

Magnetic Observations at International Polar Year Stations in Canada¹

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ABSTRACT. During the First International Polar Year (1882-83) magnetic observatories were established in northern Canada at Fort Rae, Fort Conger, and Clearwater Fiord. Repeat magnetic observations made during the centenary of the First Polar Year enable a determination of the secular variation at each of these locations. During the last 100 years the declination has increased easterly by over 20° at Fort Conger and at Clearwater Fiord; however, it has decreased by only 9° at Fort Rae. The total intensity has decreased by over 1900 nT at Fort Rae, but at Clearwater Fiord and at Fort Conger the decrease has been about 1500 nT and 1000 nT respectively. This implies that the decrease in the non-dipole field evident over most of North America in recent times has not been as great in the high Arctic.

Key words: Polar Year, Fort Conger, Fort Rae, Clearwater Fiord, Kingua Fiord, secular variation, magnetic field

RÉSUMÉ. Des observatoires magnétiques ont été établis dans le nord du Canada, à Fort Rae, à Fort Conger et au fjord Clearwater, au cours de la première Année polaire internationale (1882-83). Une répétition des observations magnétiques effectuée durant le centenaire de la première Année polaire a permis de déterminer la variation séculaire à chacun de ces emplacements. Au cours des dernières 100 années, la déclinaison a augmenté vers l'est de plus de 20° à Fort Conger et au fjord Clearwater, mais n'a diminué que de 9° à Fort Rae. L'intensité totale a diminué de plus de 1900 nT à Fort Rae, mais au fjord Clearwater et à Fort Conger, la diminution n'a été que de 1500 nT et de 1000 nT respectivement. Ces données laissent entendre que la diminution dans le champ non dipolaire, manifeste presque partout en Amérique du Nord dans les temps récents, n'a pas été aussi marquée dans le nord de l'Arctique.

Mots clés: Année polaire, Fort Conger, Fort Rae, fjord Clearwater, fjord Kingua, variation séculaire, champ magnétique

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INTRODUCTION

The First International Polar Year (FPY) was conceived by Karl Weyprecht of Germany, a lieutenant in the Austrian navy and an experienced Arctic explorer. He deplored the chauvinism of many arctic explorers who put geographical exploration ahead of scientific investigation. His proposal for an international coordinated scientific investigation of the Arctic, first made in 1875, resulted in one of the most ambitious scientific undertakings of the nineteenth century. Eleven countries established 14 scientific stations in the polar regions during the official Polar Year, 1 August 1882 to 31 August 1883. Three of these stations, Fort Rae (referred to as Old Fort Rae in this paper), Fort Conger, and Clearwater Fiord, were established in northern Canada (Fig. 1). Magnetic and meteorological observations were carried out at all stations for at least one year, and most expeditions undertook optional observations in other disciplines. A detailed account of the FPY is given by Heathcote and Armitage (1959), and recent summaries are given by Taylor (1981) and Baker (1982).

The establishment of magnetic observatories at all FPY stations indicates the importance attached to the study of the earth's magnetic field at that time. Indeed, geomagnetism had been of great interest to scientists throughout the nineteenth century (Taylor, 1981), and northern Canada held a certain strategic importance in this study because the north magnetic pole was located there. In fact, both Old Fort Rae and Clearwater Fiord were chosen as locations for observatories in part because of their proximity to the north magnetic pole (Taylor, 1981).

Considering the importance of geomagnetism during the FPY, it seemed appropriate to make repeat magnetic observations at the three Canadian sites during the centenary of the FPY. Comparison of these observations with those made during the FPY yields information about the slow change of the earth's magnetic field (secular variation) in northern Canada.

MAGNETIC OBSERVATIONS DURING THE FIRST INTERNATIONAL POLAR YEAR

The program of magnetic observations to be carried out by all expeditions during the FPY was adopted by the International Polar Commission at the St. Petersburg conference of 1881 (Heathcote and Armitage, 1959). Each expedition was to install two complete sets of apparatus to measure variations of the declination (D), horizontal intensity (H), and vertical intensity (Z) of the magnetic field. Despite the fact that a method of recording variations photographically had been developed in 1847 (Chapman, 1959), only the French expedition to Tierra del Fuego possessed this equipment. At all other observatories, the variations had to be measured visually by an

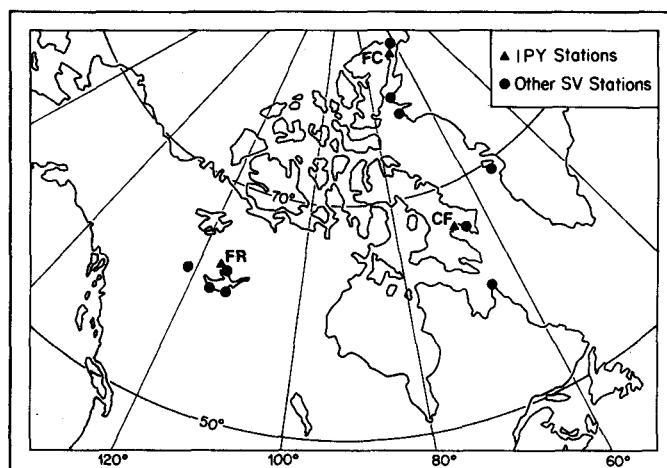


FIG. 1. The location of the International Polar Year stations (triangles) in Canada. FC = Fort Conger; FR = Fort Rae; and CF = Clearwater Fiord. Other nearby secular variation stations are denoted by dots.

