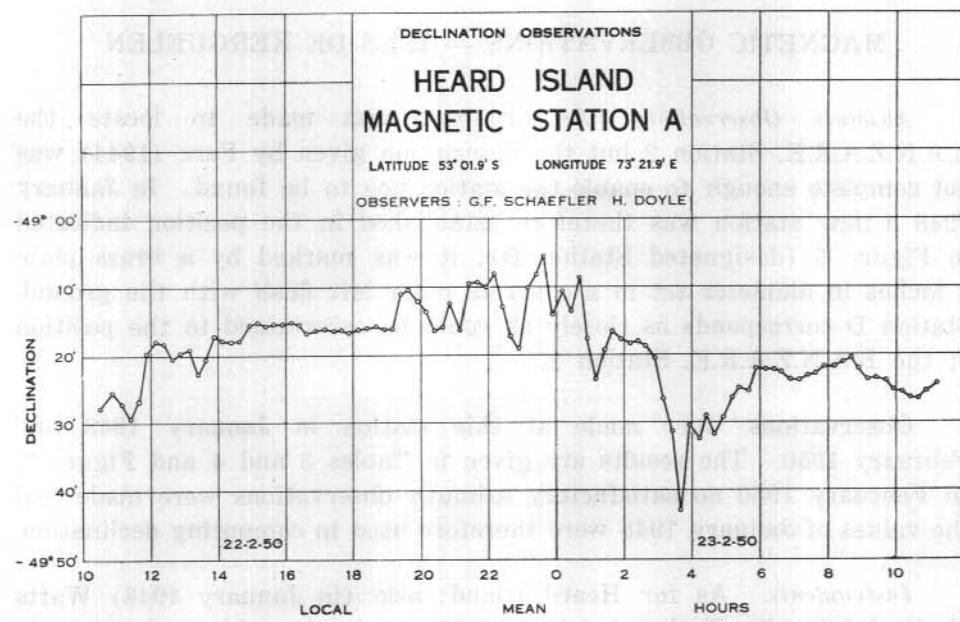


FIG. 5

Instruments.

Theodolite — Magnetometer C.I.W. No. 18

Earth Inductor C.I.W. No. 18

Marine Type Chronometer Brockbank and Atkins No. 1437.

Results of the observations have been reduced to International Magnetic Standard using the corrections of 1 September 1945 which were based on intercomparisons made at Watheroo Magnetic Observatory.

The mean value of declination given in Table 1 is that of the apparently undisturbed portion of the graph, Fig. 4, between 00h and 18h on 24 December 1947. It is evident that a magnetic disturbance was in progress during the first three hours of the declination observations. An examination of the Watheroo and Toolangi magnetograms for 23 and 24 December 1947 shows a "sudden commencement" at both observatories on 23 December 1947 at 16h 17m Heard Island L.M.T., the disturbance following being slight and lasting 4 to 5 hours. The "sudden commencement" occurred during the third H determination and accounts for the high value in the fourth determination.

MAGNETIC OBSERVATIONS — ILES DE KERGUELEN

Absolute Observations. An attempt was made to locate the B.A.N.Z.A.R.E. Station 2 but the description given by Farr (1944) was not complete enough to enable the station peg to be found. In January 1948 a new station was therefore established in the position indicated in Figure 6 (designated Station D); it was marked by a brass plate 3 inches in diameter set in a concrete pillar left flush with the ground. Station D corresponds as closely as could be ascertained to the position of the B.A.N.Z.A.R.E. Station 2.

Observations were made at this station in January 1948 and February 1950. The results are given in Tables 3 and 4 and Figure 7. In February 1950 no satisfactory azimuth observations were made and the values of January 1948 were therefore used in computing declination.

Instruments. As for Heard Island; also (in January 1948) Watts Vertical Intensity Variometer No. 15977 previously calibrated to enable absolute observations to be made.

