RAUNVÍSINDASTOFNUN HÁSKÓLANS
Science Institute of the
University of Iceland

LEIRVOGUR
MAGNETIC OBSERVATORY
1957 - 1968

by

Þorsteinn Sæmundsson

Reykjavík 1969

RAUNVÍSINDASTOFNUN HÁSKÓLANS
Science Institute of the
University of Iceland

LEIRVOGUR
MAGNETIC OBSERVATORY
1957 - 1968

by

Þorsteinn Sæmundsson

Reykjavík 1969

1. Introduction

The history of geomagnetic observations in Iceland can be traced back to the 17th century. During the 18th, 19th and early part of the 20th century, isolated measurements were made in Iceland from time to time, chiefly by various expeditions to the island. For details of these expeditions see Appendix I.

In 1932, on the occasion of the International Polar Year, a magnetic recording station was set up near the town of Reykjavík by Dr. Þorkell Þorkelsson, director of Veðurstofan, the Icelandic Meteorological Service. The station was equipped with quick-run La Cour instruments and operated for a period of ten months. In 1937, through a joint effort of the Danish Meteorological Institute, Veðurstofan and other parties, two similar recording stations were set up in the vicinity of Reykjavík with Dr. Þorkelsson in charge. After four months of operation, both stations were closed down again, largely for financial reasons.

The need for a permanent geomagnetic observatory in Iceland continued to be felt by geophysicists, and this need became more pressing as the years passed by. Finally, in 1953, steps were taken to select a suitable field site and secure the necessary financial support. The undertaking was led by Þorbjörn Sigurgeirsson, then director of the National Research Council of Iceland. Within three years a magnetic observing station had been established at Leirvogur in the district of Mosfellssveit near Reykjavík. During the preparations, close consultation was maintained with the geophysical section of the Danish Meteorological Institute.

Regular recordings at Leirvogur commenced at the beginning of August 1957, in time for the International Geophysical Year. In 1958 the running of the observatory was taken over by Eðlisfræðistofnun Háskólans, the newly established Physical Laboratory of the University of Iceland. In 1966 Eðlisfræðistofnun Háskólans was replaced by the larger Raunvísindastofnun Háskólans (Science Institute of the University of Iceland) which continued to run the observatory at Leirvogur.

2. Location of the observatory

The observatory is located at the end of a shallow bay (Leirvogur) about 13 km ENE of the Science Institute in Reykjavík (see fig. 1). Its distance from the Science Institute by road is about 20 km. The geographic coordinates of the reference point of the observatory (a concrete pillar in the hut Miðbær, see § 3) are as follows: latitude $64^{\circ}11'00''.22$ N, longitude $21^{\circ}41'56''.34$ W. These values were furnished by Landmælingar Íslands (Icelandic Survey Department). The reference point has the number 3047 in the Icelandic geodetic system. The geomagnetic coordinates of the observatory (referred to a pole position of $78^{\circ}.5$ N, $69^{\circ}.0$ W) are $70^{\circ}.2$ N, $71^{\circ}.0$ E.

The observatory grounds cover 100 m × 150 m of grassland leased from the farm of Leirvogstunga for a period of 99 years. The site is a flat river estuary or delta formation composed of basaltic gravel and covered with 1-2 metres of soil. The soil is slightly magnetic, as can be seen from the fact that the digging of holes for the foundation of buildings and pillars creates measurable field anomalies.

The bedrock in the region is Tertiary plateau basalt with alternating banks of basaltic lavas and thin sediments. In addition there are widespread remnants of a Quaternary sheet of basaltic lavas. These geological formations produce strong inhomogeneities in the magnetic field. In the area around Reykjavík there are many deep negative anomalies, as can be seen from the accompanying map (fig. 2). Leirvogur is situated on the fringe of this anomalous region. In the immediate vicinity of the observatory, the field is relatively homogeneous over distances of some hundreds of metres. A survey of the field strength across the observatory grounds is shown in fig. 3. The site represents the best choice within reasonable distance of Reykjavík. The geology of this part of Iceland makes it virtually impossible to find a place where an ideal "undisturbed" field can be observed. To improve on Leirvogur, the observatory would have to be moved more than 100 km away from Reykjavík; and, from the point of view of running the observatory, such a distant location could not be considered at the present time.

The elevation of the observatory is 5 m above mean sea level. At high tide the sea approaches as close as 0.5 km from the observatory, while at low tide the water line recedes to a distance of 3 km.

Fig. 1

The location of Leirvogur observatory and the Science Institute in Reykjavík (black triangles). The broad lines mark the seashore and inland lakes. Faint lines are 100 m elevation contours. Broken lines indicate main roads.

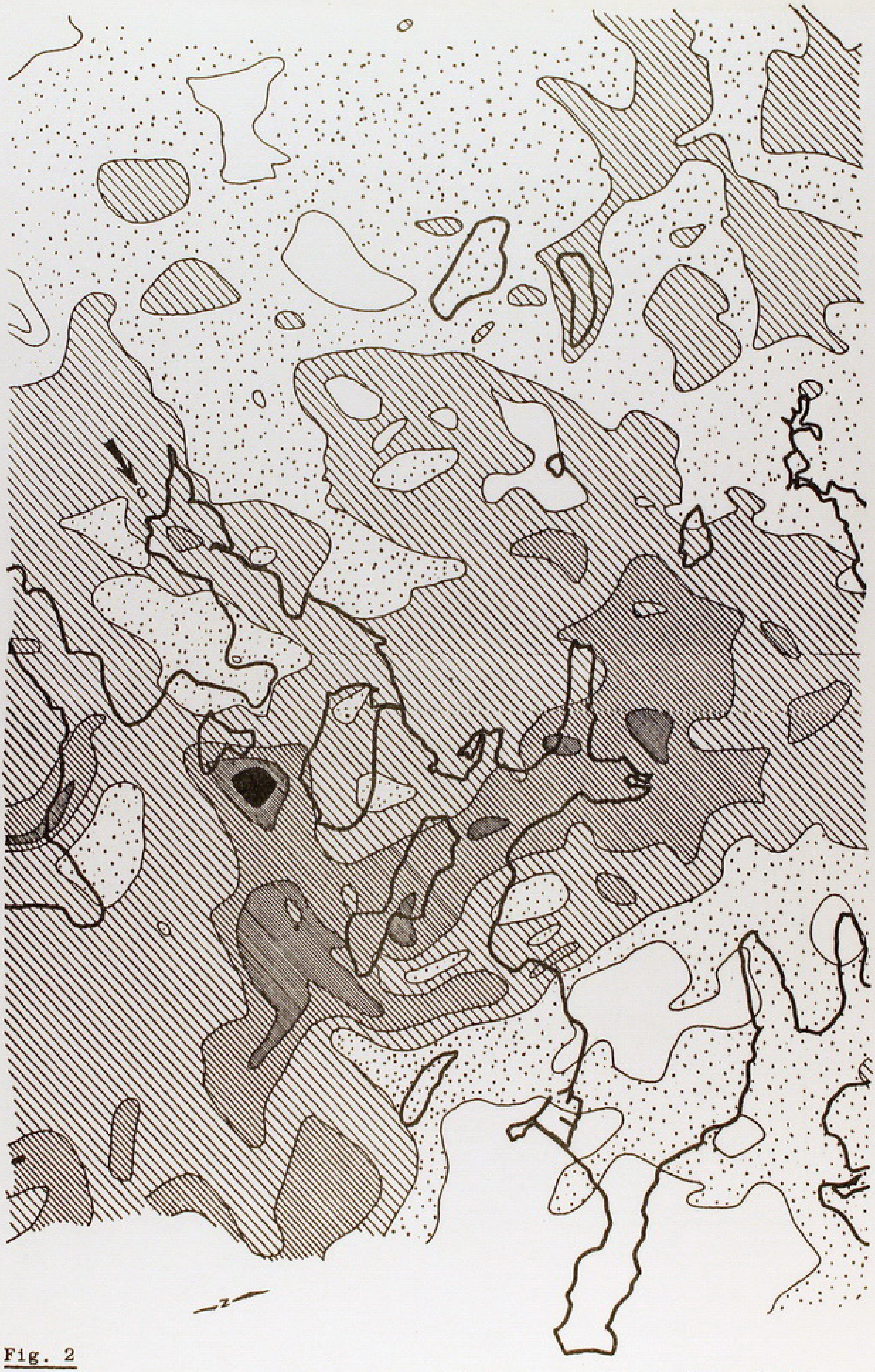


Fig. 2

Map of the total field strength (F) in the vicinity of Reykjavík. The seashore and inland lakes are shown by broad lines. Relative field strength is indicated by progressively lighter shading from solid black to full white, with contours separated by 1000 γ drawn in. The position of Leirvogur observatory is shown by an arrow (cf. fig. 2 for geographical orientation). The map is based on the 1959 survey by Hunting Survey Corporation Ltd. (see Appendix II).

