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THE NORTH MAGNETIC DIP POLE

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Abstract:—A survey of the north magnetic dip-pole area was carried out in August 1962. Six field stations were occupied within a 100-mile radius of the predicted position of the dip pole. A pole position of 75.1°N and 100.8°W has been computed based on these observations for 1962.5. The 1948 position of the dip pole was recomputed to 73.9°N and 100.9°W. The predominant secular motion of the dip pole has been northward and over the past 58 years it has averaged 5 n.m. per year in this direction. Over the same period it had a westward motion of 2 n.m. per year until the last 15 years when this motion has shifted to the east.

Résumé:—On a érigé lors de travaux de levés au mois d'août 1962 dans la zone du pôle magnétique Nord six stations dans un rayon de 100 milles de la position prédite du pôle. On a établi sa position pour 1962.5 à 75.1° de latitude Nord et 100.8° de longitude Ouest en se fondant sur les observations recueillies aux stations. Un second calcul de la position du pôle en 1948 a permis de fixer sa position exacte à 73.9° de latitude Nord et 100.9° de longitude Ouest. Le déplacement séculaire prédominant du pôle s'est fait en direction Nord, et depuis 58 ans, la vitesse moyenne en cette direction a été de 5 milles nautiques par année. Au cours de la même période le pôle magnétique s'est déplacé en direction ouest à la vitesse de deux milles nautiques annuellement jusqu'à il y a 15 ans, alors que son déplacement s'est effectué en direction est.

Introduction

The first survey of the north magnetic dip pole by the Division of Geomagnetism of the Dominion Observatory took place in the summer of 1947 (Madill, 1948), and the second in August 1962. During the latter, six field stations were occupied within a 100-mile radius of the predicted pole position. A pole position for 1962.5 has been computed based on these observations.

The 1948 pole position has been recomputed based on observations made by this division in the years 1947–49. The secular and diurnal motions of the pole are commented on. An appendix is used to list the observations of Ross (1834), Amundsen's observations as published by Wasserfall (1939), and the Dominion Observatory measurements used in the calculations described above. Figure 1 shows the stations occupied by this division in the dip-pole area from 1946 to 1962, the dip-pole positions from different determinations, and the path of the unperturbed dip pole.

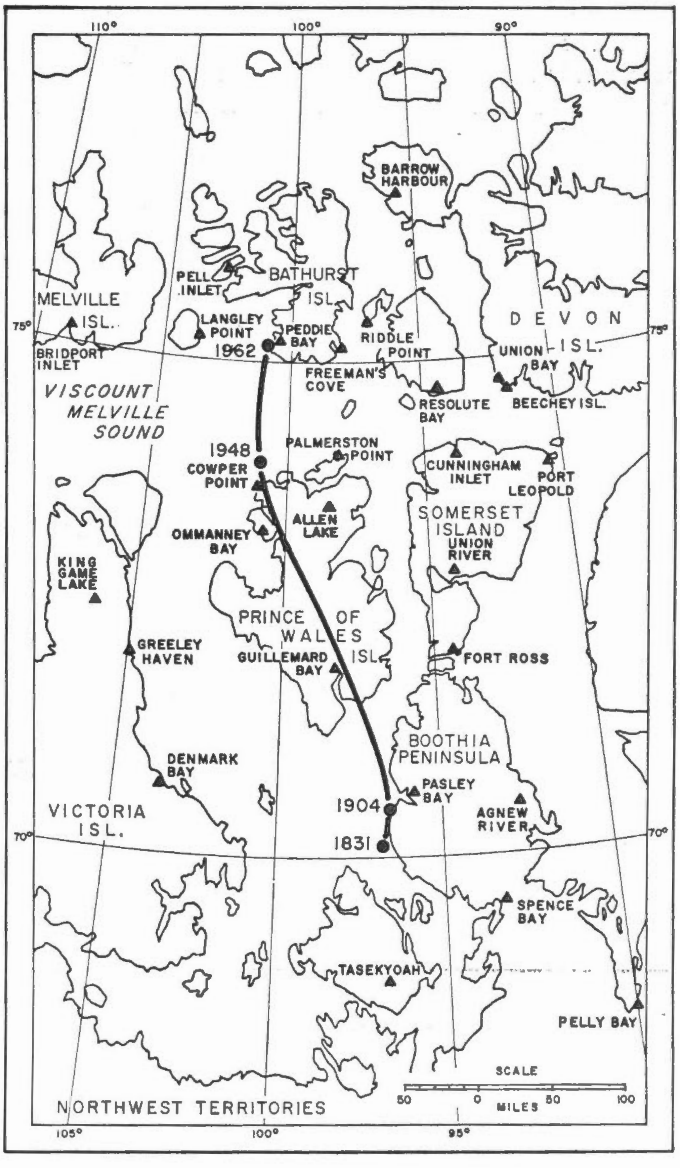

FIGURE 1

▲ Stations occupied from 1946 to 1962
● Observed magnetic dip pole positions
— Path of the unperturbed dip pole

Selection of Field Stations

From the estimated position of the dip pole in 1960 and its secular motion as deduced from the records of Resolute Bay magnetic observatory, the authors believed that the 1962 pole area was probably located at the southern end of Bathurst Island. Observations within a radius of about 100 miles of the pole and encompassing the pole area would provide an ideal basis for an accurate pole determination. Accordingly, stations were planned at Peddie Bay, Freeman's Cove and Bracebridge Inlet on Bathurst Island; at Langley Point on Byam Martin Island; on Stefansson Island, at Cowper Point on Prince of Wales Island; at Palmerston Point on Russell Island; and at Riddle Point on Little Cornwallis Island (*see* Figure 1). The stations planned at Bracebridge Inlet and on Stefansson Island were not occupied owing to ice conditions.

Field Equipment

Two portable electrical magnetometers T3, T4 of the saturable core type were used for the determination of the vector geomagnetic field. A Varian proton-precession magnetometer type M-49A, was used for the measurement of the magnitude of F, the total intensity. It was important that at each selected site the magnetic observations be representative for the area. Accordingly, the proton magnetometer was used also to check the local gradients of the magnetic field. This was done along a 300-foot line in a N-S and an E-W direction.

In the field, the fluxgate magnetometers proved reasonably reliable and rugged, but the oscillator output became unstable when temperatures dropped near the freezing mark. It was decided to use the T3, T4 instruments for measurements of declination and inclination only, and the proton magnetometer for the measurement of total intensity. The M-49A proved to be an extremely reliable magnetometer, with a probable error for a single observation in total intensity of ± 10 γ. For the T3, T4 instruments, the probable errors in the D and I measurements are estimated to be ± 6′ in D and ± 0.2′ in I at higher latitudes in a horizontal field of about 500 γ.