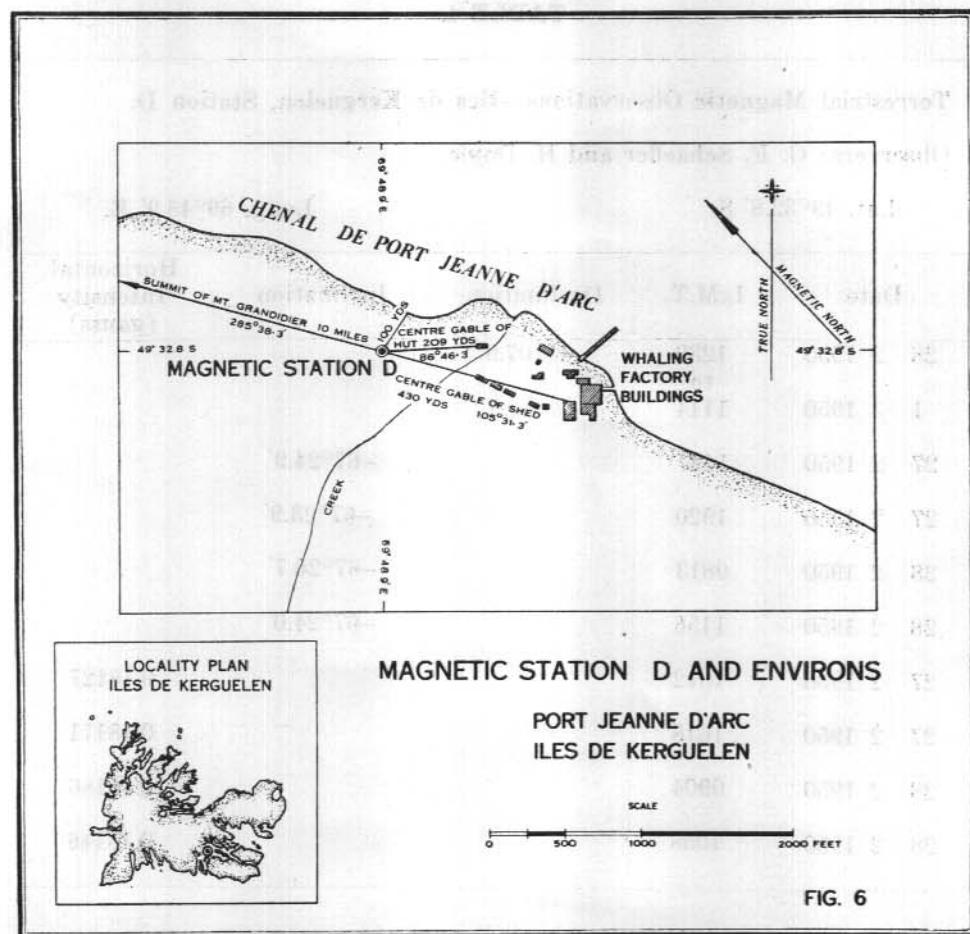


TABLE 3.

Terrestrial Magnetic Observations—Iles de Kerguelen, Station D.

Observer: N. G. Chamberlain.

Lat. $49^{\circ}32.8'$ S.Long. $69^{\circ}48.9'$ E.

Date	L.M.T.	Declination	Inclination	Vertical Intensity (gauss)
1 1 1948	1134	$-47^{\circ}40.6'$		
1 1 1948	1147	$-47^{\circ}40.0'$		
1 1 1948	1034		$-67^{\circ}19.4'$	
31 12 1947	1440			0.433

TABLE 4.

Terrestrial Magnetic Observations—Iles de Kerguelen, Station D.

Observers: G. F. Schaeffler and H. Doyle.

Lat. $49^{\circ}32.8'$ S.Long. $69^{\circ}48.9'$ E.

Date	L.M.T.	Declination	Inclination	Horizontal Intensity (gauss)
28 2 1950	1230 to 1114	-48°07.9' (mean)		
27 2 1950	1437		-67°24.9'	
27 2 1950	1920		-67°23.9'	
28 2 1950	0813		-67°20.7'	
28 2 1950	1156		-67°24.0'	
27 2 1950	1812			0.18127
27 2 1950	1618			0.18171
28 2 1950	0904			0.18186
28 2 1950	1058			0.18146