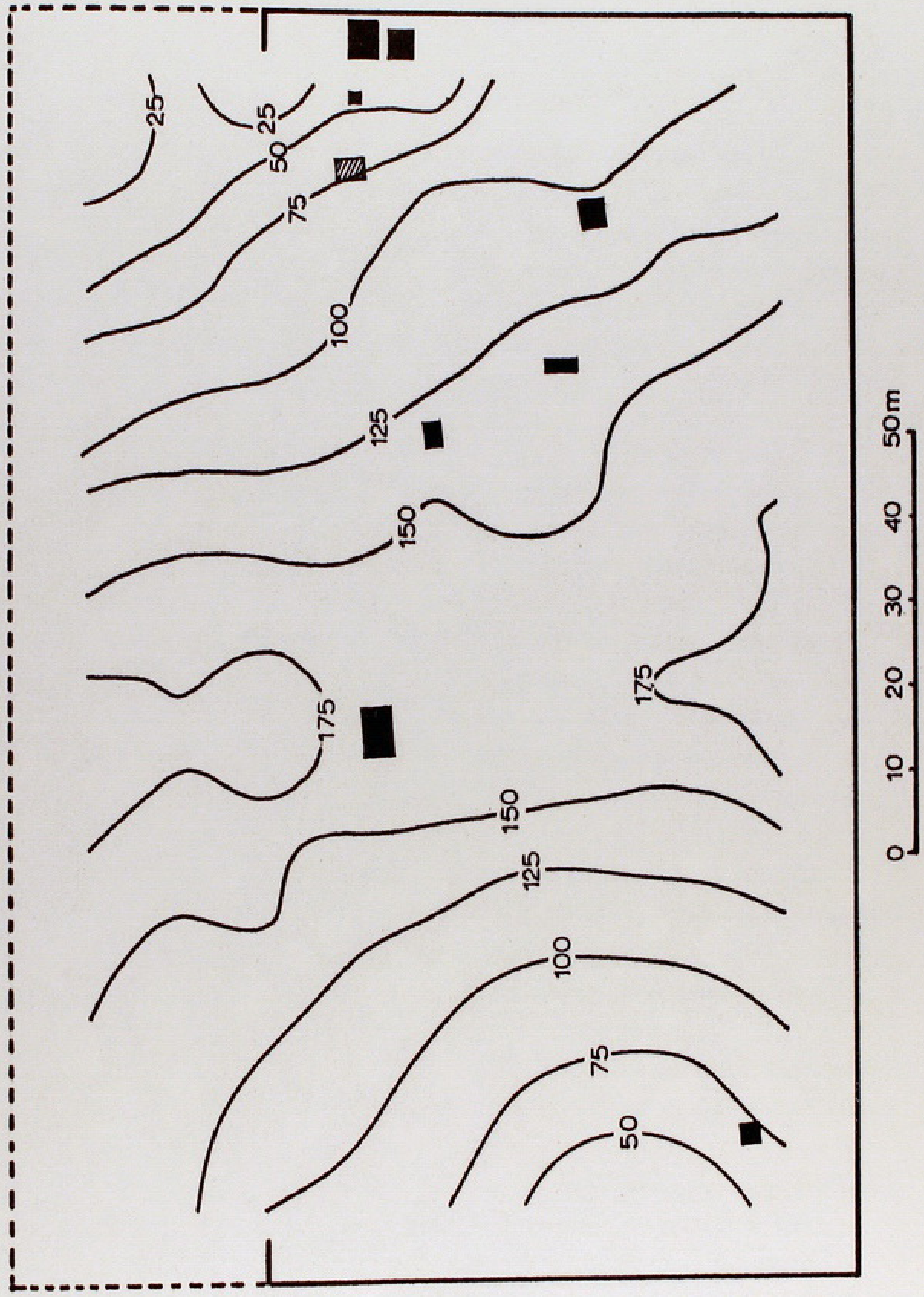


Fig. 3

Variation of the total magnetic field strength (F) inside the Leirvogur observatory grounds. For the sake of clarity the north side of the main fence is only partly drawn (cf. fig. 4). Adding 49900 γ to the contour figures gives the value of F at $16^h\ 00^m$ U.T. on June 29th 1966. Fences and buildings are drawn with less precision than in fig. 4.

The river Leirvogsá runs close to the observatory grounds, and precautionary measures are needed to ensure that the river does not endanger the observatory, especially in wintertime when the flow may be seriously obstructed by ice. Sudden thaws present a similar hazard. On several occasions bulldozers have been used to make defense walls at critical points along the river.

3. Buildings

At the present time (1969) there are nine buildings on the observatory grounds. The relative positions of these buildings are shown in fig. 4 with numbers 1 to 9 relating to the order of construction.

1. Vesturbær, the variometer house, built in 1956. This is a wooden hut, 3.5 m × 5.8 m, insulated by a 10 cm thick layer of rockwool. The foundation is of pumice-concrete. The design was based on drawings of the Nurmijärvi geomagnetic observatory in Finland. The house was unheated up to March 1965, when electric heating was installed.
2. Miðbær, the hut for absolute measurements, built in 1957. This is a wooden shed, 2.1 m × 3.1 m in size, with no insulation and no heating. It contains a non-magnetic pillar which serves as the reference point of the observatory. The foundation of the pillar is made of pumice-concrete.
3. Austurbær, the induction recorder house, also used for general purposes. Built in 1957 of the same materials as Vesturbær. Size 3.6 m × 4.6 m.
4. Suðurbær, a 2.8 m × 2.8 m hut made from pumice blocks with a wooden roof. Constructed in 1958 to house an induction coil.
5. Hitaskúr, a tiny hut (1.5 m × 1.5 m) made from the same materials as Suðurbær. Built in 1958 to house a gas stove for heating Austurbær.
6. Nýbær, the riometer house and the present "operating centre" of the observatory. Built in 1965 of wood insulated by polystyrene foam and coated by fibreglass. Size 3.0 m × 3.5 m. Electrically heated.
7. Móðabær, a tent-shaped wooden hut with aluminium roof, measuring 1.7 m × 3.7 m at the base. Built in 1966 to house a

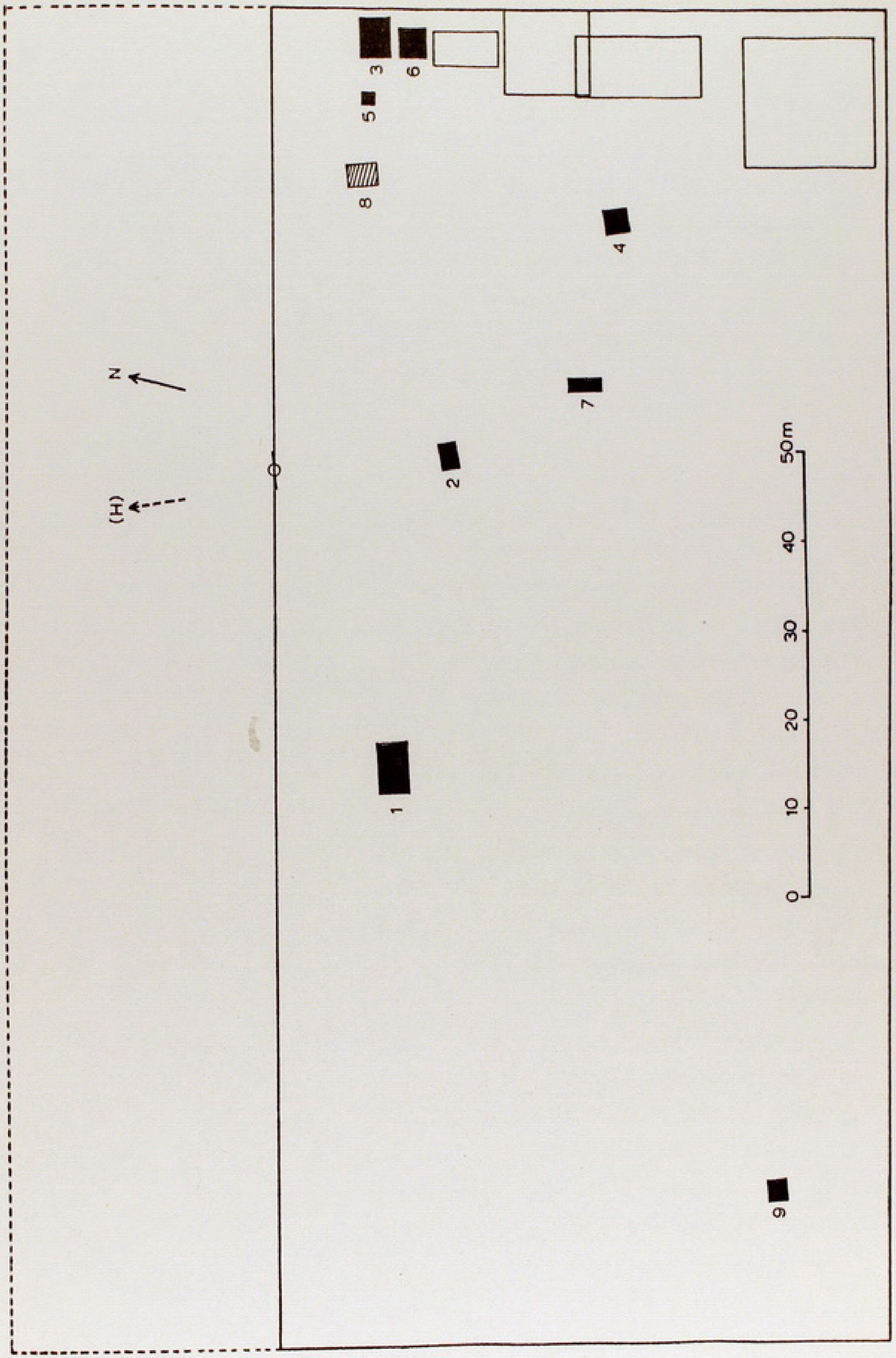


Fig. 4

Plan of Leirvogur observatory. The boundary is a barbed wire fence; on the north side the wire is of aluminium. The dotted line marks an outer fence which is incomplete. Buildings are shown by filled rectangles; open rectangles are riometer antennas. The position of the transmitting antenna is indicated by a circle on the north fence. The arrow labelled H marks the direction of magnetic north. For explanation of numbers, see text.

continuous proton-precession magnetometer.

8. Axelsskúr, a temporary hut introduced in 1967 to shelter a 3-component induction coil system. Size 2.6 m × 3.5 m, wooden construction.

9. Vansahús, a wooden hut, size 2.2 m × 2.5 m, erected in 1967 to protect an induction coil.

4. Power supply

Electric power for the observatory was at first supplied by a single lead accumulator (a 6 V car battery) in Vesturbær. Two accumulators were in use and were charged on alternate days at a nearby farm. When Austurbær was built, two similar accumulators were placed there to provide a 12 V supply and keep the accumulator in Vesturbær charged. The two accumulators were replaced daily by a fully charged set brought from the farm.

The nature of the equipment in Austurbær made it necessary to install a heating system of some kind. This was done by placing a gas stove in Hitaskúr and by piping hot water to an oven in Austurbær.

In November 1964 a 220 V cable was laid from the farm of Leirvogstunga, 700 m away. This cable made it possible to keep the batteries in Austurbær charged and provide thermostatically controlled heating in Vesturbær, Austurbær and Nýbær. The gas stove in Hitaskúr was then disconnected and the accumulator in Vesturbær removed.

In 1966, increased power requirements made it necessary to extend a high tension power line from Leirvogstunga towards the observatory. To avoid interference with the riometers, the transformer was placed some 200 m from the eastern edge of the observatory grounds. From there, a new low tension sub-surface cable was laid to the observatory. Shortly afterwards the 6 V accumulators in Austurbær were replaced by 12 V accumulators.