Astronomical Observations in the Field

At all stations the method of sun observations as described by Hazard (1957) was used to determine azimuth and longitude. The latitude was scaled from the most recent topographic maps of the area, scale 8 miles to 1 inch. The time of the observation was obtained to the nearest 0.2 seconds with a Lemania chronometer whose rate was checked daily against WWV time signal via the ship's radio.

Field Results

As previously mentioned, local gradients in total intensity were measured at each site over a 300-foot area to determine the suitability of the site. All sites picked were quite flat magnetically with no anomalies greater than 10γ within the measured area. The results shown in Table I for all stations are reduced to the mean value for the day and are given to the nearest minute in D and I, and to the nearest 10γ in F.

All these stations are within 140 miles of the Resolute Bay magnetic observatory. The August mean hourly values in X, Y, Z for Resolute Bay were compared with those for the recently established observatory at Mould Bay on the east coast of Prince Patrick Island (Figure 2). There is extremely good correlation between the two observatories particularly on a local time comparison. Hence it seemed permissible to use Resolute Bay magnetograms in the reduction of the field observations to epoch.

The observations were corrected to the mean of the year by the following steps:

1. The mean value for the day was obtained by correcting the field observations for daily variation and magnetic disturbance. The corrections for daily variation and disturbance were by far the largest corrections involved.
2. The mean value for the month was obtained by correcting the results of step 1 for post-perturbation. This was quite a small correction.
3. The mean value for the year was obtained by correcting for annual variation to convert the monthly to the yearly mean level.

Since the observations were made in August, the secular change component involved in reducing the observations to the mean of the year is quite small and

TABLE I

Magnetic Observations Reduced to Mean of the Day

Station	Date	Lat. N	Long. W	No. of Obs. each Component	Magnetic Declination	Magnetic Inclination	Total Intensity
		° ′	° ′	° ′	° ′	° ′	γ
Peddie Bay	Aug. 15	75 10	100 23	18	112 12 W	89 51 N	58040
Langley Point	Aug. 17	75 09	103 39	12	70 46 E	89 30	58150
Palmerston Point	Aug. 22	74 06	97 40	8	55 23 W	89 36	58190
Cowper Point	Aug. 24	73 41	100 43	9	44 55 E	89 40	58610
Freeman's Cove	Aug. 25	75 06	97 50	4	116 10 W	89 35	58320
Riddle Point	Aug. 25	75 21	96 50	3	106 09 W	89 22	57880

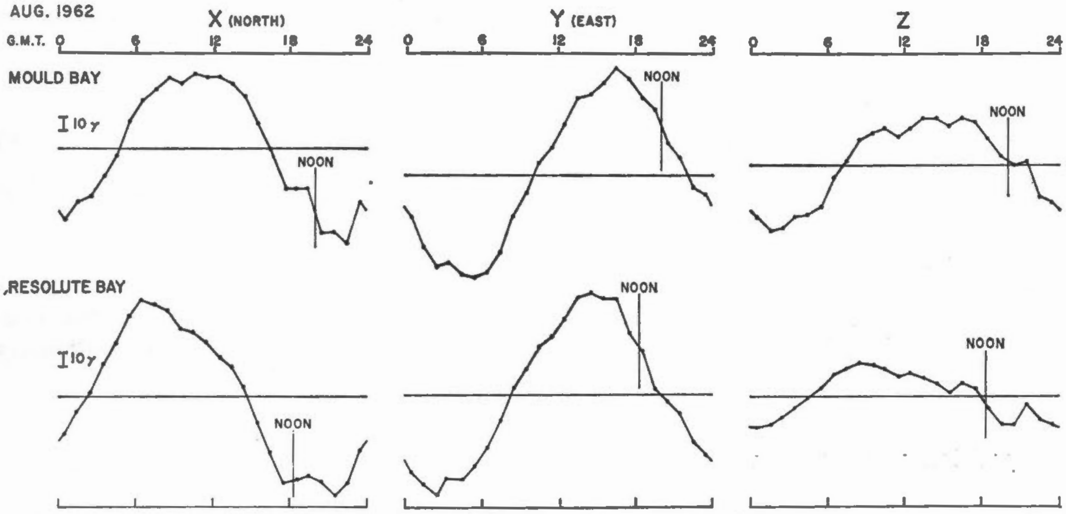

FIGURE 2.
Mean hourly values at Resolute Bay and Mould Bay magnetic observatories.

TABLE II

Magnetic Observations Reduced to Epoch 1962.5

Station	D	I	F(γ)	H(γ)	Z(γ)	X(γ)	Y(γ)
	° ′	° ′					
Peddie Bay	111 11 W	89 52 N	58040	140	58040 N	50 S	130 W
Langley Point	73 24 E	89 30	58120	500	58110	140 N	490 E
Palmerston Point	53 36 W	89 38	58170	380	58160	220 N	300 W
Cowper Point	45 24 E	89 40	58600	350	58600	250 N	250 E
Freeman's Cove	114 33 W	89 35	58310	420	58310	170 S	380 W
Riddle Point	104 32 W	89 23	57870	630	57870	160 S	610 W
Resolute Bay	82 39 W	89 11	58130	840	58120	110 N	830 W

was neglected. The corrected values of D, I, F, plus the computed values of H, the horizontal intensity, Z the vertical intensity, X and Y the north and east components of H are shown in Table II, all reduced to epoch 1962.5. The Resolute Bay observatory values are also shown.

Magnetic Dip-pole Determination

By definition, the north magnetic dip pole is the point where the earth's magnetic field is directed vertically downwards. If the field is resolved into a vertical and horizontal component, then the pole is the point where the horizontal component vanishes. It is this horizontal component that gives direction to the compass, and it may be considered as a force that is directed generally but not necessarily towards the magnetic pole. It has increasing magnitude with increasing distance from the pole.

There are various methods of determining the pole position. Several of these methods were considered and rejected. A spherical harmonic analysis is more adaptable to magnetic measurements on a world-wide basis, and is certainly not the ideal technique to apply to the small area with which this survey is concerned. The construction of magnetic meridians has the advantage of simplicity and speed in determining an approximate pole position. Its disadvantage is that it really requires a denser network of stations surrounding the pole area, than is available. By definition, at the pole H = 0; therefore X and Y, the north and east components of H respectively are also zero here. If one constructs the X and Y maps for this area, the point of intersection of the two zero contours defines the magnetic dip pole. However, these contours display a marked curvature it would be preferable to avoid. Again, by definition, I = 90° at the dip pole. Methods involving inclination, such as assuming a linear relation between H and the distance from the pole, are usually quite subjective.

The most decisive method is to treat the magnetic field as a vector problem where force and direction are mutually dependent. The laws governing their distribution are defined in vector form by Maxwell's equations. The horizontal intensity is considered as a vector representing the gradient of a potential field. Hutchison's projection (1949) outlined in the Appendix of Whitham et. al. (1960), appears best.