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observer. This was routinely done every hour, but on the first and fifteenth of each month, term days, readings were made every five minutes, and during a preselected term hour, readings of declination were made every 20 seconds. To determine baseline values for the variation data, a series of absolute observations of declination, inclination (I), and horizontal intensity were to be made with an accuracy of one minute of arc in D and I and 0.1% in H. Observations were also to be made in the region around the magnetic observatory to detect any local anomalies. The full program specified by the Commission was extremely exacting, and many expeditions failed to conform completely to it.

Old Fort Rae

The British expedition to Old Fort Rae was a reluctant, last-minute undertaking (partly financed by Canada) and the most modest of all the FPY expeditions. Captain H.P. Dawson of the Royal Artillery and his three subordinates established a station at the Hudson Bay Co. trading post of Old Fort Rae on Great Slave Lake (62°39'N, 115°44'W). This small crew carried out all the basic magnetic and meteorological observations plus observations of aurora and soil temperature (Gerson, 1958).

Since the expedition had only six weeks to prepare before departure and special instruments could not be constructed for them, they were forced to borrow equipment from Kew observatory. The magnetic instruments consisted of: a unifilar magnetometer for determining absolute declination and horizontal intensity; a Kew-pattern dip-circle for measuring inclination; two Lamont-type declinometers for measuring D variations; a Weber bifilar magnetometer for measuring H variations; and a Lloyd's balance for measuring vertical field variations (Dawson, 1886). The instruments, which were calibrated at Kew observatory before leaving England, arrived at Fort Rae relatively unharmed despite the arduous overland journey. The variation instruments were installed on wooden piers in an existing log hut from which all iron had been removed, and the absolute instruments were installed nearby in a newly constructed building. Magnetic observations began on 6 September 1882 and continued until 31 August 1883 (Dawson, 1886). The full complement of variation observations was carried out. In addition, 17 absolute observations of D and H and 68 absolute observations of I were made during the course of the year.

Fort Conger

The American expedition to Fort Conger (81°44'N, 64°44'W) was the most ambitious of any FPY expedition. The 24-man crew, commanded by Lt. A.W. Greely, arrived in Lady Franklin Bay on Ellesmere Island in August 1881, a full year before the start of the FPY. Greely chose this site in order to compare his observations with those made at the same location by the British explorer Nares in 1875-76. Fort Conger was also an excellent base for the extensive geographical exploration planned by the Americans. The scientific program was thorough, with meteorological, magnetic, auroral, grav-

ty, sea ice, botanical, zoological, and tidal observations being carried out (Greely, 1888; Gerson, 1958).

The American expedition was not equipped with a full set of magnetic apparatus upon departure (Greely, 1888). They were supplied only with a Kew dip-circle for measuring inclination, and a magnetic theodolite for measuring both declination and horizontal intensity. Additional instruments were to be delivered by the supply ship in the summer of 1882 for use during the FPY, but unfortunately the ship did not reach Fort Conger. The available magnetic instruments were mounted on wooden tripods or piers sunk in the ground in a small non-magnetic building located about 137 m NE of Greely's main building and very close to the site of Nares' magnetic observatory of 1875-76 (Greely, 1888). Except for temperature coefficients, no instrumental constants for the magnetometers were determined prior to the expedition's departure. The non-arrival of the relief ship in 1883 resulted in the abandonment of Fort Conger and the subsequent starvation of most of Greely's crew. However, the survivors returned the magnets safely to Washington where the necessary constants were determined in 1886.

During the first 10 months at Fort Conger, hourly observations of declination were made during three days each month. From 1 July 1882 to 1 August 1883, hourly observations were carried out, and the scheduled term day and term hour observations were made. Since the magnetometer was used primarily for taking hourly declination observations, horizontal force observations were made only two or three times a month. A total of 23 observations of H was made between 16 September 1881 and 8 August 1883.

Hourly dip readings were made between 25 September 1882 and 1 June 1883, and term day observations were made between 1 October 1882 and 1 June 1883. However, most dip readings taken prior to 24 October were later rejected because they seemed inconsistent with later observations.

Clearwater Fiord

The German expedition, consisting of 11 men under Dr. W. Giese, chose Clearwater (Kingua) Fiord (66°36'N, 67°20'W) as its base of operations. The normal magnetic and meteorological observations were carried out, and observations of aurora, earth current, geology, botany and zoology were also undertaken.