5. Instrumentation

In 1957, two sets of three-component La Cour variometers were installed in Vesturbær as shown in fig. 5. One set has a normal recorder running at a speed of 15 mm/hour, the other a quick-run recorder with a recording speed of 180 mm/hour. Both use photographic

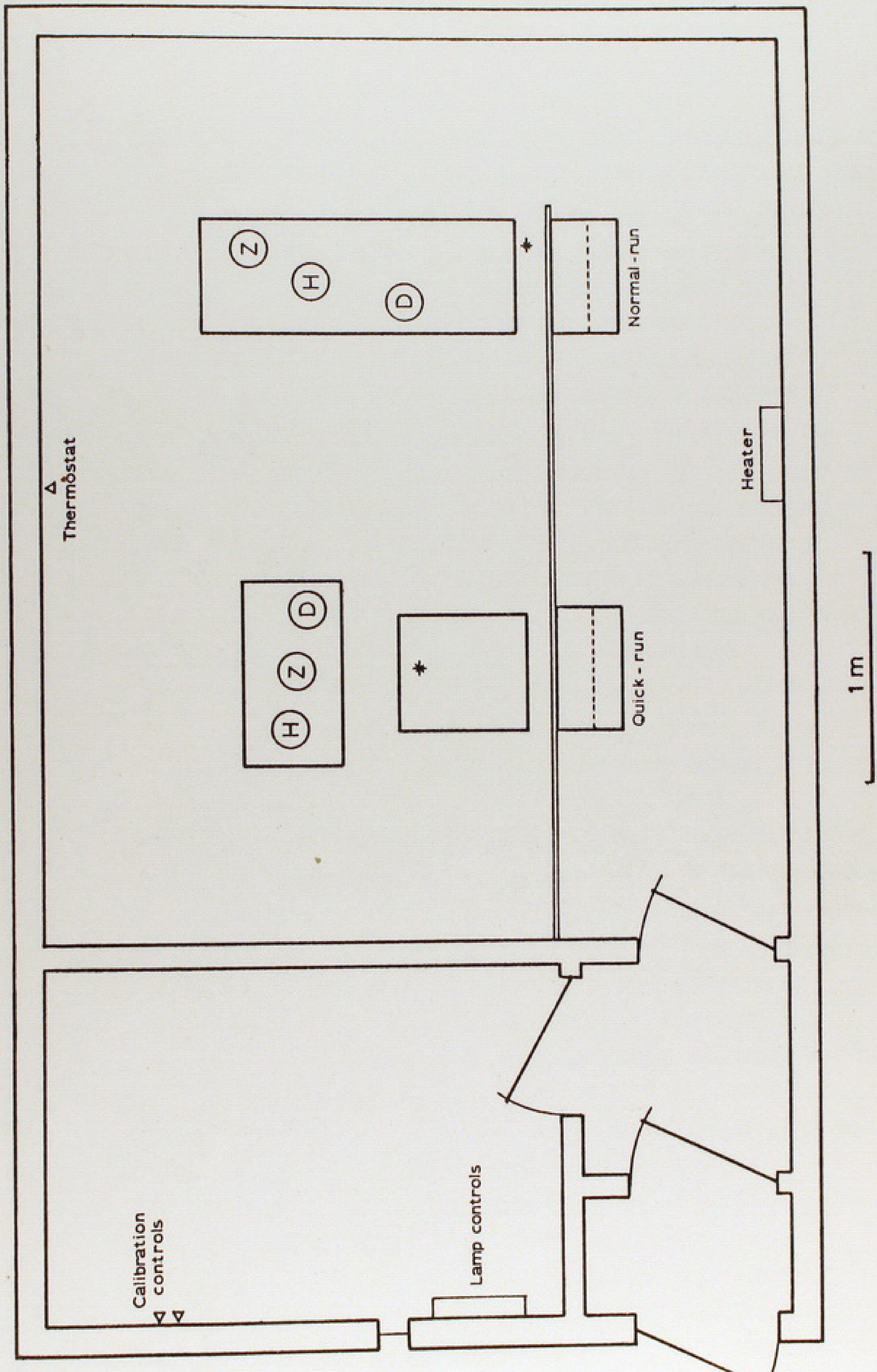


Fig. 5

Vesturbær, the variometer house. The plane of registration is shown by dotted lines.

paper for registration. The approximate scale values of the normal-run records are 15 γ/mm for H and Z, and 2.3 '/mm (corresponding to 8 γ/mm) for D. The scale values of the quick-run records are of the order of 7 γ/mm for H, 6 γ/mm for Z, and 1.4 '/mm (corresponding to 5 γ/mm) for D. The variometer magnetis are oriented with reference to the magnetic meridian through the reference pillar in Miðbær.

In June 1958 the La Cour variometers were supplemented by an induction type variometer housed in Suðurbær. This consists of a coil 2 m in diameter with 750 turns of copper wire. The axis of the coil is in the N-S direction (magnetic). The induced current is passed directly through a galvanometer in Austurbær. The current variations are registered on photographic paper on a helically rotating drum moving at a speed of 1 mm/sec. This arrangement is effective for observing pulsations up to a frequency of about 1.5 Hz. The equipment was supplied by Prof. Benioff of the California Institute of Technology. Dr. Gunnar Böðvarsson of Raforkumálastofnunin (The State Electricity Authority) arranged the loan and further directed the building of Austurbær to house the recorder. The building was financed by Raforkumálastofnunin.

Towards the end of 1962, registration of the total magnetic force was begun with a proton-precession magnetometer built at the University Physical Laboratory (ref. Proc. of the Fifth International Instruments and Measurements Conference, Stockholm 1960, p. 917). This instrument has been called Magni. The probe was fixed in Miðbær whilst the electronics were placed in Austurbær. The equipment was made to receive pulses from the observatory clock and take measurements at fixed intervals. The interval was at first set to 6 minutes but soon changed to 10 minutes. Registration is performed by means of an 8 mm cine camera which photographs a matrix showing both the magnetometer reading and the time. In 1965 the recorder and electronics were moved to Nýbær.

In the beginning, two Quartz Horizontal Magnetometers (QHM 317 and QHM 318) and one Magnetic Zero Balance (BMZ 127) were available for making absolute (or semi-absolute) measurements. All three instruments were of the La Cour type. After the introduction of the proton magnetometer (1961) the BMZ soon became redundant. In 1965 a third QHM instrument (QHM 602) was purchased for further control.

In addition to the magnetic instruments, four riometers were installed at Leirvogur in 1965. This was done at the initiative of Dr. J.K. Hargreaves of the National Bureau of Standards, Boulder, Colorado, and Dr. C.F. Sechrist of HRB-Singer Inc., State College, Pennsylvania. These two, working independently, supplied all the equipment. The location of the riometer antennas can be seen in fig. 4. The recorders were placed in Nýbær. The riometers operate at the following frequencies: 20, 26.3, 30 and 40 MHz.

In 1966 the construction of a new type of proton-precession magnetometer was completed at the Science Institute. This work, which began at the Physical Laboratory in 1964, was led by Prof. Sigurgeirsson. It involves the development of an idea described by H. Benoit (C.R. Acad. Sci. 1958, p. 3053, and Ann. Physique 1959, p. 1440) and further discussed by Grivet, Blaquiere, Bonnet and others. The instrument produces a continuous tone signal, the frequency of which varies with the strength of the magnetic field to be measured. Further details will be published elsewhere. The new magnetometer was given the name Móði, and a special hut (Móðabær) was made to protect the probe and the associated pumping system. The electronics were placed in Nýbær. Registration is on punched tape. The output gives a measure of the mean field strength over each hour, but shorter intervals can be measured if required.

In 1967 the old power line from Leirvogstunga was connected to a telephone exchange to carry the signal from Móði to the Science Institute in Reykjavík, where a pen recorder was used to monitor the field. The use of the telephone line turned out to be too costly, and in 1968 a UHF radio link was established instead. The position of the transmitting antenna is shown in fig. 4.

In 1966 a new ultra-low-frequency induction magnetometer was installed at Leirvogur at the suggestion of Dr. W.H. Campbell of the NBS, Boulder, who furnished the equipment. The sensor is a 2 metre diameter loop antenna of 16 000 turns, buried in the ground under Vansahús, with the axis in the magnetic N-S direction. The signal is recorded on magnetic tapes in Austurbær, both direct and FM. There is also a chart recorder monitor. The unit is designed to observe in the frequency range 4 Hz to 0.003 Hz. A crystal-controlled clock is incorporated into the recording system. Owing to malfunction of the clock and accidental damage to the sensor, the system did not come into steady operation until 1968.

In 1967 a 3-component set of induction variometers of the Grenet type was brought to the observatory on a temporary basis. This was done by Mr. Axel Björnsson as a part of his work for an M.Sc. (Diploma) degree in physics at the Institute of Geophysics in Göttingen. The equipment was the property of the State Electricity Authority. The sensors were placed in Axelsskúr and the recorder in Austurbær. The detection range is from approximately 0.2 Hz to 0.003 Hz. The equipment has been operated from time to time, as required by Mr. Björnsson's research programme.

6. Time control

When the observatory was first established, time marks for the magnetograms were obtained from a pendulum clock in Vesturbær. Because of interference with the variometer magnets, the clock was moved to Austurbær at the first opportunity (1958). The clock provided hourly and five-minute time marks for all recorders. Samples of magnetograms from this period are shown in fig. 6. The marks are free from parallax, except on the quick-run records, where the prominent marks have a parallax of about 1 minute. Fainter, parallax-free marks on the trace itself can just be discerned.

In March 1963 the pendulum clock was superseded by a crystal clock made at the Physical Laboratory. The crystal clock was also housed in Austurbær and supplied 1-minute, 10-minute, 1-hour and 24-hour marks for the La Cour and Benioff variometers, and 1-minute pulses for the timing unit in the proton magnetometer Magni. Fig. 7 shows the appearance of the magnetograms after the introduction of the crystal clock. The 1-hour and 24-hour marks on both the normal-run and quick-run records have a parallax of about 1 minute. This can be detected by comparison with the nearest 10-minute marks, which are free from parallax.

The crystal clock was moved to Nýbær in 1965 and subsequently made to provide 24-hour marks for the riometers, 1-hour pulses for the continuous proton magnetometer Móði, and time marks for the Grenet induction variometers.

The time kept at the observatory is Universal Time. From the beginning the clocks have been controlled by listening to radio time signals on 10 or 15 MHz (WWV, Rugby and other stations). A special WWV receiver which arrived in 1966 as part of Dr. Campbell's equipment