By resolving the horizontal intensity parallel and perpendicular to the Greenwich grid direction and plotting isolines of the two components U, the grid-north component, and V, the grid-east component, on a polar stereographic projection, the following advantages are obtained at high latitudes: 1. The proximity of the geographical pole does not curve the isolines. 2. The isolines can be easily adjusted to intersect at right angles which is a necessary result if the field represented is derivable from a potential. Expressed analytically,

$$\frac{\delta V}{\delta u} = \frac{\delta U}{\delta v} \qquad \text{(Hutchison 1949)} \quad (1)$$

Small u, v, are parameters of position and are defined later.

All corrected D, H values were converted to U, V components using the relations

$$U = H \cos (\lambda \pm D) \qquad (2)$$

$$V = H \sin (\lambda \pm D) \qquad (3)$$

where λ is west longitude and the sign is positive for east declination. The contours of U and V were derived analytically to avoid arbitrary smoothing. Since such a small area was involved only the first-order terms of a Taylor expansion were used.

$$U = U_0 + a_1 \alpha + a_2 \beta \qquad (4)$$

$$V = V_0 + b_1 \alpha + b_2 \beta \qquad (5)$$

where U_0, V_0 are the values of U, V at the central point of the expansion. An approximate pole position was picked as this central point.

$$\alpha = u_s - u_0$$

$$\beta = v_s - v_0$$

where u_s, v_s are the grid coordinates of any point with field components U, V and u_0, v_0 are the grid coordinates of the assumed central point, which were $u_0 = .0246$ and $v_0 = -.1284$ and u, v, are both functions of west longitude λ and co-latitude φ such that

$$u = \tan \varphi/2 \,.\, \cos (\lambda - 180°)$$

$$v = \tan \varphi/2 \,.\, \sin (\lambda - 180°).$$

Applying the orthogonal relation (1) to equations (4) and (5) the following set of consistent equations was derived.

$$U = U_0 + a_1 \alpha + a_2 \beta \qquad (6)$$

$$V = V_0 + a_2 \alpha + b_2 \beta \qquad (7)$$

Applying a least-squares solution to 14 equations in U, V, it was found that the best expansions were, in units of gammas,

$$U = -1 - 68501 \alpha + 4641 \beta \qquad (8)$$

$$V = -5 + 4641 \alpha - 22568 \beta \qquad (9)$$

At the dip pole, $U = V = 0$.

Solving equations (8) and (9) for α and β, then converting back to latitude and longitude, the preliminary 1962.5 position for the dip pole is

Latitude	75.1° N
Longitude	100.8° W

Maps were drawn using equations (8) and (9) and values of U and V were scaled off at convenient intervals, then converted back to magnetic elements D, H, X, and Y. Maps were then drawn in D, I, H, X, Y, and are shown in Figures 3 to 7. The inclination map was drawn by assuming a linear relationship between H and I. This is only valid if Z is constant over the area concerned. Actually from Table II, the observed value deviated from the mean by ± 240 γ.

A comparison was made between the observed station values and the values interpolated from the maps. The standard deviation of the differences were:

D ± 4.2°
I ± 2.2′
H ± 45 γ
X ± 60 γ
Y ± 45 γ

Secular Motion of the Dip Pole

The most direct method of obtaining information as to the pole's secular motion is by comparing the present position with one in the past. For this reason, it was decided to re-examine the preliminary pole position of 1948 using the observations made by this Division in the years 1947-49, (Figure 1). Thirteen stations were picked from these observations, all within 100 miles of the 1948 preliminary pole position 73° N, 100° W. All station values were reduced to epoch 1948.0 (*see* Table VI Appendix). Using the same method of analysis as for the 1962 dip pole, and applying a least-squares solution to 26 equations in U, V, it was found that the best expansions were