This expedition was equipped with a greater variety of magnetic apparatus than the other two expeditions. Absolute declination and horizontal intensity were measured using a Bomberg magnetic theodolite. Inclination was measured either with a needle inclinometer or an Ellerman earth inductor. Two complete sets of Lamont variometers were available for variation observations of D, H, and Z. One set was used for the regular hourly observations, and the second to check the operation of the first by taking parallel observations. Magnetic observations began on 13 September 1882 and continued until 8 September 1883. Starting in February 1883, a Lloyd's balance was also used for vertical variation observations because it was found that the Lamont vertical instruments were not sufficiently sensitive.

Discussion of Observations

All three expeditions experienced problems which sometimes caused observational errors to exceed the specifications laid down by the International Polar Commission. At Old Fort Rae, the balance magnetometer had to be continually realigned because of the rapid change in declination. It was also found that the slow oscillations of the magnet were a source of error when reading the scale, so that variations could be determined only to the nearest ten nanoteslas (nT). The German expedition experienced similar problems with the Lamont vertical variometer. However, these problems did not significantly affect the annual mean values.

The instrument problems experienced by Greely were far more serious. The dip-circle proved to be unsuitable for use at Fort Conger. The large value of inclination caused one end of the needle to be obscured by the vertical supports so that only its top end could be read. Attempts were made to correct for this before the results were published, but the uncertainty in an individual result was still thought to be $\pm 10'$ to $\pm 15'$ (Greely, 1888), which significantly reduced the value of the observations.

The hourly and term variation observations made at all three stations have been fully published (Dawson, 1886; Neumayer and Borgen, 1886; Greely, 1888), but for determining the secular variation of the magnetic field, we are primarily interested in the average values of the components of the magnetic field. These are listed in Table 1. For Fort Conger, the declination value is the mean for the period September 1881 to July 1883. The value given for the horizontal intensity is a mean of all 23 observations over the two-year period. The value of inclination is for the period October 1882 to May 1883. The date given is the mean date of the declination observations. Also included in Table 1 are the mean values obtained by Nares during his expedition of 1875-76 (Creak, 1879), and Second International Polar Year observations made at Rae, which will be discussed later.

TABLE 1. Mean values of magnetic elements observed at International Polar Year stations

Observatory	Mean Date	D_E	I	H	Z	F
				nT	nT	nT
Old Ft. Rae	1883.2	40°22.7'	82°56.5'	7649	61778	62250
Rae	1933.1	37°31.1'	82°39.0'	7734	59955	60452
Clearwater	1883.2	287°47.6'	83°51.8'	6379	59327	59669
Ft. Conger	1876.0	258°16.0'	84°50.0'	5160	56904	57137
Ft. Conger	1882.6	259°34.0'	85°01.0'	5155	59120	59344

Table 1 shows a discrepancy at Fort Conger between the vertical or total intensity (F) measurements made in 1876 and those calculated for 1882 from the H and I observations. An increase of over 2000 nT in both these components in a six-year period is highly improbable. Nares's observations are suspect to a certain extent since the value of F (57 907 nT) derived from observations made with a unifilar magnetometer differs by 1540 nT from the value (56 367 nT) obtained from observations made with a Lloyd's dip-circle (Creak, 1879).

(The 1876 value in Table 1 is a mean of these values.) However, the major problems appear to be with Greely's observations. If his value for F were correct, it would imply a secular change of almost 4000 nT between 1882 and 1945; all other data from the high Arctic indicate much smaller changes in that region. Moreover, we have pointed out that Greely possessed an improper dip-circle and insufficient apparatus to make continuous H observations. Since $Z = H \tan I$, and I is very large, only a small error in either I or H will produce a large error in Z or F. We estimate that Z is too high by about 2300 nT, which can be explained by an error of 185 nT in H or 11' in I. Since the value of H was a mean of only 23 observations, it is unlikely to be a reliable approximation of the yearly mean value and could be in error by several tens of nanoteslas. In addition, the inclination observations are known to have errors of up to 15' (Greely, 1888). A combination of these two factors could easily account for the observed errors in Z and F.

OBSERVATIONS DURING THE SECOND INTERNATIONAL POLAR YEAR

Although many magnetic observatories were established during the Second International Polar Year (1932-33), Fort Rae was the only FPY site in Canada to be revisited. The original fort had been abandoned in the early twentieth century, and a new post (referred to as Rae in this paper) established some 25 km to the north (62°50'N, 116°04'W). A British expedition under J.M. Stagg established its base at Rae, but auxiliary observations were carried out at the old fort (Stagg, 1934).