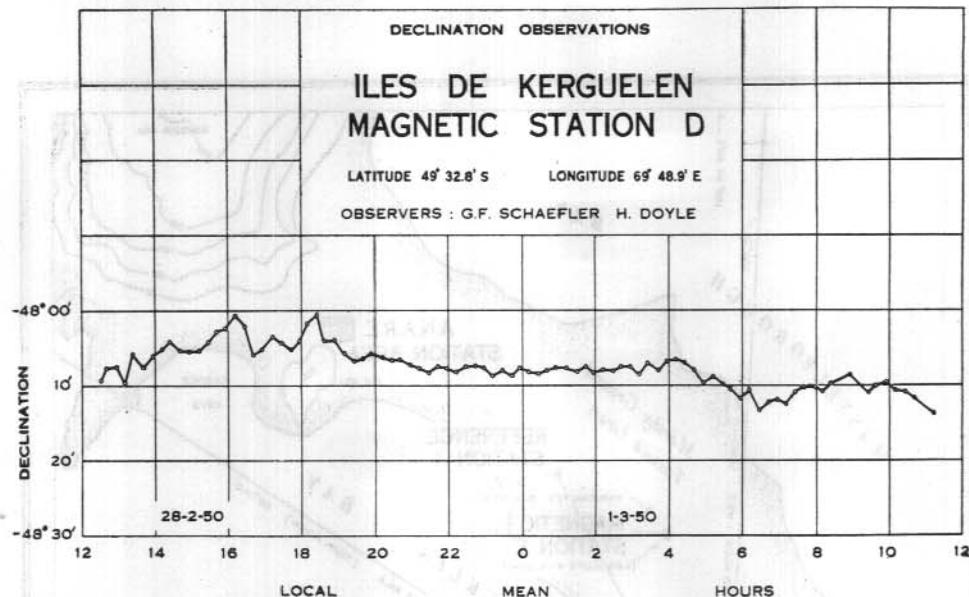


FIG. 7

MAGNETIC OBSERVATIONS — MACQUARIE ISLAND

Absolute Observations — Station A. In March 1948 the station peg of the B.A.N.Z.A.R.E. (1929-1931) was located. This was replaced by a brass plate 3 inches in diameter set in a concrete pillar left flush with the ground. This station was considered by Farr (1944) to be within 2 feet of Station A of the A.A.E. (1911-14). Its location is shown in Figure 8.

Observations were made at this station in March 1948 and April 1950. The results are given in Tables 5 and 6 and Figures 9 and 10. Azimuth observations by R. Dovers, A.N.A.R.E. Surveyor, were used in computing declination.

Instruments. As for Heard Island.

Establishment of Magnetic Observatory. With the view of selecting a site for a permanent magnetic observatory at Macquarie Island a vertical intensity variometer survey was carried out in April 1949. After considering the accessibility from the central part of the A.N.A.R.E. Station and convenience of the region for erection of buildings the survey was restricted to the Isthmus area S.W. of the A.N.A.R.E. Station and another section S.W. of Magnetic Station A.