$$U = 9 - 66078 \alpha + 4012 \beta \qquad (10)$$

$$V = 194 + 4012 \alpha - 23815 \beta. \qquad (11)$$

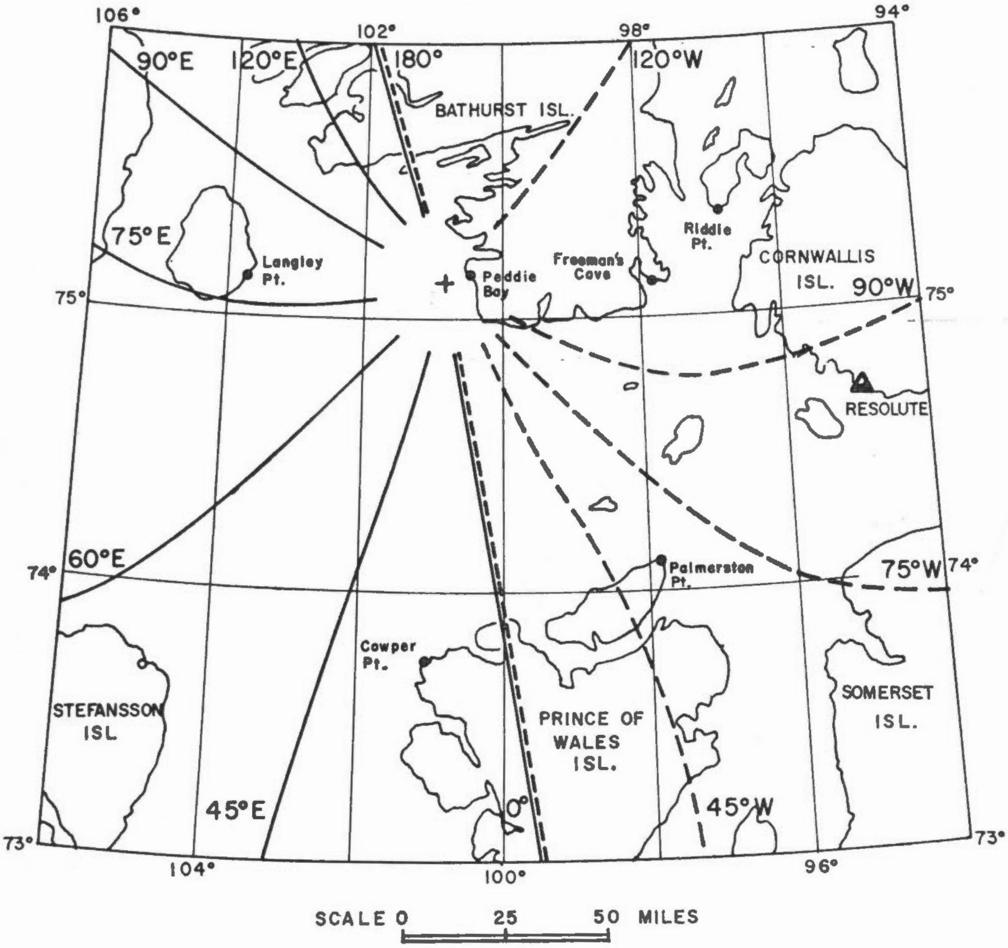

FIGURE 3
D-isolines in the vicinity of the north magnetic dip pole for 1962.5

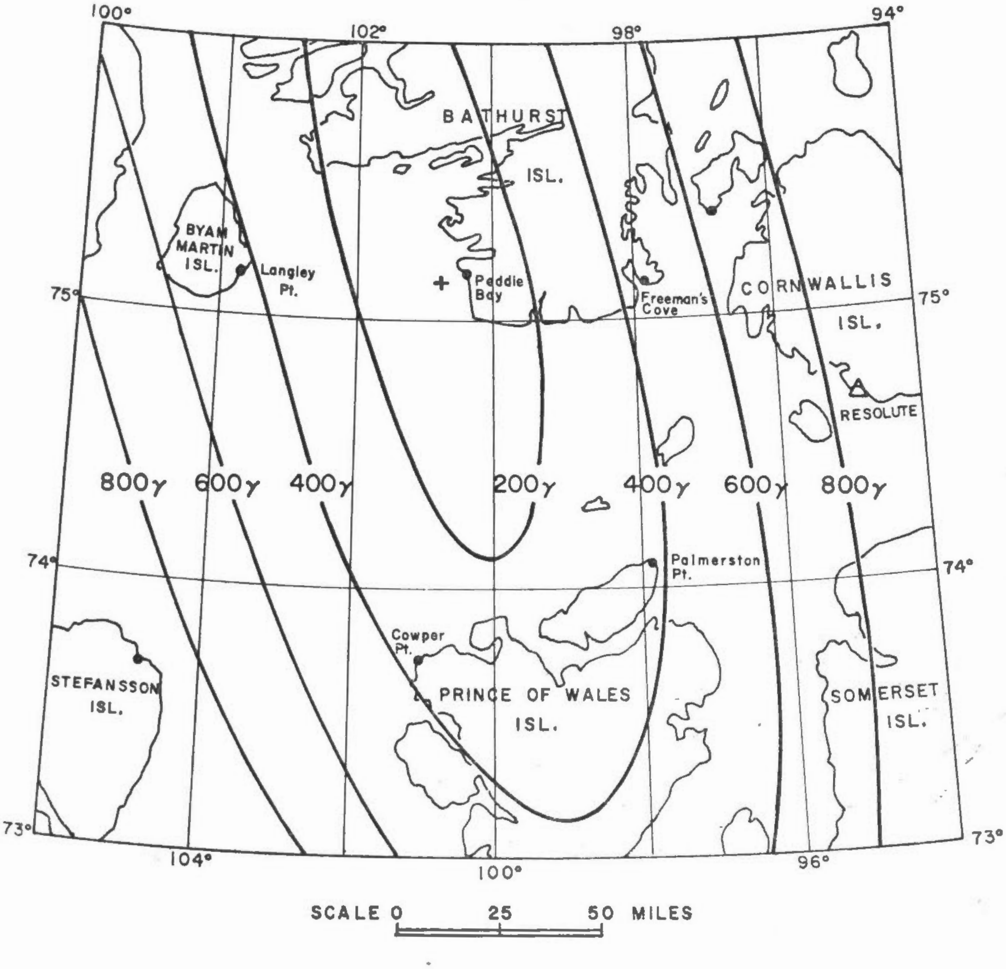

FIGURE 4
H-isolines in the vicinity of the north magnetic dip pole for 1962.5

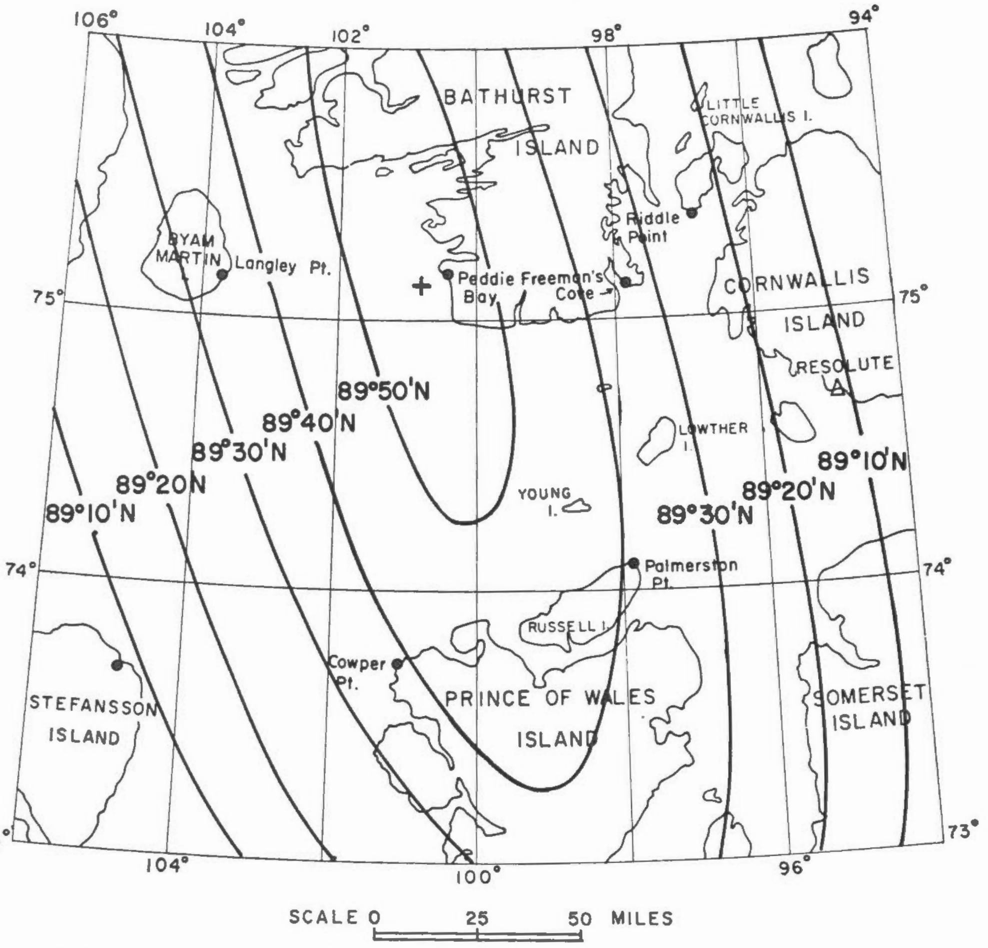

FIGURE 5
I-isolines in the vicinity of the north magnetic dip pole for 1962.5

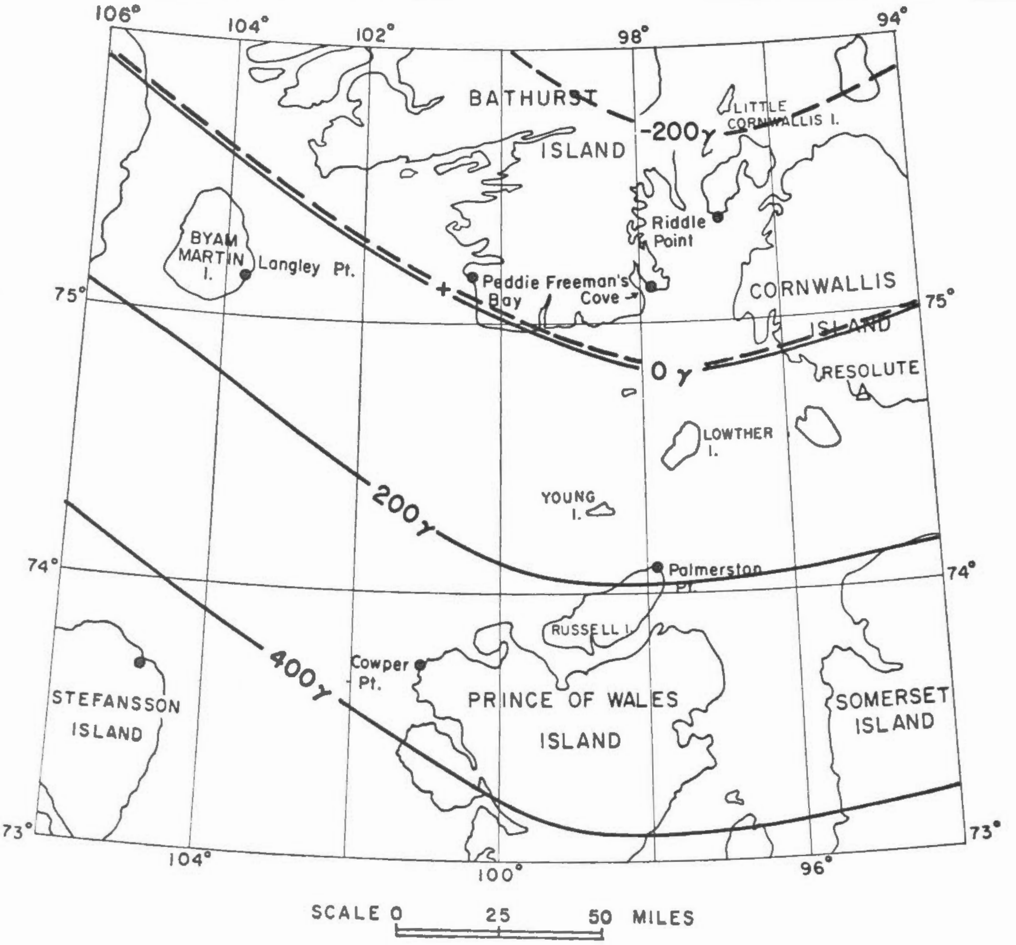

FIGURE 6
X-isolines in the vicinity of the north magnetic dip pole for 1962.5

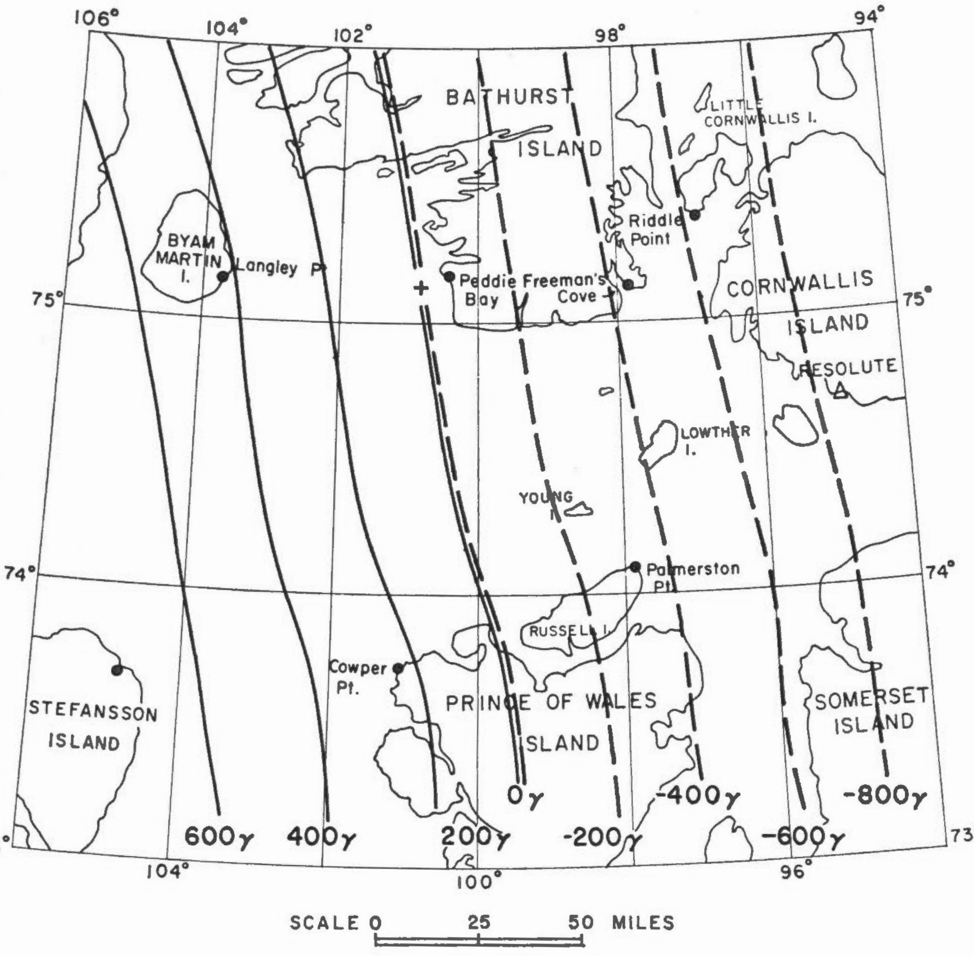

FIGURE 7
Y-isolines in the vicinity of the north magnetic dip pole for 1962.5

Solving equations (10) and (11) for α and β, the 1948.0 position for the dip pole is

Latitude 73.9° N

Longitude 100.9° W.

All the observed positions for the north magnetic dip pole are shown in Table III. The original observations are given in the Appendix.

Figure 1 shows the path of the unperturbed dip pole according to the above observed positions. Amundsen's observations gave the first observed proof that the secular change of the earth's magnetic field produces a gradual change in the position of the dip pole. Such a change must be expected since every point of the earth's surface is subject to these gradual changes in the earth's magnetic field.

The predominant motion of the dip pole has been northward and over the past 58 years it has averaged 5 n.m. per year in this direction. Over the same period, the dip pole had a westward motion of 2 n.m. per year approximately until the last fifteen years when this motion has shifted to the east.