During the Second Polar Year (SPY), all observatories used photographic magnetographs to record variations. At Rae, the variometers consisted of a standard La Cour magnetograph, a quick-run La Cour, and a standard Greenwich magnetograph. Absolute instruments consisted of a Smith magnetometer for measuring H and D and a dip inductor for measuring I. In total, 289 absolute observations of H, 251 of D, and 283 of I were made at the main base (Stagg, 1937). The mean values, based on the period 1 August 1932 to 31 August 1933, are given in Table 1.

Absolute observations were made at Old Fort Rae, primarily during the months of September 1932 and June and July 1933, with a Kew magnetometer and dip-circle. Certain problems were encountered using these instruments. There was some difficulty in determining the proper magnetic constants for the calculation of H; residual torsion was present in the silk fiber when D was measured; the construction of the dip-circle was such that the needle was obscured at high values of inclination, a problem similar to that experienced by Greely at Fort Conger 50 years earlier. After allowing for these problems, Stagg (1937) calculated the following station differences between the Old Fort Rae (o) and Rae (r) sites:

$$\begin{aligned}
 H_o - H_r &= 134 \text{ nT} \\
 D_o - D_r &= 16.7' \\
 I_o - I_r &= -7.8'
 \end{aligned}$$

Stagg (1937) estimated that the observations at Old Fort Rae were within 120 m of the site of the FPY observatory. We

have found no explanation of why they did not try to take observations closer to the original site when apparently they had a good knowledge of its location.

MAGNETIC OBSERVATIONS DURING THE CENTENARY OF THE FPY

Magnetic observations were made by the authors at Fort Conger, Fort Rae, and Clearwater Fiord during the spring and summer of 1982. At all three sites a three-component recording fluxgate magnetometer (Trigg *et al.*, 1971) was used for continual monitoring of variations in D, H, and Z. These were recorded on a digital cassette recorder at a sampling interval of one minute, and also on a three-channel chart recorder.

Absolute observations of declination and inclination were made with a portable D and I magnetometer (Trigg, 1970) which consists of a fluxgate magnetometer coil mounted on a Zeiss-Jena non-magnetic theodolite. The theodolite was also used for astronomical observations to determine azimuth. The total intensity was measured using a Scintrex MP-2 proton magnetometer.

Observations were made at Rae between 14 and 18 May 1982. The variometer was installed near Russel Lake, approximately 5.5 km from the town, and recorded for a total of 111 hours. The approximate site of the SPY observatory was located using the maps and description given by Stagg (1937). All signs of the observatory buildings had disappeared, and subsequent construction in the vicinity made absolute observations impractical. Consequently, observations were made at a site approximately 150 m from the SPY site. The magnetic field in this area is relatively uniform. Within 30 m of the site, the range in total force values, measured with a proton magnetometer, was only 40 nT. We estimate that F was 40 nT higher here than at the SPY observatory site. The positions of the two sites are shown in Fig. 2a. We took a total of 18 absolute observations each of D, I, and F between 14 and 16 May.

Old Fort Rae, approximately 25 km to the south, was visited

by helicopter on 17 May. Two stone outlines (Fig. 2b) were found which seemed to correspond to the positions of the FPY observatory buildings as shown on Stagg's (1937) map. (The maps published by Dawson (1886) are not detailed enough to be of much use.) The magnetic field in the area varied by only 19 nT within 30 m of the site. We made a total of 12 observations each of D, I, and F at a point on the foundation of the south wall.

In 1932-33 the British expedition took observations at Old Fort Rae some 120 m from the FPY observatory site. We made total force observations in the vicinity of the 1932 site. Total force values in a 30-m radius had a range of 30 nT. We also found that the average total force at this location differed by less than 15 nT from the total force at the FPY site.

At Fort Conger, variometer recordings were made over a period of 101 hours between 22 and 26 May. Finding the site of the magnetic observatory proved to be difficult. Deep snow obscured the remains of Greely's structures, and subsequent alterations by explorers such as Peary added to the difficulty. We finally found a small brick structure approximately 80 m from the remains of Peary's huts. Based on Greely's (1888) map and the map drawn by Chouinard in 1948 (Hattersley-Smith, 1964), we are confident that this is the brick fireplace which was constructed in the observatory for the second winter (Fig. 3). The range of F within 30 m of the site was only 27 nT. We took 23 observations of D, I, and F beside the fireplace.

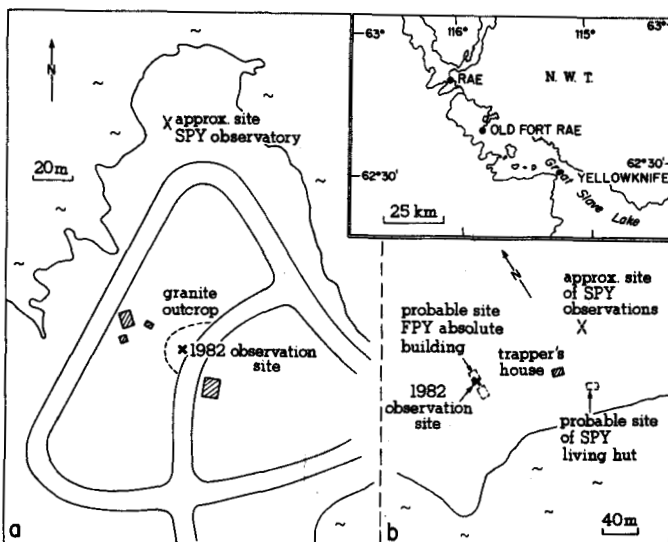


FIG. 2. Site map of Rae (a) and Old Fort Rae (b).