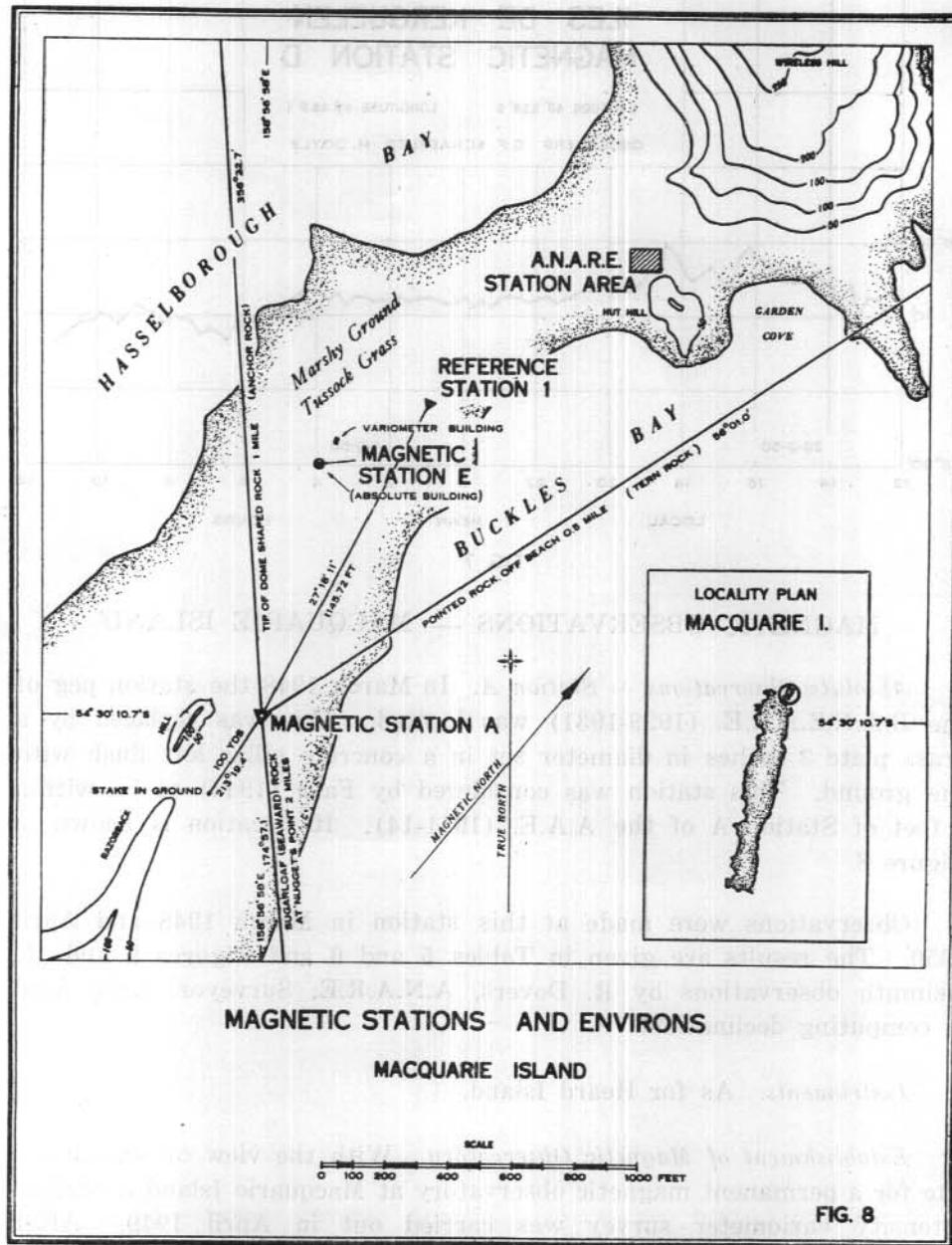


TABLE 5.

Terrestrial Magnetic Observations—Macquarie I., Station A.

Observer: N. G. Chamberlain.

Lat. $54^{\circ}30.2'$ S.Long. $158^{\circ}57.0'$ E.

Date	L.M.T.	Declination	Inclination	Horizontal Intensity (gauss)
18 3 1948	1826 to 1744	+23°26.7' (mean)	-78°14.7'	
18 3 1948	0849		-78°15.7'	
18 3 1948	1215		-78°15.2'	
18 3 1948	1302		-78°13.9'	
18 3 1948	1636			
18 3 1948	1001			0.13430
18 3 1948	1113			0.13434
18 3 1948	1347			0.13464
18 3 1948	1525			0.13465
18 3 1948	1722			0.13465

The results of this survey are shown in Figure 11 which gives the departures in gamma of the vertical intensity from the values at Reference Station 1* in the case of the Isthmus area and from Magnetic Station A in the case of the area S.W. of Magnetic Station A. The instrument used for the measurements was Watts Vertical Intensity Variometer No. 15977.

* Reference Station 1 was established primarily as a reference point for azimuth determinations; its position is marked by a brass plate in a square section concrete block set in the ground.

TABLE 6.

Terrestrial Magnetic Observations—Macquarie I., Station A.

Observers: G. F. Schaefer and H. Doyle.

Lat. $54^{\circ}30.2'$ S.

Long. $158^{\circ}57.0'$ E.

Date	L.M.T.	Declination	Inclination	Horizontal Intensity (gauss)
18 4 1950	1324 to 1235	+ $23^{\circ}58.0'$ (mean)		
14 4 1950	1443		- $78^{\circ}16.6'$	
15 4 1950	1055		- $78^{\circ}16.1'$	
15 4 1950	1543		- $78^{\circ}10.1'$	
14 4 1950	1625			0.13458
15 4 1950	1117			0.13410
15 4 1950	1255			0.13433

The magnetic observatory buildings were erected during 1950; their positions are shown in Fig. 8. Both the absolute building and the variometer building are of entirely non-magnetic construction, the walls, floors and roofs being fabricated from 2 inches thick sheets of "onozote" faced with bondwood.