TABLE III

Date	Latitude	Longitude	Secular Motion	
			North	East
	°	°		
1831.4	70.1 N	96.9 W(a)		
			0.3 n.m./yr	+0.1 n.m./yr
1904.5	70.5	96.6 (b)		
			4.7 n.m./yr	−1.8 n.m./yr
1948.0	73.9	100.9		
			5.0 n.m./yr	+0.1 n.m./yr
1962.5	75.1	100.8		

All positions are given to the nearest tenth degree. The abbreviation n.m. refers to nautical miles.

(a) a re-computation of Ross's position by A. Nippoldt (1930).

(b) a re-computation of Amundsen's position by K. F. Wasserfall (1939).

More precision can be gained concerning this dip pole secular motion if the assumption is made that the secular variation field at the dip pole and at Resolute Bay, 96 miles distant, are nearly identical.

An indication of the validity of this assumption was made this summer when two repeat stations at Peddie Bay and Freeman's Cove were re-occupied. Peddie Bay was not an exact re-occupation, but as mentioned previously, the area proved to be quite flat magnetically, the local gradients in F being less than 1γ per 50 feet.

From the graphs of X, Y, shown in Figure 8 for Resolute Bay, Freeman's Cove and Peddie Bay, 96, 44 and 6 miles from the dip-pole position respectively, the average secular change over the past 15 years is 21 ± 3γ in X and 8 ± 1γ in Y.

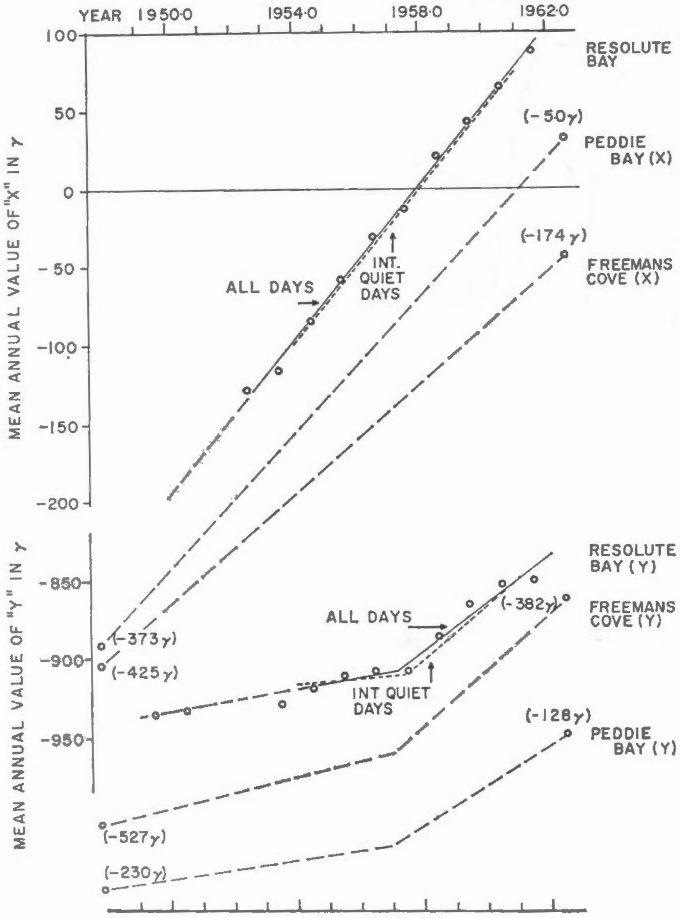

FIGURE 8. Comparison of secular change at Resolute Bay as given by the mean annual values in X and Y with the secular change at Peddie Bay and Freeman's Cove as determined from the observed field values shown in the brackets.

At Resolute Bay, X is increasing at the rate of 24γ a year. The gradient in X from Figure 6 is 4.6γ per mile. Therefore the dip pole is moving north at the rate of 5.2 miles a year. This agrees favorably with the previous estimated rate of 5 miles a year. Y increased 4γ a year east until 1957 when this eastward trend increased to 15γ a year.

The gradient of Y from Figure 7 is 9.52γ/mile. In terms of miles a year, this means that from at least 1952 until 1957 the pole moved east 0.4 mile a year and this rate increased to 1.6 miles a year east after 1957. Or, estimating over the past 15 years, the dip pole has an average eastward motion of 0.8 mile a year. This is about a magnitude larger than the estimate made from the pole positions of 1948 and 1962 and reflects the uncertainty in the longitude of these positions.

The Standard Deviation in the Dip-pole Determination of 1962

Since the maps (Figures 3 to 7) were derived from observations taken at only seven stations, the use of the standard deviation of the differences between the observed station values and values interpolated from the maps does not give a valid indication of the accuracy of the dip-pole position. The variance of U, V in the 14 equations involved in obtaining the consistent equations (8) and (9) was determined. This leads to a standard deviation of ±99 γ in X and Y. The gradient of X is 4.6γ per n.m. and the gradient of Y is 9.5γ per n.m. Therefore the deviation in latitude is ±0.2° and in longitude ± 0.7°.

$$\therefore \text{ the dip pole position for 1962.5 is } \begin{array}{r} 75.1° \pm 0.2°\text{N} \\ 100.8° \pm 0.7°\text{W.} \end{array}$$

A Note on the Predicted Dip-pole Position for 1960.

The predicted pole position for epoch 1960 (Whitham, et al. 1960) was 74.8° ±0.3°N; 99.6° ±1.2°W and was based mainly on two premises:

1. A 1950 dip-pole position of 74°N and 100°W.
2. The prediction of the pole drift from secular change data at Resolute Bay observatory.

The validity of the latter premise (Figure 8) has been verified. From 1948 to 1950, the unperturbed dip pole moved 10 miles north and 1 mile east. Therefore, the 1950 position based on the re-computed 1948 position is 74° 06′N and 100° 51′W. This means using the methods of Whitham, et al. (1960) a more accurate 1960 prediction would have been 74.9°±0.3°N and 100.4° ±1.2°W. By accident this value is close to the adopted value for that epoch.

The Diurnal Motion of the North Magnetic Dip Pole

The pole position was calculated for each hour of the day on international disturbed days and international quiet days, using Resolute Bay observatory data for the twelve-month period from July 1961 to June 1962. These plots are shown in Figure 9, centred about the unperturbed pole position for epoch 1962.5. The two plots are very similar in form indicating that the disturbed-day variation may be regarded as produced by an enhancement of the polar-cap current system responsible for the quiet-day variation. As noted in a paper of

Whitham and Loomer (1956) this diurnal motion, produced by current systems in the ionosphere, may displace the pole position 50 to 100 miles during a severe magnetic storm. This is in marked contrast to the average yearly drift of approximately 5 miles north and 1 mile east produced by the secular variation field of internal origin.