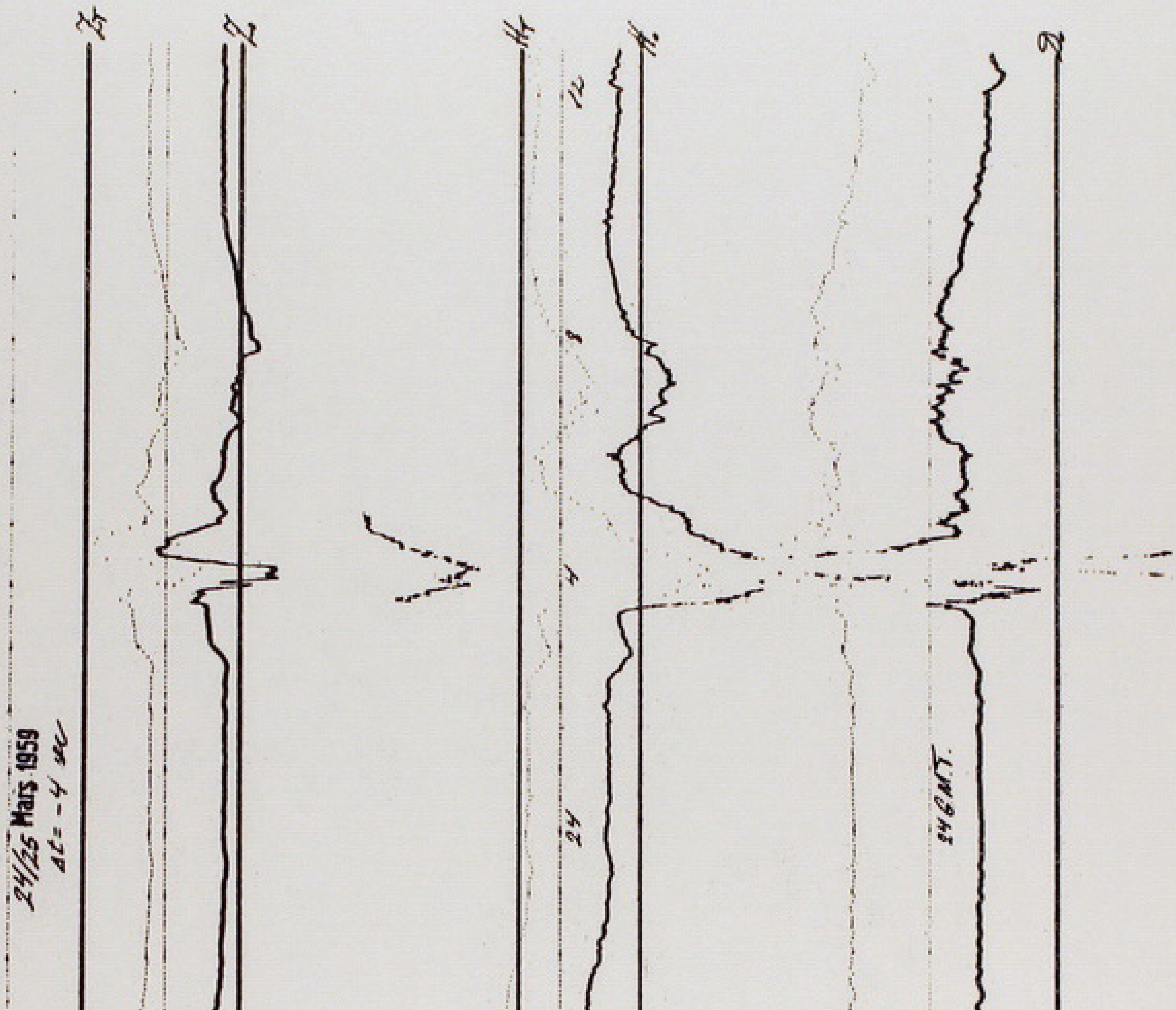


Fig. 6 (a)

Appearance of a normal-run magnetogram from Leirvogur up to 1963.

Fig. 6 (b)

Appearance of a quick-run magnetogram from Leirvogur up to 1963.

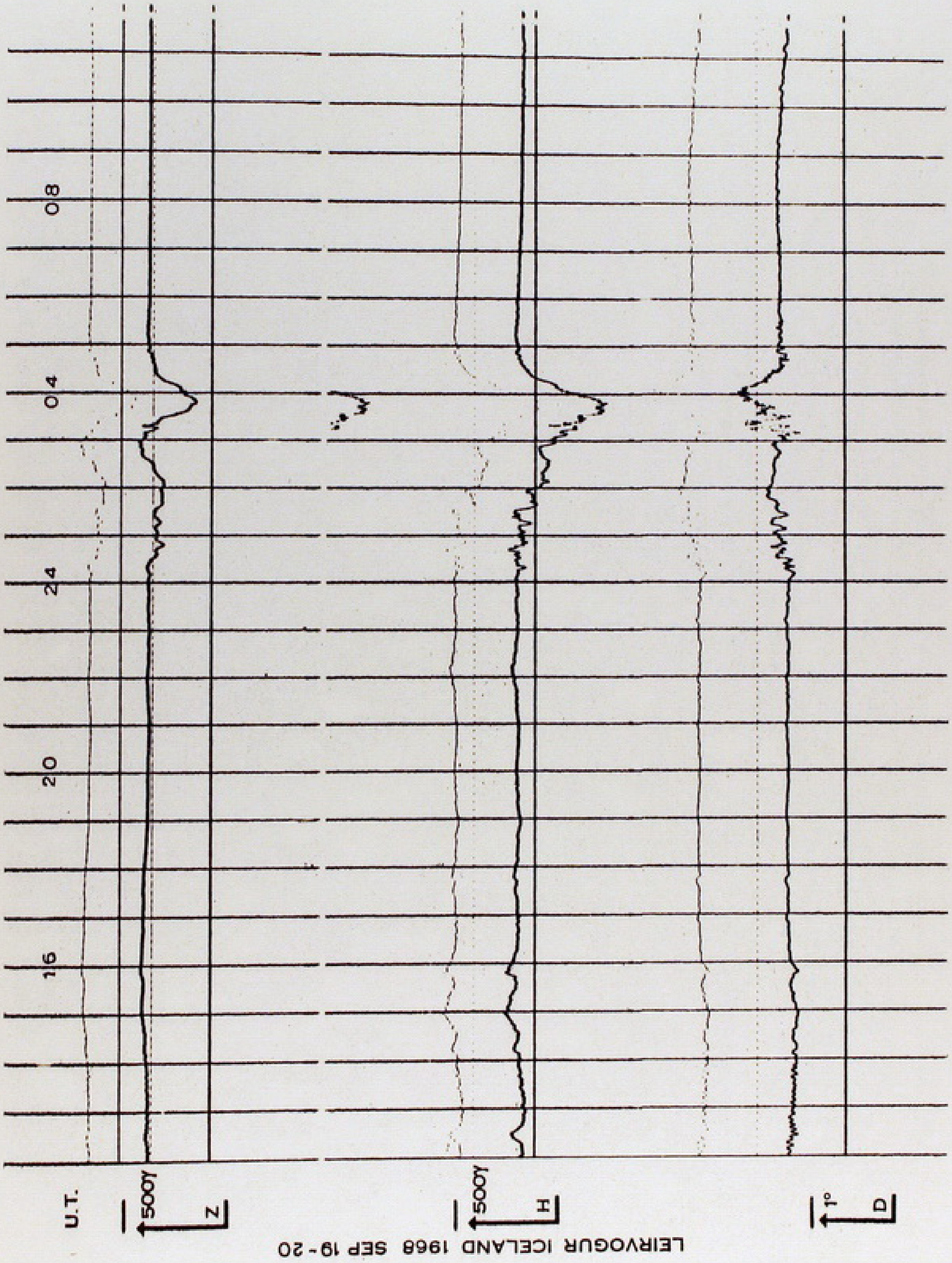


Fig. 7 (a)

The present appearance of a normal-run magnetogram from Leirvogur.

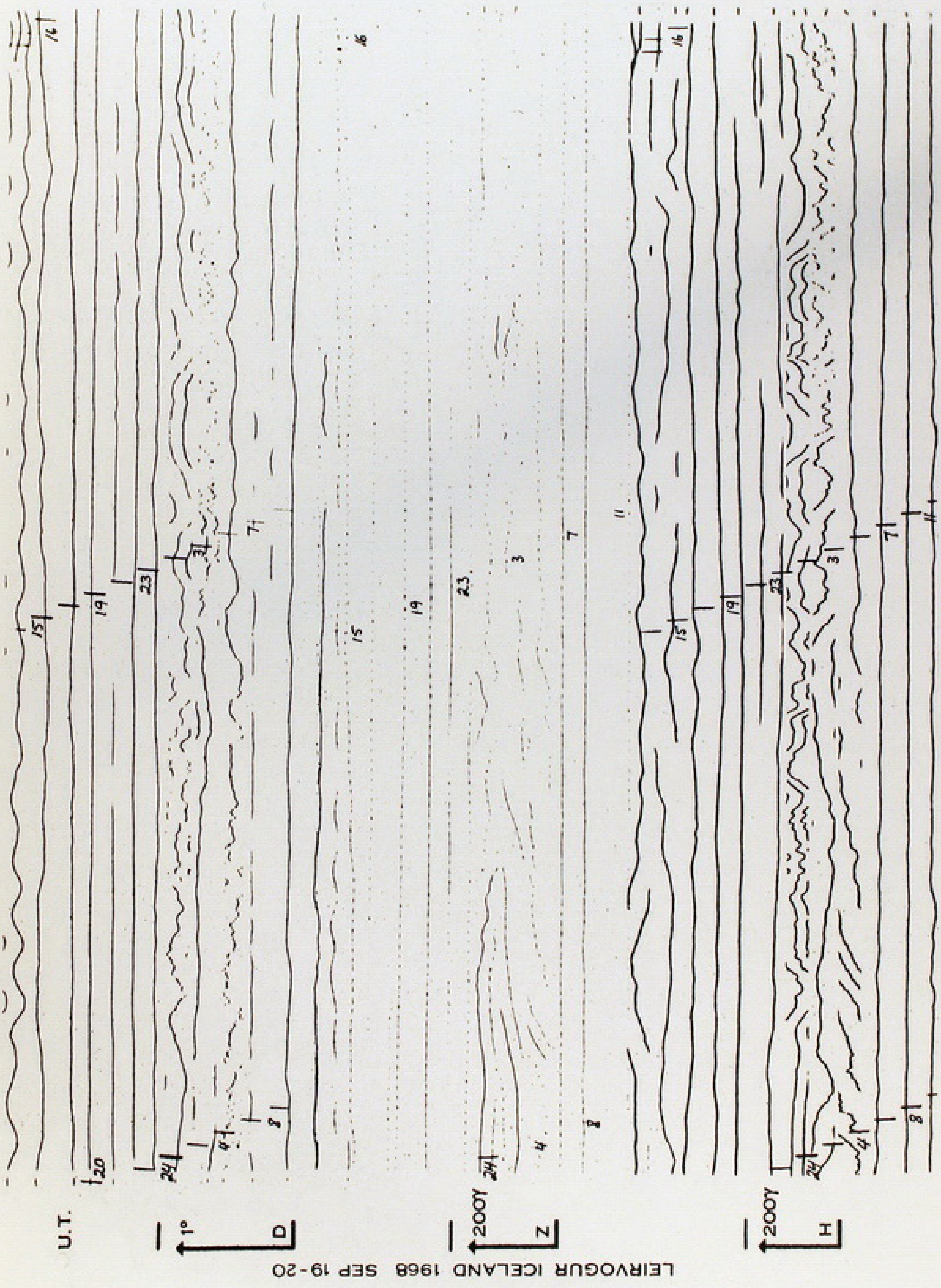


Fig. 7 (b)

The present appearance of a quick-run magnetogram from Leirvogur.