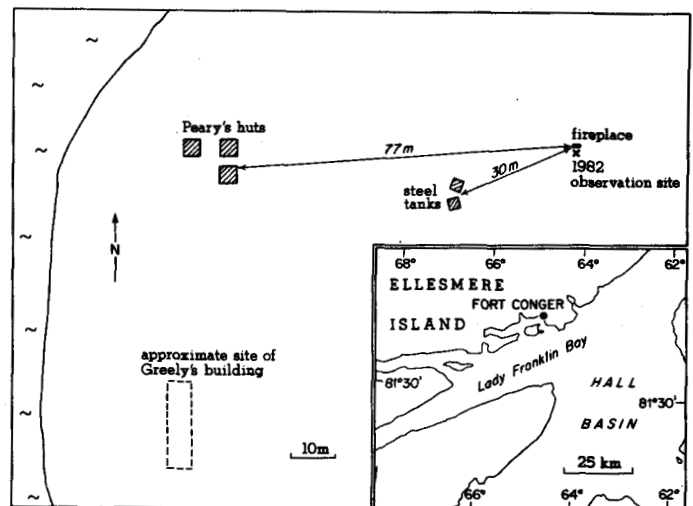


FIG. 3. Site map of Fort Conger.

In Clearwater Fiord the variometer was installed at a camp approximately 25 km from the site of the FPY station, and 126 hours of recording were obtained between 20 and 25 August. The site of the absolute observatory was easily located using the detailed maps published by Neumayer and Borgen (1886) and the conspicuous ruins of the stone astronomical observatory (Fig. 4). The magnetic field in this location was less homogeneous than at the other sites, with the range in F being 127 nT within a 30-m radius. We took a total of 34 sets of absolute observations at the site of the magnetic observatory.

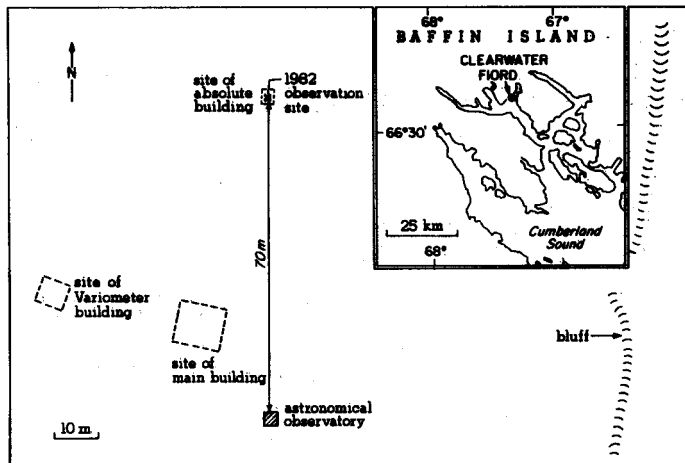


FIG. 4. Site map of Clearwater Fiord.

Reduction of Data

To determine accurately the secular variation of the earth's magnetic field the effects of the short-period, or transient, variations caused by external sources should be eliminated from the observations or at least minimized. This is sometimes done by averaging the variations over a two- or three-day period. Alternatively, a short magnetically quiet interval of time may be chosen when the average value approximates the undisturbed magnetic field.

If a station is close to a magnetic observatory, and if the magnetic field variations at the station are highly correlated with those at the observatory, it is preferable to use the observatory variation data to reduce the repeat station observations to an undisturbed value. There are two reasons for this. First, observatory data are much less susceptible to instrumental drift than are repeat observations. Second, a much longer interval of variation data can be used for determining a quiet period to which the repeat observation can be reduced. In our case, both Fort Conger and Fort Rae are within 100 km of magnetic observatories (Alert and Yellowknife, respectively). A comparison of Alert magnetograms with Fort Conger variometer records showed a high correlation between the two (0.94 between Z hourly mean values). It is therefore probable that differences between magnetic field values measured at Alert and at Fort Conger during the period 22-26 May would remain constant over a period of several weeks. An examination of Alert magnetograms from 3 May to 16 June showed that 22 and 23 May were among the quietest days during that period. Therefore, station differences in three components were added to mean values from Alert for this two-day period

TABLE 2. Undisturbed magnetic elements observed during centenary of the IPY

Station	Date	D_i	I	H	Z	F
	1982			nT	nT	nT
Old Ft. Rae	23 May	30°26.1'	81°52.8'	8522	59726	60331
Rae	23 May	30°44.9'	81°56.6'	8430	59559	60153
Clearwater	22 Aug ¹	310°41.3'	82°52.8'	7225	57838	58288
Ft. Conger	22-23 May	281°18.6'	86°22.8'	3539	55949	56061

¹For interval 0400-0800 UT

to give values of the undisturbed field at Fort Conger (Table 2).