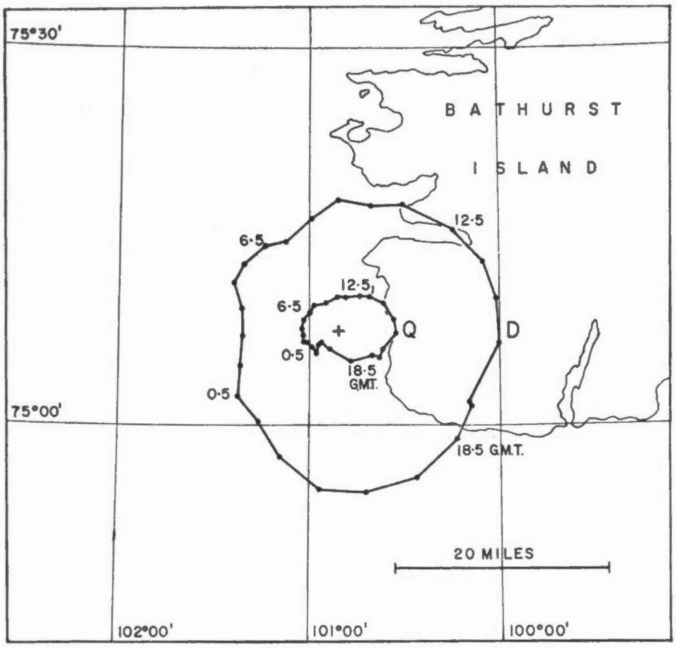

FIGURE 9. Average diurnal paths of the north magnetic dip pole on (D) International disturbed days and (Q) international quiet days for the period July 1961 to June 1962.

Acknowledgments

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APPENDIX

Table IV lists the observations made by Commander J. C. Ross on the position of the north magnetic pole in 1831 (J. C. Ross, 1834).

Table V lists the observations made by Amundsen in 1904 as stated by K. F. Wasserfall (1939).

Table VI lists the observations used in the re-computation of the 1948.0 dip pole position. These observations were made by personnel of the Division of Geomagnetism in the period 1947–1949. Also listed are the U, V values reduced to epoch 1948.0.

TABLE IV

Observations on the Dip of the Magnetic Needle

Date	Time of the day	Poles of the Needle direct					Poles of the Needle reversed					Observed Dip	Remarks
		Axis direct		Axis reversed		Mean	Axis direct		Axis reversed		Mean		
		Face East	Face West	Face West	Face East		Face East	Face West	Face West	Face East			
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1831													
Feb. 15	Noon	78 11.5	99.34.73	78 6.23	99 25.67	88 49.53	79 26.17	98 37.67	79 17.33	98 52.5	89 3.42	88 56.47	Mean observed dip at Sheriff's Bay in lat. 70° 1′ N., and long. 91° 54′ W. Variation 96° 12′.3 W. previous to my journey towards the magnetic pole = 88° 57′.04 N. (1831).
28	1 P.M.	81 30	98 38.78	79 35.60	98 14.50	89 29.72	72 7.86	103 38.44	72 52	105 43.75	88 35.51	89 2.61	
March 1	2 P.M.	81 42.8	97 52	81 7	96 49.4	89 22.80	77 16	100 27	77 47.42	98 49.6	88 35.0	88 58.90	
4	Noon	81 34.8	96 37.4	81 18	97 25	89 13.8	76 30.4	101 10	78 15.6	99 27	88 51.25	89 2.52	
15	1 P.M.	81 34.7	96 34.5	81 34.2	96 41.2	89 6.15	75 27.5	102 12.3	75 6.9	102 59.5	88 56.55	89 1.35	
21	4 P.M.	75 5.67	103 6.17	74 12.83	101 8.33	88 23.14	81 14.5	97 6	81 56.1	95 35.3	88 57.97	88 40.56	
22	4 P.M.	86 7.63	91 30.17	87 0.0	90 29	88 47.7	86 13	92 35.7	87 19.83	90 37.83	89 11.59	88 59.15	
23	3 P.M.	86 18.2	91 11.35	87 9.14	90 47	88 51.42	86 24.17	90 17	87 28	91 22	88 47.29	88 49.36	
24	2 P.M.	81 56.5	96 18.7	81 49.7	96 0.20	89 1.27	81 57.70	95 40.1	81 18	97 20.2	89 4.0	89 2.64	
25	3 P.M.	78 56	98 30	78 1.1	99 27.5	88 43.65	79 51.4	99 12.17	80 8.72	97 21.4	89 8.42	88 56.04	
30	3 P.M.	77 41	99 49.25	77 38.75	99 44.44	88 43.36	81 23.9	96 58.3	81 59.4	96 26.4	89 12.0	88 57.68	
April 1	2 P.M.	76 47.1	100 2.90	78 29	100 14.20	88 53.27	81 52.4	95 48.14	81 27.12	97 13.4	89 5.27	88 59.27	
	4 P.M.	78 40.67	99 2.17	78 36.33	98 52	88 48.04	80 8.27	97 51.13	80 20.27	97 48.5	89 2.04	88 55.04	
May 28	8 A.M.	86 31.7	92 47	86 26.83	93 30	89 48.87	73 9.5	106 11.5	84 20	94 35.8	89 34.2	89 41.53	89° 41′.9 N. Variation 57° 15′ W.; lat. 69° 34′ 45″ N.; long. 94° 53′ W.
	2 P.M.	86 17.22	92 51.3	87 2.14	93 32.16	89 55.71	74 42.2	104 58.22	83 24.7	94 50.18	89 28.83	89 42.27	
June 1	Noon	86 23.67	93 8.33	87 6.17	93 32.83	90 2.75	73 53.67	104 51.67	83 44.33	97 7.5	89 54.29	89 58.52	89° 58′.11 N. Assumed direction of meridian S. 75° W. (True.)
	3 P.M.	85 55.5	93 32.62	86 40.67	93 54	90 0.71	73 22	105 24.83	83 23.33	97 28.67	89 54.71	89 57.71	
	5 P.M.	86 32.33	93 10.33	87 16.67	93 9.83	90 1.79	74 58.83	104 16.83	83 0.83	97 5.13	89 50.15	89 55.97	89° 59′.465 N. Assumed direction of meridian N. 60° W.; lat. 70° 5′ 17″ N.; long. 96° 45′ 48″ W.
	7 P.M.	86 52.83	93 9.67	87 14.50	93 32.0	90 12.25	74 55	104 24.5	83 38.17	96 37	89 53.67	90 2.96	
2	9 A.M.	84 24.33	96 12.67	82.46.37	96 55.1	90 4.62	82 29.5	97 14.33	85 14.5	94 58.33	89 59.14	90 1.88	89° 59′ N. Assumed direction of meridian N. 15° W.
	11 A.M.	84 3	96 25.56	82 32.60	96 35.75	89 54.08	82 36.5	97 26.75	85 20.67	94 29.0	89 58.17	89 56.12	
6	8 A.M.	86 0.5	92 15.83	86 58.33	93 6.67	89 42.38	75 25.67	103 55.83	82 40.17	96 28.5	89 37.54	89 40.19	Same position as on the 28th of May.
8	9 A.M.	86 27.5	92 3.33	87 13.67	92 17.83	89 30.58	75 20	101 36.17	81 22.33	98 37.83	89 14.04	89 22.33	At Cape Isabella. Lat. 69° 26′ 20″; long. 93° 51′ W.
9	8 A.M.	84 42.83	94 33.13	84 25.67	93 42.5	89 21.03	77 48.83	100 1	81 42	97 21.5	89 13.33	89 17.18	At Padleak. Lat. 69° 30′ 1″; long. 93° 27′ 52″ W.
17	2 P.M.	86 5	92 40.2	87 41.5	91 52.5	89 34.8	82 41	93 30	85 1.3	93 2.3	88 33.65	89 4.22	Observed dip at Sheriff Bay on my return from the magnetic pole 89° 3′.32 N. (1831.)
	5 P.M.	86 9.8	91 48.5	87 45	91 15	89 14.57	80 45	96 30.8	85 9.2	93 7	88 53	89 3.79	
July 13	2 P.M.	85 43.33	92 4.5	87 50.33	91 42	89 20.40	82 23	95 1.5	82 37	95 14.83	88 49.04	89 4.74	
Aug. 12	1 P.M.	86 27.5	91 41.7	87 57.5	91 14.7	89 20.35	84 9.2	93 24.2	79 45.8	97 38.3	88 44.37	89 2.36	
20	Noon	80 3.34	98 7.5	80 46.7	97 20.8	89 4.53	76 15.7	101 30	99 53.2	78 15	88 58.47	89 1.50	
Oct. 21	10 A.M.	84 40.17	93 52	84 24	93 33.45	89 7.40	79 1.89	98 5.67	81 36.67	96 5	88 42.31	88 54.86	Observed dip at Victory Harbour 88° 54′.86 N. Variation 101° 32′.03 W.; lat. 70° 9′ 18″ N.; long. 91° 30′ 33″ W.
22	9 A.M.	84 40.5	94 16.5	84 50.12	93 49.37	89 24.12	77 29.4	99 41	80 24.5	96 45.2	88 35.03	88 59.57	
23	Noon	84 9	93 13.9	84 40.6	93 43.2	88 56.67	78 55.4	99 5.9	81 57.6	95 32.8	88 53.93	88 55.30	
Nov. 21	Noon	84 18.8	94 8.1	84 18.1	94 27.9	89 17.98	77 20.5	99 22	78 41.8	98 5.6	88 22.47	88 50.22	
22	1 P.M.	84 56.2	93 46.6	84 54.6	93 48.6	89 21.5	78 55.3	98 24	79 28.3	96 51	88 24.65	88 53.07	
23	1 P.M.	84 43	93 37.6	84 59	93 24.4	89 11	79 39.8	98 8	80 36.2	95 55.4	88 34.88	88 52.92	
Dec. 24	10 A.M.	84 42.9	93 50.7	84 11.7	94 32.6	89 16.97	79 47.5	98 31	81 51.5	94 46	88 44	89 0.49	
	1 P.M.	85 21.5	93 2	84 19.8	93 57	89 10.07	79 58.6	98 16.8	81 37	94 41.5	88 38.48	88 54.27	
1832													
Jan. 21	Noon	85 1	94 8.6	84 24.5	94 23.2	89 29.32	76 53	100 16.2	81 7	95 59.4	88 33.9	89 1.61	
Feb. 16	1 P.M.	84 58.5	95 11.8	83 17.3	95 14	89 40.04	76 46.1	100 52	79 51.7	96 31.1	88 30.22	89 5.31	
18	1 P.M.	83 48.4	95 18.6	81 58.1	95 19.7	89 6.2	77 30.1	100 39.5	81 30.4	95 37.8	88 49.45	88 57.82	
March 17	3 P.M.	83 16.2	94 41.6	82 32	95 42.1	89 2.98	74 53.9	102 45.2	78 55	96 3.1	88 9.3	88 36.14	
27	2 P.M.	83 30.7	94 48.4	84 2.9	94 38.4	89 15.1	74 4.5	102 54.7	78 28	98 45.6	88 33.2	88 54.15	
April 13	......	83 38.5	94 47	82 47.6	95 14.9	89 7	75 36.9	101 13	78 53	98 23.6	88 31.62	88 49.31	
15	......	83 5.5	95 22.5	82 30.9	96 27.2	89 21.52	78 21	98 23.3	75 45.4	101 46.7	88 34.12	88 57.82	