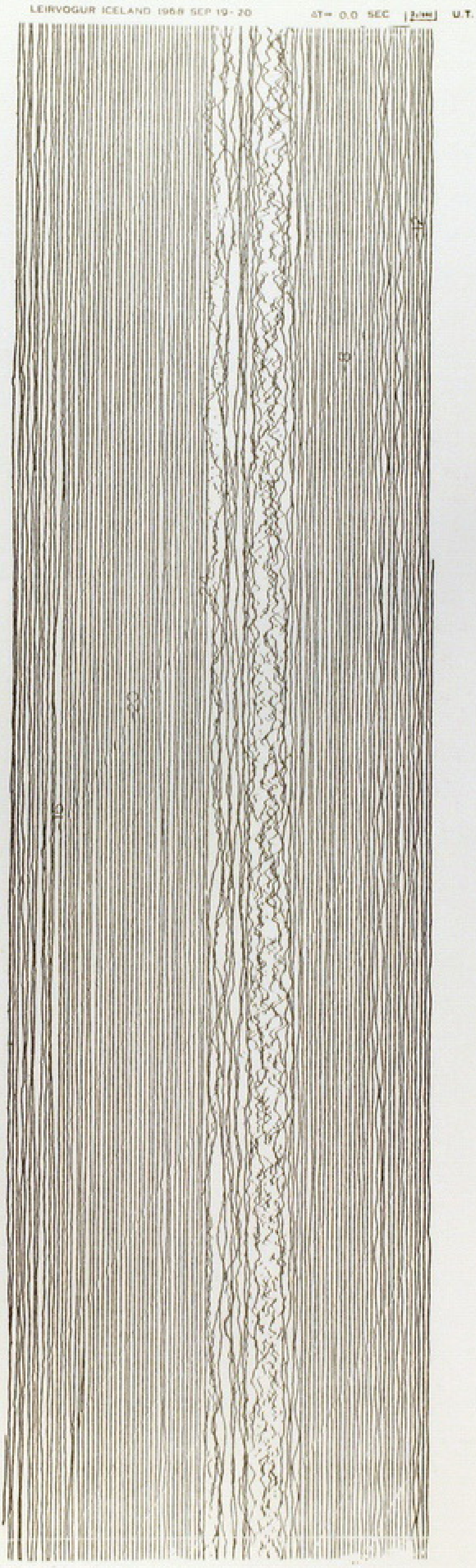


Fig. 7 (c)

The present appearance of a Benioff induction magnetogram from Leirvogur.

made the time control considerably easier. According to an estimate, the maximum time uncertainty was about 1 second while the pendulum clock was in use, but only 0.2 seconds after the crystal clock came into operation. The error of the pendulum clock was kept within 20 seconds. The crystal clock has an average drift rate of 1-2 seconds per month. It is checked at least once a week to keep the error from exceeding 1 second. Since 1966 the checks have been made almost every day, or whenever reception conditions have permitted. The crystal clock in Dr. Campbell's equipment (see previous section) has also been checked daily; its stability has been improving and is now similar to that of the observatory clock.

7. Scale values

The scale values of the La Cour magnetograms are determined by passing a known current through a Helmholtz coil placed over the variometer in question. This has been done about twice a year.

The sensitivity of the Benioff induction magnetograms is checked by introducing a measured e.m.f. (usually 10 μV) into the galvanometer-coil circuit. This is done daily and the resulting calibration mark appears at the beginning of each record. In addition, the response of the magnetometer to rapid pulsations has been determined by rotating a small magnet on the coil axis. Fig. 8 shows the result of one such test, carried out in 1964.

8. Base-line values

Base-line values for the normal La Cour magnetograms are found by weekly control measurements in Miðbær. The horizontal component (H) and declination (D) are measured by the QHM instruments. From 1957 to 1960 the vertical component (Z) was measured by the BMZ. During 1961 the proton magnetometer Magni was used side by side with the BMZ and the vertical component derived independently from the total force (F) and the values of H supplied by the QHMs. In 1962 it was decided to dispense with the BMZ altogether in favour of Magni.

The QHM and BMZ measurements are made on top of the reference pillar in Miðbær. The probe of Magni, however, was initially fixed above the door in Miðbær, about 1 m from the pillar. The field difference (about 2 γ) between the location of the probe and the

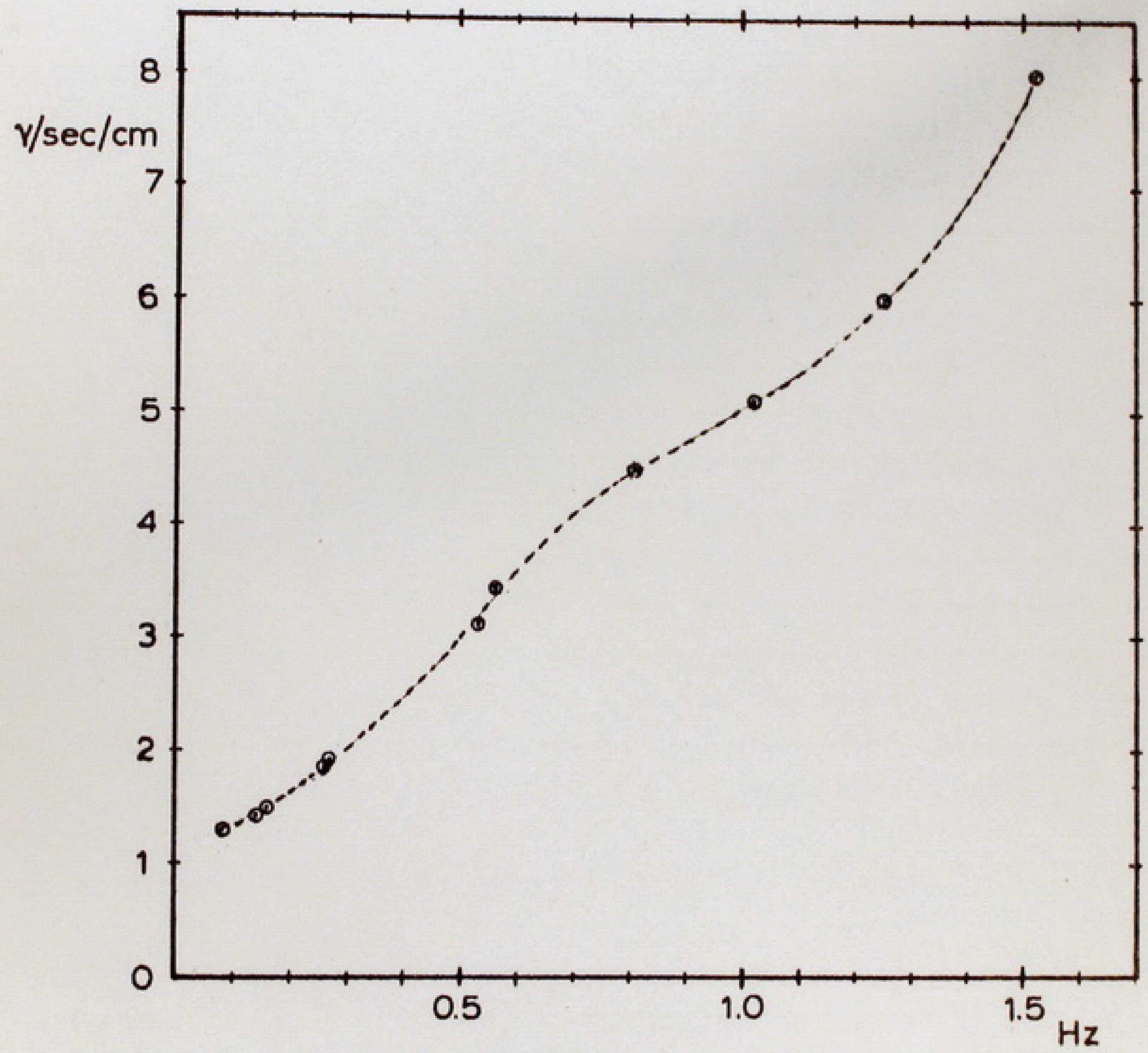


Fig. 8

Calibration of the Benioff induction variometer. The fall-off in sensitivity at high frequencies is due to the limited response of the galvanometer.

pillar was checked periodically and taken into account. In 1967 the probe was moved to the pillar and fixed in position by means of a special box which can be removed when necessary to make way for other instruments.

When the control measurements are made, the ordinary time marks on the magnetograms are interrupted and special time marks introduced by pressing a switch. The time lamp produces sharp and easily measurable images of all base lines and field-tracing lines.

About once a year the QHMs are taken to the Rude Skov magnetic observatory in Denmark for calibration purposes. The base-line values for D and H at Leirvogur are thus dependent on the values at Rude Skov. The same applies to the base-line values for Z up to 1961, as the BMZ instrument was also calibrated at Rude Skov. In 1961, when Z began to be calculated from F and H in the control measurements, the base-line values for Z became primarily dependent on the accuracy of Magni. The possibility of magnetic contamination of the Magni probe can be checked by carrying out a series of measurements with the axis of the probe in different positions. The results of such measurements have shown that the effects of contamination amount to much less than 1 gamma. The oscillator of Magni has also been tested from time to time against a signal of known frequency from the crystal clock. The corrections applied on the basis of these tests have not exceeded 1 gamma.

9. Data reduction and distribution

Scaling of the hourly means of the magnetograms is carried out on a monthly basis and the results (mm values), together with copies of all the regular magnetograms, are sent each month to data centres abroad in the form of 35-mm microfilms. The chief geomagnetic data centre for Iceland is WDC-C1 at the Meteorological Institute in Copenhagen but, by special agreement, since 1963 microfilms have also been sent directly to WDC-A at the Coast and Geodetic Survey in Washington.

Daily values of the magnetic character figure C have been determined for the whole period from 1957 onwards. K-scalings were begun in 1965 and are being extended to cover the preceding years. The K and C values are sent to the Royal Netherlands Meteorological Institute, De Bilt, as well as to the other data centres.

Up to 1965 the original magnetograms from the Benioff induction magnetometer were sent to the California Institute of Technology. Copies were kept in Reykjavík, first at the State Electricity Authority and later at the Physical Laboratory and the Science Institute. Since 1965 the originals have been kept in Reykjavík whilst microfilm copies have been sent monthly to the Department of Geophysics at Stanford University.

The FM tape and one monitor chart from Dr. Campbell's induction magnetometer are sent to Boulder every fortnight. The direct tape and a second monitor chart are kept by the Science Institute.

Calculations of hourly values of the magnetic elements for 1957-1967 have been completed and are published in separate volumes. For the period 1957-1961 the calculations were done by means of conventional electric desk calculators. For the remaining period use has been made of an IBM 1620 II computer at the Computing Centre of the University of Iceland. Since 1964 the computer has also been used to derive base-line values from the QHM- and proton magnetometer measurements.

10. Computation of hourly means

The processing of data to obtain hourly means of the magnetic elements can be divided into two steps, one involving the preparation of the computer input, and the other dealing with the processing itself.

Step I: Preparing the input.

Z, H and D: The scaling of hourly means from the magnetograms is done manually and the values read into a tape recorder. Using this recorded dictation, the data are then punched on cards and are ready for processing.

F (Magni): The 10-minute readings of Magni are read from the film by means of an 8 mm viewer and punched directly on cards. The hourly means are then derived by computer and punched on cards in the same standard form as adopted for Z, H and D.

F (Móði): The hourly values, which are on punched tape, are transferred to punched cards by means of a tape-to-card machine. A special computer programme is used to search for gross errors before the results are changed into the standard form and punched on new cards. The F-values from Magni and Móði are then compared by computer to check for discrepancies. At present the results from Móði are only used for checking purposes and for supplementing the data from Magni during gaps in the operation. In future, however, this situation is likely to be reversed, and the output from Móði will then be used as primary data.

Step II: Processing.