The rock in the vicinity of the observatory is a basic lava which forms the whole of the Isthmus. The island as a whole is dominantly composed of basic igneous rocks — gabbro, serpentine, trachylite and palagomite. c.f. Mawson (1943).

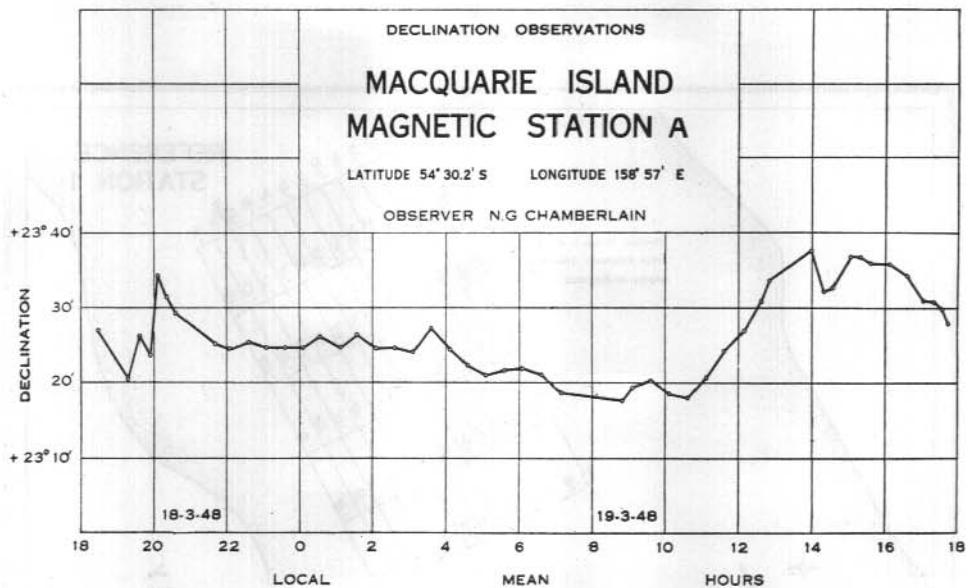


FIG. 9

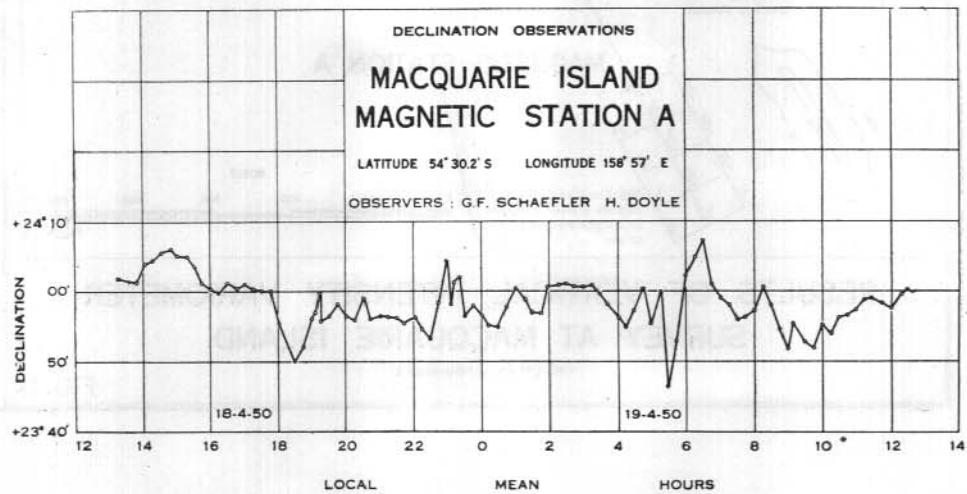
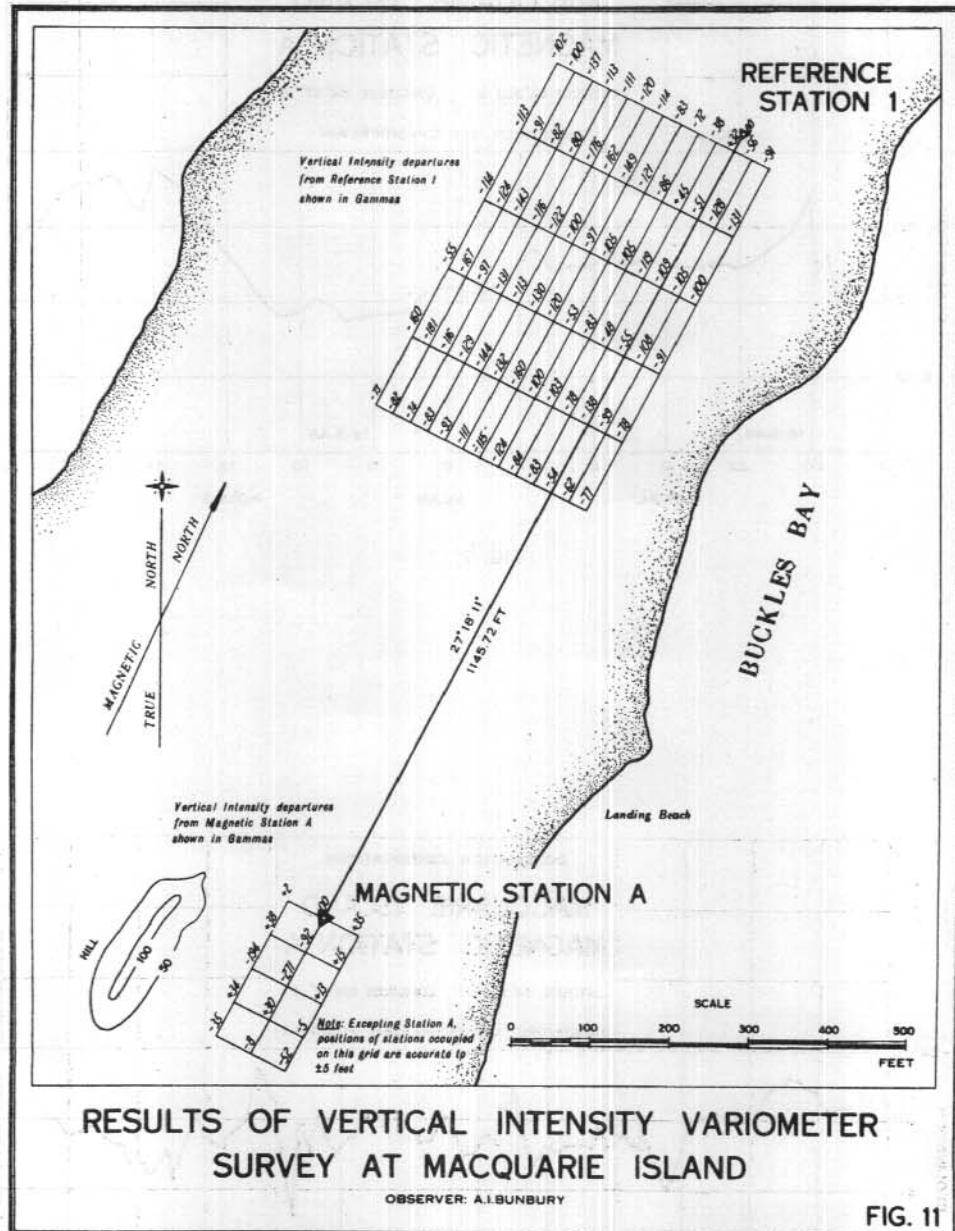


FIG. 10



Absolute Observations — Station E. Absolute observations in the observatory absolute building were commenced at Station E in July 1950. The instruments were mounted on a tripod the legs of which passed through holes in the floor and rested on wooden pegs set in a concrete block. The position of Station E in the absolute building is indicated in Fig. 12.