TABLE V

Particulars for magnetic stations, Gjoa expedition 1904

Station	Latitude	Longitude	D	H γ	I
	° ′	° ′	° ′		° ′
Beechey Island	74 43 N	91 54 W	128 28 W	1550*	88 20.0 N
Gjoahaven	68 37	95 53	7 24 W	761	89 17.4
1	68 27	95 49	44 00 E	755	89 15.0
2	68 28	96 18	02 50 E	900	
3	68 42	95 31	35 15 E	645	
4	68 48	95 56	04 10 W	655	
I	69 24	95 22	35 30 W	410	89 36.0
II	70 25	96 18	45 40 E	395	89 34.0
III	70 42	96 15	120 00 E	140*	89 52.0
IV	70 56 N	96 21 W	101 30 W	285	89 38.0

*Interpolated.

TABLE VI

Measurements used in the recomputation of the 1948 dip pole position

Station	Latitude	Longitude	Date of Observation	D	I	H γ	Reduced to Epoch 1948.0	
							U γ	V γ
	° ′	° ′		° ′	° ′			
Resolute Bay (A)	74 41.2	94 49.9	1947.6	101 14.5 W	89 03.8	893	882	−90
Resolute Bay (B)	74 41.1	94 53.4	1947.7	105 29.4 W	88 57.3	1089	1065	−190
Freeman's Cove	75 11.5	98 03.9	1947.7	128 52.0 W	89 20.4	677	577	−339
Guillemard Bay	71 51.3	98 13.3	1947.6	38 35.7 W	89 31.6	488	242	428
Allen Lake	73 41.0	98 26.0	1947.6	124 54.3 W	89 35.6	412	365	−173
Peddie Bay	75 11.0	100 39.0	1947.7	148 17.3 W	89 34.0	438	291	−317
Greeley Haven	71 56.0	104 50.0	1947.7	61 39.5 E	88 29.4	970	−946	234
Pasley Bay	70 42.0	95 53.1	1948.6	25 49.7 W	88 59.1	1046	365	969
Pell Inlet	75 54.4	102 15.4	1948.6	168 20.0 E	89 41.1	386	11	−400
King Game Lake	72 27.0	106 15.0	1948.6	48 30.0 E	88 36.8	1414	−1273	589
Cunningham Inlet	75 06.0	93 45.0	1949.6	90 57.9 W	88 52.1	1138	1157	13
Union River	72 46.6	93 57.0	1949.6	73 23.4 W	88 59.9	1019	970	318
Ommanney Bay	73 15.7	102 21.0	1949.6	46 26.7 E	89 46.0	238	−183	92