The input data are first checked by a programme which compares several adjacent values at a time and gives a warning if unlikely values are encountered. When these have been checked, the input data cards (mm-readings, in the case of H, Z and D) are listed in tabular form which may be copied for despatch to the data centres. The cards are next read into the computer which calculates the hourly means in gammas (or minutes of arc) and returns the output on cards. A special programme is used to compare the results for Z and H with those for F. The difference between F and $\sqrt{H^2+Z^2}$ for each hour is tabulated as a final and sensitive indicator of errors. If appreciable errors are found, some of the processing may have to be repeated before the final tables of hourly values are printed.

11. Secular variations

Table I gives a list of the annual means of the magnetic elements at Leirvogur. A closed line separates the measured values from the calculated ones. Comparison with the maps in Appendix II shows that the field at Leirvogur deviates considerably from the ideal mean for that region. From the map the following values would be expected for the position of Leirvogur (1965):

Z	H	D	F	X	Y	I
50090	12590	$-25^{\circ}20'$	51650	11380	-5380	$75^{\circ}55'$

Subtracting the above figures from the actual Leirvogur values for 1965 we obtain

Z	H	D	F	X	Y	I
-560	-548	$+2^{\circ}12'.3$	-676	-306	+650	$+25'.1$

Because of the possibility that the secular variations at Leirvogur might be abnormal in some way, comparison measurements have been made at two carefully chosen locations: at Guðnastaðir in S-Iceland ($63^{\circ}34'.7$ N, $20^{\circ}09'.6$ W) and at Húsey in E-Iceland ($65^{\circ}38'.6$ N, $14^{\circ}16'.6$ W). The results of these measurements are given in Table II.

Table I

Annual means of the magnetic elements at Leirvogur 1957-1967

	Z	H	D	F	X	Y	I
*1957	49317	11854	-23 47.9	50722	10846	-4783	76 29.1
	5	18	3.2	9	21	3	-1.1
1958	49322	11872	-23 44.7	50731	10867	-4780	76 28.0
	30	14	5.5	32	20	11	-0.5
1959	49352	11886	-23 39.2	50763	10887	-4769	76 27.5
	51	11	5.3	52	18	13	0.1
1960	49403	11897	-23 33.9	50815	10905	-4756	76 27.6
	26	32	6.9	33	39	9	-1.7
1961	49429	11929	-23 27.0	50848	10944	-4747	76 25.9
	20	33	5.6	27	38	5	-1.8
1962	49449	11962	-23 21.4	50875	10982	-4742	76 24.1
	31	18	5.0	37	23	8	-0.7
1963	49480	11980	-23 16.4	50912	11005	-4734	76 23.4
	24	35	5.0	31	39	3	-1.9
1964	49504	12015	-23 11.4	50943	11044	-4731	76 21.5
	26	27	3.7	31	30	1	-1.4
1965	49530	12042	-23 7.7	50974	11074	-4730	76 20.1
	33	22	3.3	38	25	2	-0.9
1966	49563	12064	-23 4.4	51012	11099	-4728	76 19.2
	50	21	3.6	51	24	3	-0.6
1967	49613	12085	-23 0.8	51063	11123	-4725	76 18.6

(*August to December 1957) The values for D and I are expressed in degrees and minutes; the remaining values are in gammas.

Table II

Comparisons between Leirvogur and two field stations 1960/1965

	Guðnastaðir - Leirvogur	Húsey - Leirvogur	S_L	S_G	S_H
ΔH		+365/333	+145		+113
ΔZ	+467/453	+138/131	+127	+113	+120
ΔF	+655/631	+244/207	+158	+134	+121

The values shown in Table II are in gammas. The first two columns show how the field difference between Leirvogur and the two stations changed from 1960 to 1965. S_L gives the secular change at Leirvogur during that period. S_G and S_H give the secular changes at Guðnastaðir and Húsey as judged from the measurements in 1960 and 1965. These values are somewhat lower (6 % to 24 %) than those obtained at Leirvogur, but more measurements are needed to establish the reality of the difference. Broadly speaking, the present data (Table II) give no reason to question the validity of the secular changes observed at Leirvogur.

12. Personnel

From 1957 to 1962 the observatory was supervised by Þorbjörn Sigurgeirsson, professor and Head of the Physical Laboratory. In 1963, Dr. Þorsteinn Sæmundsson joined the laboratory staff and took over the supervision of the observatory. When the Science Institute replaced the Physical Laboratory in 1966, Dr. Sæmundsson remained in charge of the observatory.

Daily attendance of the equipment was initially entrusted to persons living on farms in the vicinity of the observatory. Among these were Mr. Ingólfur Ingólfsson from Fitjakot (1957-58), Mr. Viggó Valdimarsson from Hlégarður (1958-60) and Mr. Haukur Níelsson from Helgafell (1960-65). In 1965 the addition of the riometer equipment made it necessary for someone from the laboratory to visit the observatory each day to take care of routine work and maintenance. The first person assigned to this task was Mr. Vilhjálmur Þ. Kjartansson. He was succeeded in 1966 by Mr. Guðmundur Örn Árnason.

The scaling and microfilming of the magnetograms was undertaken sporadically by various persons until 1963 when Mrs. Þorgerður Sigurgeirsdóttir was engaged as a full-time assistant for the purpose of bringing this work up to date and placing it on a routine basis. During the summers of 1967 and 1968, she was joined by Miss Inga Hersteinsdóttir.

The calculation of hourly means of the magnetic elements was begun by Mr. Halldór Grímsson fil. mag. who dealt with the 1957 data. The calculations were continued by Mr. Einar Júlíusson who completed the work for 1958-61. In 1964, computer programming became an integral part of the observatory work. Up to date, most of the programming has been done by Mr. Júlíusson and Dr. Sæmundsson. Computer processing of the hourly means for 1962-65 was carried out by Mr. Júlíusson. The 1966 data were similarly handled by Mr. Vésteinn Eiríksson, and the 1967 data by Mrs. Sigurgeirsdóttir.

From the beginning, Prof. Sigurgeirsson has played the leading role in the construction of new equipment for the observatory. In the course of his work he has engaged the technical assistance of many people including Mr. Örn Garðarsson, Mr. Björn Kristinsson, Mr. Þorsteinn Halldórsson, Mr. Þorkell Helgason and Mr. Þorvaldur Búason.

The maintenance of the electronics at the observatory has mostly been handled by Mr. Björn Kristinsson, Mr. Vilhjálmur Kjartansson and

Mr. Kristján Benediktsson.

Since 1965, Mr. Óskar Ágústsson has been responsible for most of the repair and construction of buildings and fences on the observatory site. Mr. Guðmundur Örn Árnason has also taken an active part in the manual work involved.

APPENDIX I

Geomagnetic observations in Iceland prior to 1957

The following list gives for each observation the year, the name of the person in charge or the name of the expedition, the place of observation, the components observed, whether the measurements were single (s) or continuous (c), and references. The list may not be complete, and readers are kindly asked to send in any additional information which they may possess.

1672 Þórður Þorláksson

- Skálholt D(s)

(Þorvaldur Thoroddsen: Landfræðisaga Íslands III, 1902, p. 140)

1767 Kerguelen de Tremarec

- D(s)

(Þorv. Thoroddsen: Landfrs. Ísl. III, 1902, p.94)

1772 De la Crenne

- Patreksfjörður D(s)

(Halldór Hermannsson: The Cartography of Iceland, 1931, p. 59)

1786 Löwenörn

- Reykjavík D(s, c), I(s)
- Hafnarfjörður D(s), I(s)
- Dýrafjörður D(s), I(s)

(Nye Samling af det Kgl. Danske Videnskabernes Selskabs Skrifter, /1799)

1806 Frisak

- Flatey D(s)
- Súgandisey D(s)

(Þorv. Thoroddsen: Landfrs. Ísl. III, 1902, p. 264)

1808 Frisak & Scheel

- Akureyri D(s)

(Þorv. Thoroddsen: Landfrs. Ísl. III, 1902, p. 269)

1833 Blosseville

- Vopnafjörður D(s), I(s), H(s)
- Norðfjörður D(s), I(s), H(s)

(Hansteen: Kgl. danske Vidensk. Selsk. Forh. 1861, p. 394)

1836 Lottin ("La Recherche")

- Reykjavík D(s), I(s), H(s)
- Þingvellir D(s), I(s), H(s)

- Hekla D(s), I(s), H(s)
- Selsund D(s), I(s), H(s)

(Hansteen: Kgl. danske Vidensk. Sels. Forh. 1861, p. 394)

<u>1840 De la Roche</u>

- Reykjavík I(s)

(Hansteen: Kgl.danske Vidensk. Selsk. Forh. 1861, p. 394)

<u>1850 Tuxen</u>

- Reykjavík I(s)

(Hansteen: Kgl. danske Vidensk. Selsk. Forh. 1861, p. 394)

<u>1850 Kierulf</u>

- Keflavík H(s)
- Þingvellir H(s)
- Geysir H(s)
- Bjólfell H(s)
- Dýrastaðir H(s)
- Hrútafjörður H(s)
- Þingeyrar H(s)
- Skíðastaðir H(s)
- Fagranes H(s)

(Hansteen: Kgl. danske Vidensk. Selsk. Forh. 1861, p. 394)

<u>1856 De la Roche</u>

- Reykjavík I(s)

(Hansteen: Kgl. danske Vidensk. Selsk. Forh. 1861, p. 394)

<u>1860 Davis</u>

- Reykjavík D(s)

(E. Sabine: Contrib. to Terr. Magn. No. XIII, 1872)

<u>1860 McClintock</u>

- Reykjavík D(s), I(s)

(E. Sabine: Contrib. to Terr. Magn. No. XIII, 1872)

<u>1866 Kierulf</u>

- Keflavík H(s)
- Þingvellir H(s), D(s)
- Geysir H(s), D(s), Z(c)

(Reference missing)

<u>1876 "Væringen"</u>

- Reykjavík I(s)

(Th. Moureaux: Annuaire de la Société Météorologique de France 41, 1893, p. 121)

1892 "La Manche"

- Reykjavík D(s), I(s), H(s)
- Dýrafjörður D(s), I(s), H(s)
- Ísafjörður D(s), H(s)
- Patreksfjörður D(s), H(s)

(Th. Moureaux: Annuaire de la Société Météorologique de France 41, 1893, p. 121)

1902-1903 Birkeland

- Dýrafjörður H(c), Z(c), D(c,s), F(s), I(s)

(The Norwegian Aurora Polaris Expedition 1902-1903, Vol. I, 1908-1913, p. 18)

1910 Angenheister

- Ísafjörður D(s), H(s), I(s)
- Dýrafjörður D(c), H(c), Z(c), I(s)
- Patreksfjörður D(s), H(s), I(s)
- Stykkishólmur D(s), H(s), I(s)
- Reykjavík D(s), H(s), I(s)
- Vestmannaeyjar D(s), H(s), I(s)
- Seyðisfjörður D(s), H(s), I(s)

(Angenheister & Ansel: Nachr. Akad. der Wiss. in Göttingen, Math.-Phys. Klasse, 1912, p. 42)

1914 "Carnegie"

- Reykjavík D(s), I(s), H(s)
- Akranes D(s), I(s), H(s)
- Viðey D(s), I(s), H(s)
- Grótta D(s), I(s), H(s)
- Kjalarnes D(s), I(s), H(s)

(Carnegie Institution of Washington Publication No. 175, Vol. IV, 1921, p. 91 & p. 337)

1928 "Carnegie"

- Reykjavík D(s), I(s), H(s)

(Carnegie Institution of Washington Publ. No. 175, Vol. VIII, 1947, p. 137 & p. 217)

1929 "Pourquoi-Pas ?"