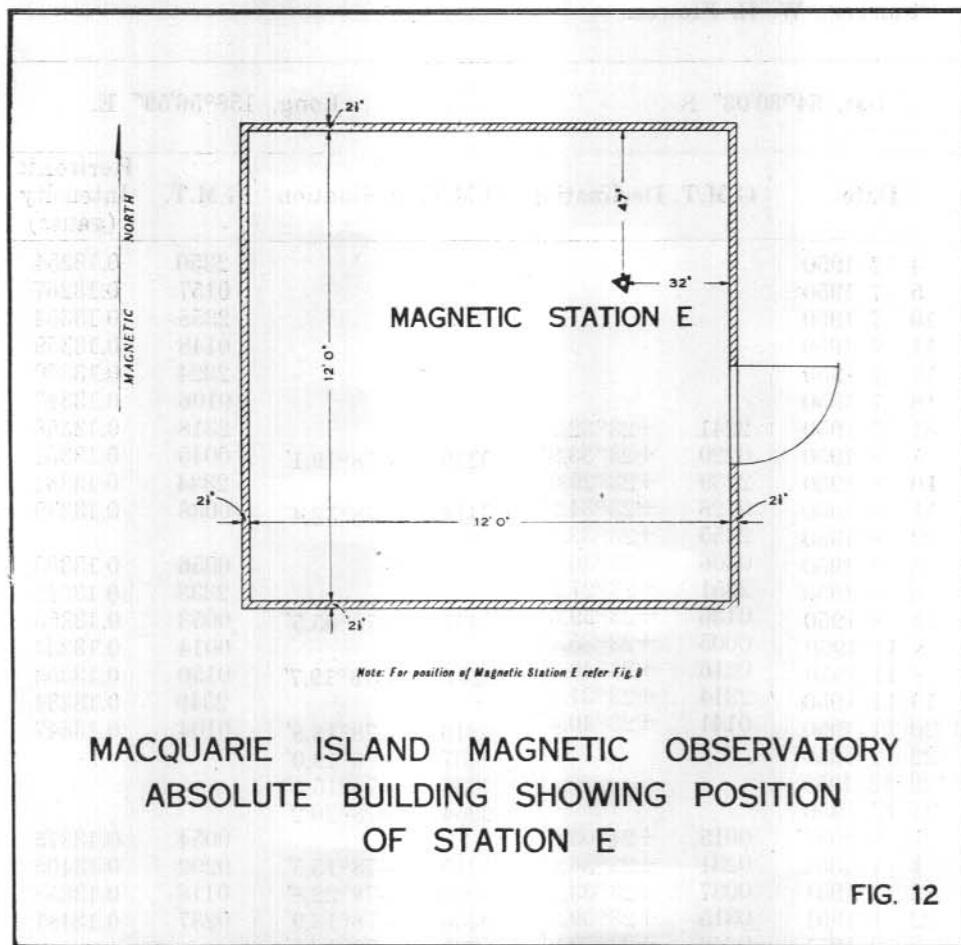


FIG. 12

Results of the observations over the period July 1950 to April 1951 are presented in Tables 7 and 8. The values of H given in Table 8 were determined from oscillations only, assuming a value for the moment of the oscillating magnet.

Instruments. Kew Magnetometer No. 158 (Dover, Charlton and Kent; on loan from U.S. Navy Hydrographic Office).

Dip Circle No. 125 (on loan from U.S. Navy Hydrographic Office).

Marine Type Chronometer.

TABLE 7.

Terrestrial Magnetic Observations—Macquarie Island, Station E.

Observer: W. R. Flower.