The same procedure was carried out for both Rae and Old Fort Rae, using magnetograms for the month of May from Yellowknife observatory. The correlation coefficient between Z hourly means was 0.99. Daily mean values were calculated for 23 May, which was the quietest day during the month. These are given in Table 2. Computing station differences between Old Fort Rae (o') and Rae (r') we find:

$$\begin{aligned}
 H_{o'} - H_{r'} &= 92 \text{ nT} \pm 4 \text{ nT} \\
 D_{o'} - F_{r'} &= -18.1' \pm 1.0' \\
 I_{o'} - I_{r'} &= -3.8' \pm 0.1'
 \end{aligned}$$

These are not the same as the differences obtained by Stagg (1937), probably because the 1932 and 1982 observations were not carried out in exactly the same location.

Observations from Clearwater Fiord cannot be referenced to magnetograms from an observatory because the nearest observatory is situated more than 650 km away. Therefore it was necessary to select the quietest interval from the five days of recordings obtained at Clearwater, which unfortunately were all significantly disturbed.

To remove some of the short-period disturbance variations and thus better determine a quiet interval, we used a technique developed by Walker (1982). The data for each day were filtered with a low-pass, 8-pole recursive Butterworth filter with a cut-off at 2 h to remove short-period events. The mean of the filtered data for a 6-h period centered on local midnight was then determined. This period of time should be less affected by ionospheric current systems than the daylight hours. The raw data, filtered data, and mean values for each day were then plotted, and from an examination of the plots it was clear that the only significantly quiet period occurred between 0400 and 0800 U.T. on 22 August. The mean values for this period were computed and are listed in Table 2.

It is probable that these values are still affected somewhat by transient variations. In fact, even annual mean values, such as those listed in Table 1, can be affected by magnetic disturbances (Walker, 1982). However, for the purposes of determining the secular variation of the magnetic field over a period of 100 years, any errors introduced by disturbance should be of little consequence.

USES OF POLAR YEAR MAGNETIC OBSERVATIONS

It has been pointed out (Gerson, 1958) that although a great deal of data was gathered during the first International Polar Year, the follow-up in terms of research on the data was relatively small. Nevertheless, the magnetic variation data gathered during the FPY proved valuable to our early understanding of aurora, magnetic storms, and ionospheric current systems (Birkeland, 1908). Incomplete as the data were, they provided the only polar records of two of the largest magnetic storms of the past century and were still being studied up to the 1930s (Chapman, 1959), despite the fact that magnetic readings taken hourly, or even every five minutes, gave inadequate descriptions of the variations and were not suitable for proper statistical analysis (Serson, 1982). One can only

speculate on what the impact might have been on geomagnetic research if the organizers of the FPY, taking advantage of the available technology, had installed photographic variometers at all observatories.

The magnetic data had another, more practical use. The average values of declination obtained from the observatories, and other scattered values obtained during the FPY, were used in making charts of magnetic declination in polar regions. These data formed the basis of charts in use up to the time of the SPY (Gerson, 1958).

The FPY magnetic observations are still valuable today because of what they can tell us, in conjunction with our recent observations, about the secular variation of the magnetic field. The average rates of change are given in Table 3.

TABLE 3. Average secular variation at International Polar Year stations

Station	Time Period	D 'yr ⁻¹	I 'yr ⁻¹	H nT·yr ⁻¹	Z nT·yr ⁻¹	F nT·yr ⁻¹
Rae	1883-1982	-5.9	-0.6	8.8	-20.7	-19.3
	1883-1933	-3.1	-0.5	4.4	-37.2	-36.9
	1933-1982	-8.2	-0.8	14.0	-8.0	-6.1
Clearwater	1833-1982	13.8	-0.6	8.5	-14.9	-13.9
Ft. Conger	1876-1982	13.0	0.9	-15.2	-9.0	-10.1
	1883-1982	13.1				

The increase in inclination at Fort Conger and the decrease at Clearwater Fiord and at Fort Rae are consistent with a northward-moving magnetic dipole. This is also reflected in the decrease in H at Fort Conger and the corresponding increase at Clearwater Fiord and at Fort Rae. At both Fort Conger and Clearwater Fiord the increase in D has been $>20^\circ$ in the past 100 years; this contrasts with Fort Rae, where D has decreased by only 9° . F and Z have decreased at all three stations during the past century. This is part of a continental trend which has seen a decrease in total intensity of up to 4000 nT, or approximately 6% of the field strength, since 1850 in central North America (Newitt and Dawson, 1984). This decrease may be attributed to a slow decrease in the intensity of the earth's dipole field of about $15 \text{ nT}\cdot\text{yr}^{-1}$ coupled with a similar decrease in the intensity of the non-dipole field over much of North America (Newitt and Dawson, 1984). Table 3 shows, however, that the decrease in F in northern Canada is not as extreme; the decrease over the past century has been about 1900 nT at Fort Rae, 1400 nT at Clearwater and 1100 nT at Fort Conger. This implies that the decrease in the non-dipole part of the magnetic field is minimal in the extreme north-eastern part of North America.