- Akureyri D(s), I(s)
- Vatneyri D(s), I(s)
- Þingvellir D(s)

(Charcot: Rapport préliminaire sur la campagne de Pourquoi-Pas ?)

1932-1933 Þorkell Þorkelsson

- Reykjavík H(c), Z(c), D(c)

(IATME Bull. No. 10, 1937, p. 441)

1937 Þorkell Þorkelsson

- Reykjavík H(c), Z(c), D(c)

(D. la Cour & S. Chapman, IATME Bull. No. 11, p. 263. D. la Cour: Terr. Mag. 43, 1938, p. 199)

1954 Þorbjörn Sigurgeirsson

- Reykjavík D(c)

(Unpublished)

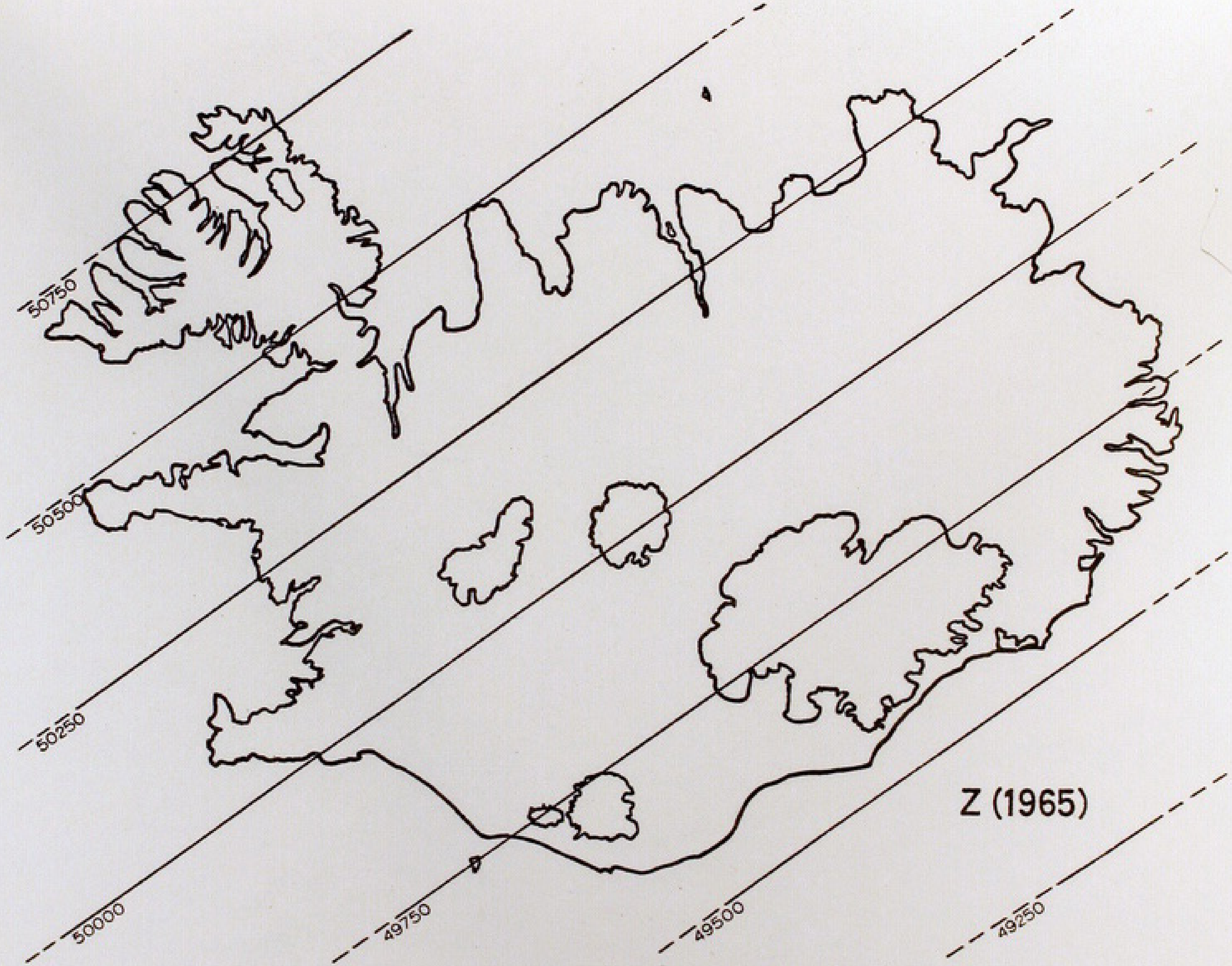
APPENDIX II

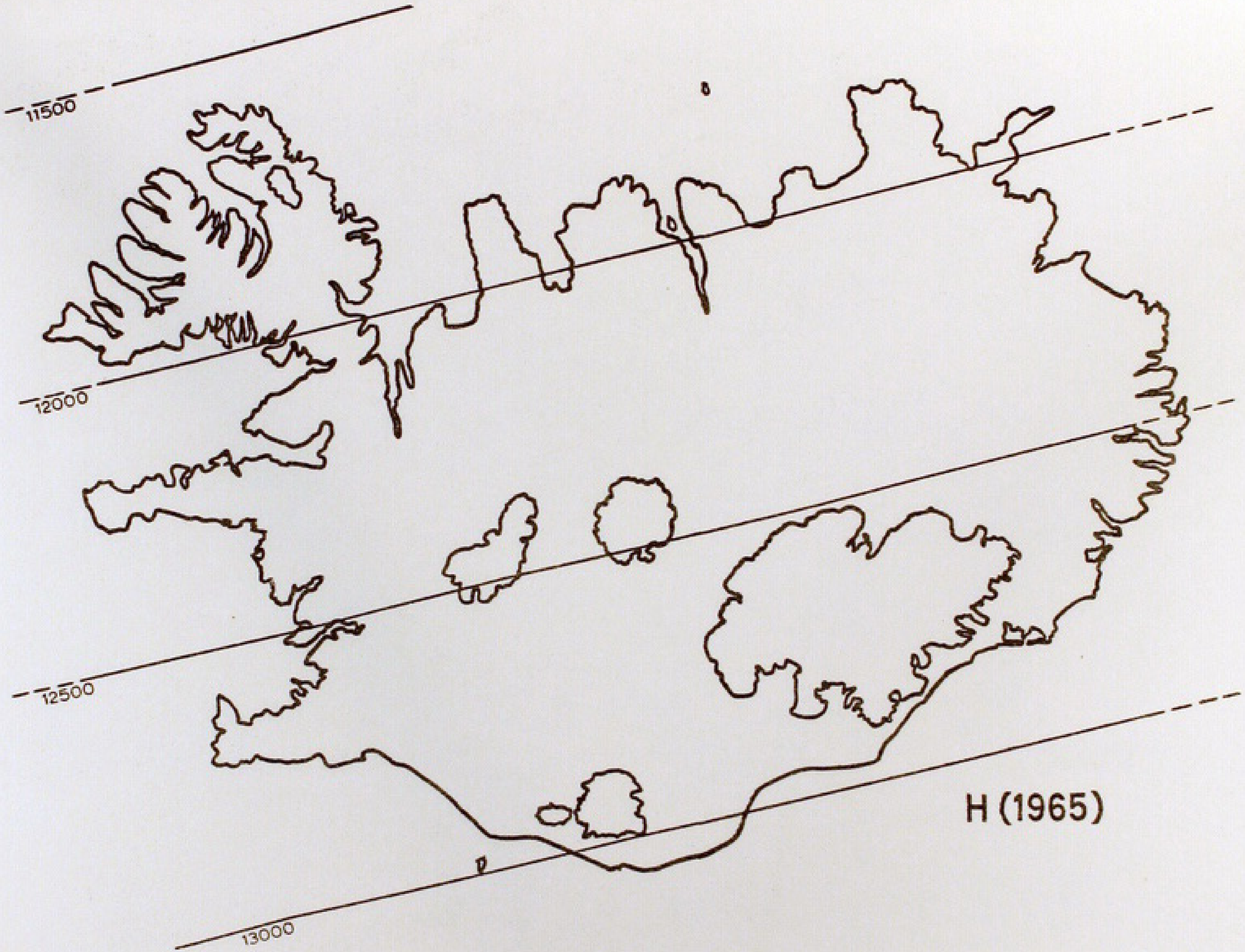
Magnetic maps of Iceland

In 1959, Hunting Survey Corporation Ltd. of Toronto made a survey of a 300 km^2 area in SW-Iceland, including the town of Reykjavík. The survey was made from an aeroplane flying at an altitude of 150 m with a track spacing of 500 m. Only the total intensity (F) was measured. The survey was financed by Hitaveitan, the Reykjavík Municipal Heating Service. It resulted in a series of detailed maps, each showing a relatively small area. These maps were later united into a single, less detailed version by the State Electricity Authority. The map in fig. 2 is based on that secondary version.