Lat. $54^{\circ}30'03''$ S.			Long. $158^{\circ}56'59''$ E.		
Date	G.M.T. Declination	G.M.T. Inclination	G.M.T.	Horizontal Intensity (gauss)	
4 7 1950			2350	0.13254	
5 7 1950			0157	0.13267	
10 7 1950			2358	0.13354	
11 7 1950			0148	0.13359	
17 7 1950			2324	0.13360	
18 7 1950			0106	0.13347	
31 7 1950	2241	+23°32.2'	2318	0.13358	
1 8 1950	0220	+23°33.9'	0045	0.13361	
10 8 1950	2239	+23°29.0'	2334	0.13361	
11 8 1950	0128	+23°34.2'	0038	0.13339	
22 8 1950	2355	+23°33.1'			
23 8 1950	0306	+23°36.8'	0056	0.13333	
28 8 1950	2251	+23°27.2'	2333	0.13345	
29 8 1950	0136	+23°39.6'	0053	0.13355	
8 11 1950	0005	+23°35.4'	0014	0.13334	
8 11 1950	0216	+23°40.2'	0150	0.13353	
19 11 1950	2314	+23°31.1'	2349	0.13334	
20 11 1950	0141	+23°40.4'	0216	0.13347	
22 12 1950			0037	-78°19.0'	
22 12 1950			0336	-78°15.4'	
31 12 1950			2254	-78°20.2'	
1 1 1951	0015	+24°03.9'			
1 1 1951	0231	+23°56.6'	0319	-78°15.5'	
22 1 1951	0037	+23°33.4'	0020	-78°22.8'	
22 1 1951	0315	+23°39.5'	0336	-78°13.9'	
3 2 1951	0242	+23°39.2'	0225	-78°16.8'	
3 2 1951	0527	+23°39.4'	0545	-78°22.5'	
16 2 1951	0027	+23°39.7'	0532	-78°19.2'	
16 2 1951	0243	+23°43.3'			
28 2 1951			2356	-78°21.9'	
1 3 1951	0011	+23°38.1'			
1 3 1951	0203	+23°38.8'	0251	-78°15.4'	
16 3 1951	0320	+23°44.5'	0303	-78°16.8'	
16 3 1951	0619	+23°47.5'	0638	-78°16.5'	
12 4 1951	0103	+23°58.3'	0031	-78°19.6'	
12 4 1951	0253	+23°44.3'	0317	-78°20.4'	
24 4 1951	0043	+23°40.3'	0018	-78°19.7'	
24 4 1951	0226	+23°44.7'	0245	-78°20.4'	

TABLE 8.

Terrestrial Magnetic Observations, Macquarie I., Station E.

Observer: W. R. Flower.

Lat. $54^{\circ}30'03''$ S.Long. $158^{\circ}56'59''$ E.

Date	G.M.T.	Horizontal Intensity (gauss)
16 10 1950	0000	0.13255
28 11 1950	0328	0.13477
13 12 1950	0050	0.13501
27 12 1950	0719	0.13433
1 5 1951	0043	0.13357
10 1 1951	0557	0.13410
25 1 1951	0120	0.13338
1 2 1951	2320	0.13346
9 2 1951	0553	0.13468
21 2 1951	0604	0.13413
25 2 1951	2354	0.13358

Variometer Observations. A recording H variometer was put into operation in the variometer building in August 1950. The instrument used was Watts Horizontal Intensity Variometer No. 61911 with photographic recording attachment: Drum speed 16 mm/hr., sensitivity 8.5 gamma/mm. Recorded hourly mean values of horizontal intensity referred to Station E are tabulated in Table 9. For the following reasons, however, these values are of limited accuracy and errors of the order of 20 gamma are probably not uncommon.

- (1) The paper dimensions were variable due to its hygroscopic nature and the high and variable humidity.
- (2) The trace was frequently broad and faint.
- (3) The instrument used is a "magnetic balance" which gives an accurate measure of the variations in H when the magnet axis is in the vertical plane. If the value of H is such as to deflect the magnet from the vertical plane the magnet experiences a couple dependent on the vertical component of the field which in this case is unknown.
- (4) The base line checks were infrequent due to the generally disturbed conditions which made it impossible to carry out frequent absolute observations with the instruments available.

Difference in Magnetic Elements between Station A and Station E. The difference in declination and horizontal intensity between Station A and Station E were determined from simultaneous observations at the two stations. The difference in vertical intensity was determined from observations made alternately at Station A and Station E with a vertical intensity variometer, corrections for change of vertical intensity with time being obtained from the magnetograms of the magnetic observatory (La Cour magnetographs were installed in the Variometer Building during 1951).

Instruments. Q H.Ms. 177 and 179.

Askania Magnetometer No. 508810.

Watts Vertical Intensity Variometer No. 15887.

Observers. R. E. Ervin and W. H. Oldham.

Date. 4/4/52 - 6/4/52.

Results. The mean differences observed were for (Station A--Station E).

Declination: 27.0 min.

Horizontal Intensity: 57 gamma.

Vertical Intensity: -51 gamma.

ACKNOWLEDGEMENTS

The writer would like to acknowledge the assistance of officers of the Bureau of Mineral Resources, Geology and Geophysics, especially Messrs. R. Ervin and L. Prior. Thanks are also due to Mr. K. Summons for preparing the Figures and Miss L. Sternberg for checking all computations and scaling.

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