Since the secular variation of the earth's magnetic field includes periods much shorter than 100 years (Currie, 1973; Newitt and Dawson, 1984), additional information is necessary to provide a more detailed description than that provided by the Polar Year observations alone. During the last 150 years, observations have been taken at several locations near the IPY observatories (Fig. 1). Secular variation curves have been drawn for these locations by Newitt and Dawson (1984) but they are subject to some uncertainty due to offsets in the curves caused by frequent site changes and the unknown

quality of many of the observations. The Polar Year observations act as control observations for these curves, and confirm their major features. Secular variation curves for each of the Polar Year stations, incorporating data from the nearby sites, are shown in Figures 5 through 8. Curves for total intensity are not shown since they closely resemble those for vertical intensity.

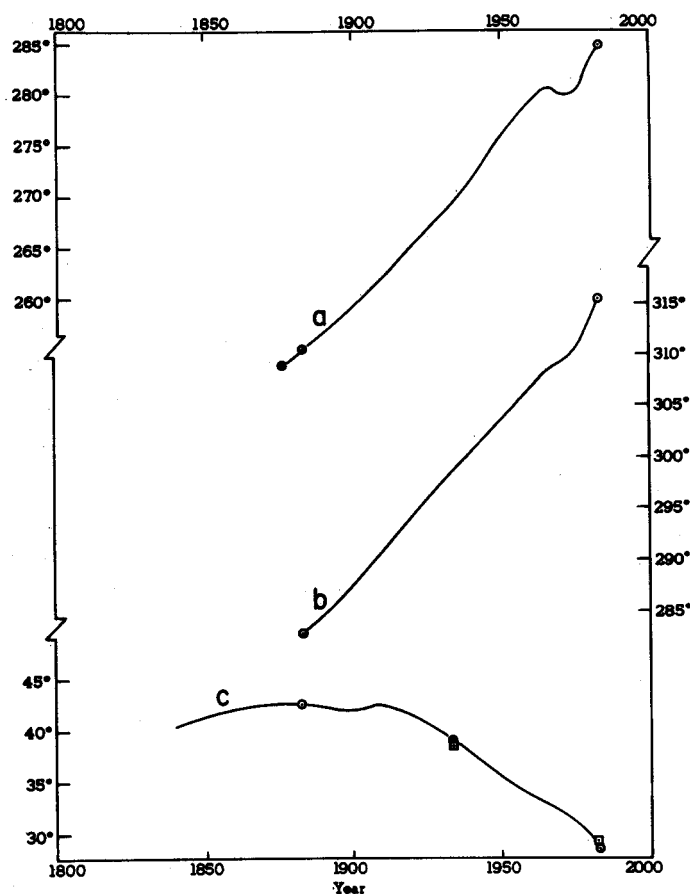


FIG. 5. Change of magnetic declination with time at Fort Conger (a), Clearwater Fiord (b), and Fort Rae (c). Circles represent observations made at FPY sites; squares represent observations made at SPY sites.

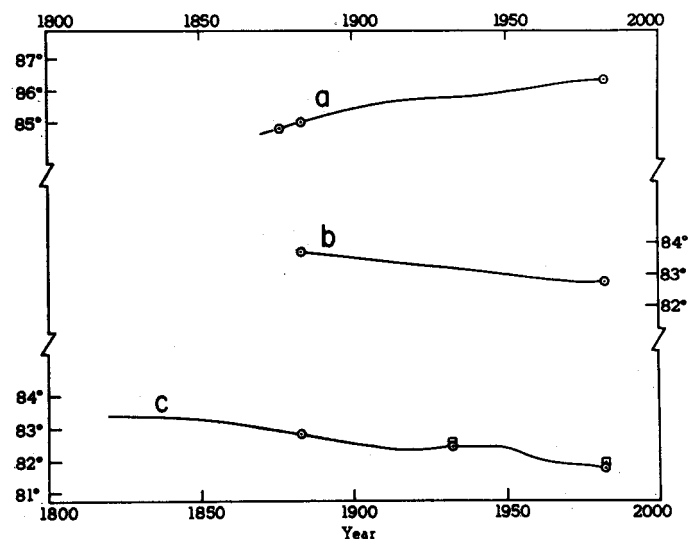


FIG. 6. Change of magnetic inclination with time at Fort Conger (a), Clearwater Fiord (b), and Fort Rae (c). Circles represent observations made at FPY sites; squares represent observations made at SPY sites.