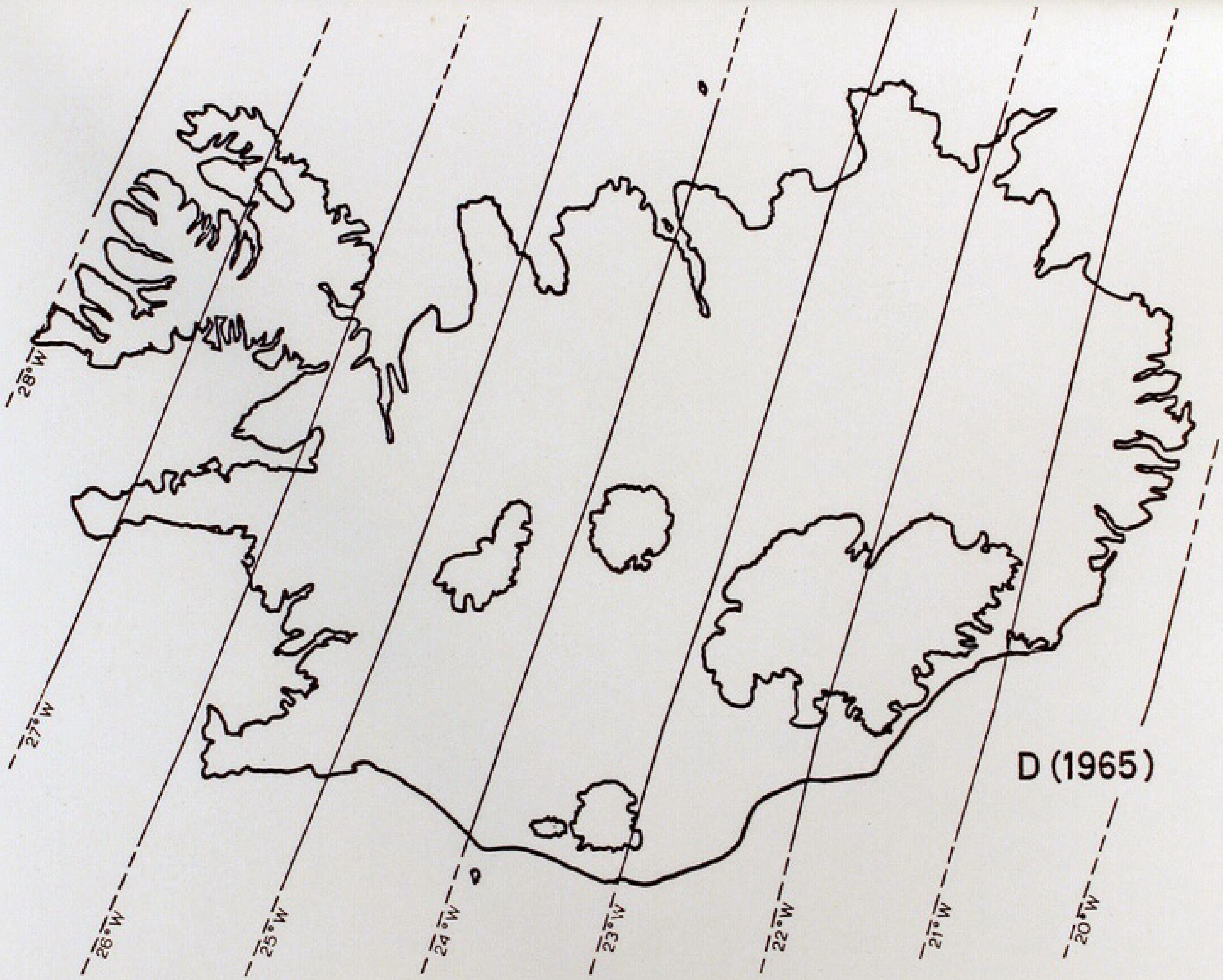
In 1964, the U.S. Naval Oceanographic Office carried out an aeromagnetic survey of the region around the volcano Surtsey out to a distance of 30-80 km, thereby covering part of S-Iceland. The flights were made both at 600 m and 1800 m altitude, with track spacings of 1-4 km. The survey, which was included in "Project Magnet", was repeated in 1966.

In 1965, the Dominion Observatory in Ottawa undertook an airborne magnetic survey of the Nordic countries, including Iceland. The flights over Iceland were made at an altitude of 3300 m to 4000 m along tracks running from SE to NW with a spacing of approx. 40 km (ref. Serson, Hannaford and Haines, Science, Vol. 160, 1968, p. 355). From results supplied by Dr. Paul Serson, smoothed magnetic maps have been prepared and are shown on the following pages. The maps refer to sea level; the approximate gradients in γ/km are as follows: $\Delta X = + 4.5$, $\Delta Y = - 2.5$, $\Delta Z = + 21.0$, $\Delta H = + 5.0$.

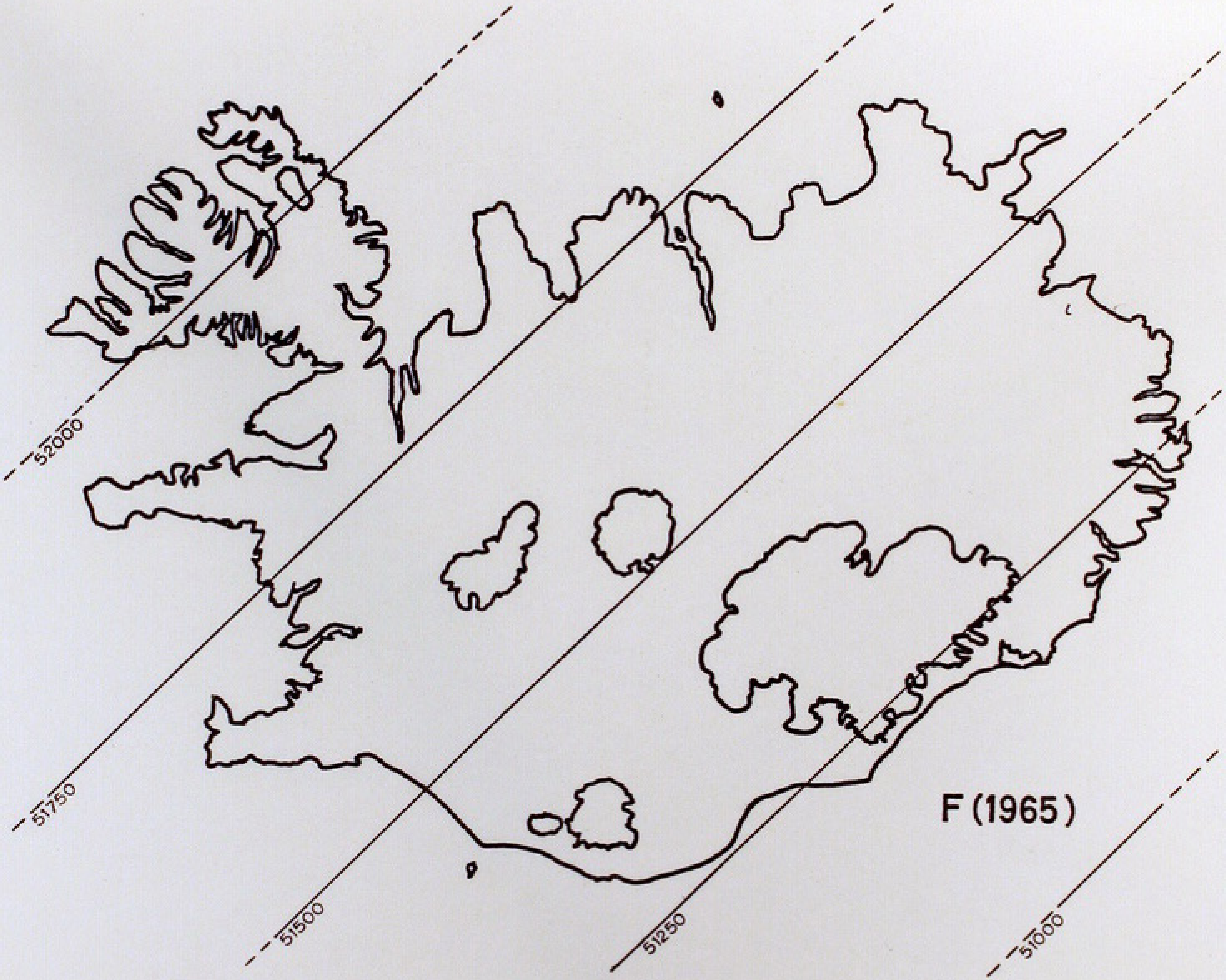

50750
50500
50250
50000
49750
49500
49250
Z (1965)



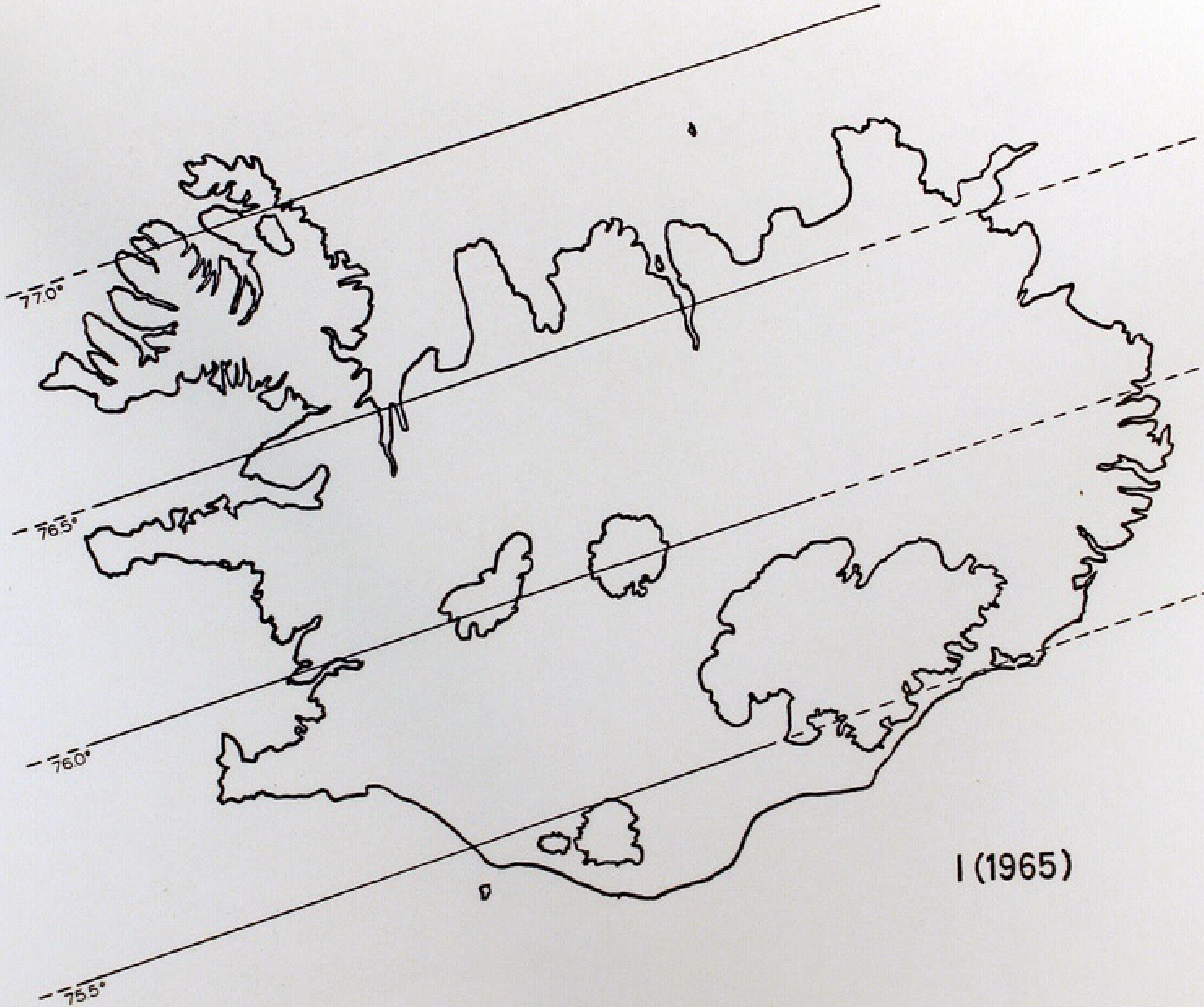
H (1965)



D (1965)



F (1965)



I (1965)

Contents