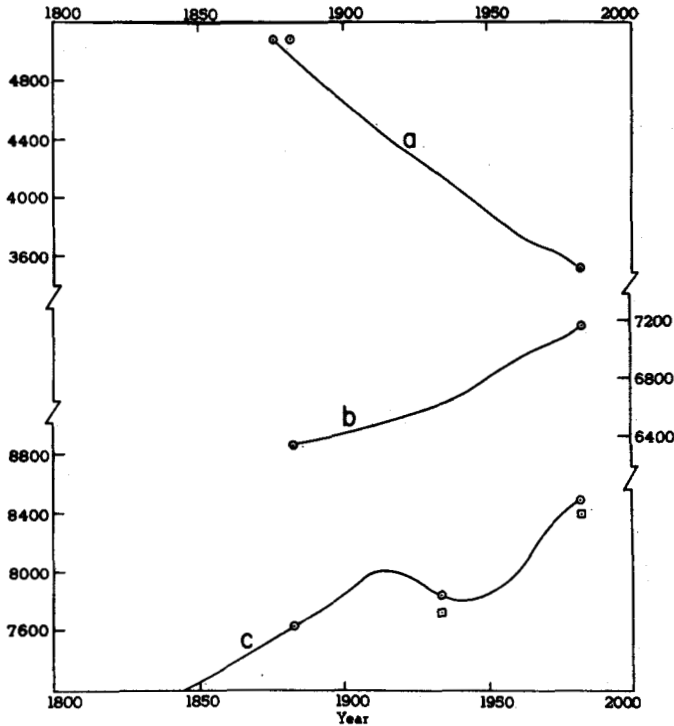


FIG. 7. Change of horizontal intensity with time at Fort Conger (a), Clearwater Fiord (b), and Fort Rae (c). Circles represent observations made at FPY sites; squares represent observations made at SPY sites. Units are nanoteslas.

CONCLUSIONS

The reoccupation of the three International Polar Year stations in Canada provided important information about the secular variation of the magnetic field in Canada. By providing the opportunity for repeat observations a century apart, the Polar Year stations enable us to use with greater confidence other available data to determine the secular variation for these regions of Canada.

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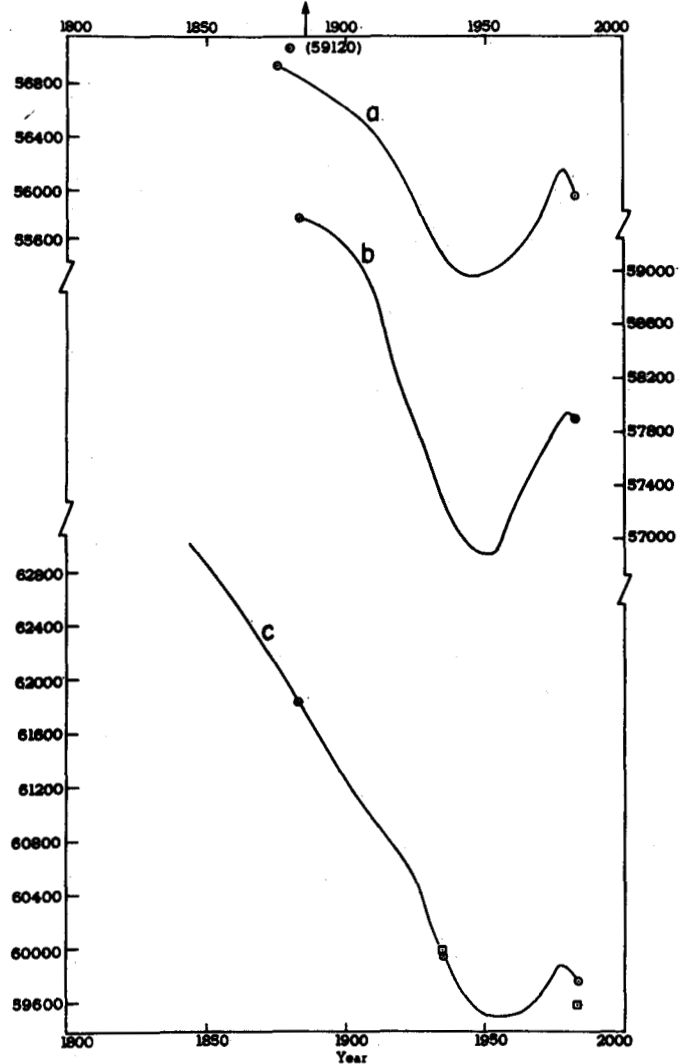


FIG. 8. Change of vertical intensity with time at Fort Conger (a), Clearwater Fiord (b), and Fort Rae (c). Circles represent observations made at FPY sites; squares represent observations made at SPY sites. Units are nanoteslas.

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