BRITISH GEOLOGICAL SURVEY

GEOMAGNETIC BULLETIN 23

Magnetic Results 1993

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES

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T D G Clark, D J Kerridge and T J Harris

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1 INTRODUCTION

This bulletin is a report of the measurements made between 1 January and 31 December 1993 at the UK geomagnetic observatories operated by the British Geological Survey (BGS) at Lerwick, Eskdalemuir and Hartland.

The three observatory sites are described, with notes of any changes made during the year and a description is given of the Automatic Remote Geomagnetic Observatory System (ARGOS), operated at each observatory since 1 January 1987 (Riddick *et al.* 1990). The method of collecting the data from each observatory, the quality control procedures and the method of reducing the data to absolute values are also outlined.

The presentation of the data in this bulletin is principally in graphical form, with complete sets of daily magnetograms derived from one-minute values, and plots of hourly and daily mean values for each observatory. The data are available in digital form on request (details are given in Section 7).

2 DESCRIPTIONS OF THE OBSERVATORIES

The locations of the UK geomagnetic observatories are shown on the front cover of the bulletin. The history of the current UK geomagnetic observatories, and of other observatories that have operated in the British Isles, is described by Robinson (1982).

Lerwick (Shetland, Scotland)

Lerwick Observatory is situated on a ridge of high ground about 2.5 km to the SW of the port of Lerwick. The surrounding countryside is moorland comprising peat bog, heather and outcropping rock. The observatory is operated by the Meteorological Office as a meteorological station carrying out routine synoptic observations and upper-air measurements. Other work includes detection of thunderstorms, measurement of solar radiation, ozone and atmospheric pollution levels, and chemical sampling. BGS uses Lerwick as a seismological station, recording data from a local three-component seismometer set and, via radio link, from the Shetland seismic array.

Lerwick was established as a meteorological site in 1919 and geomagnetic measurements began in 1922. Responsibility for the magnetic observations passed from the Meteorological Office to BGS in 1968. There are no members of BGS staff stationed at Lerwick.

Figure 1 is a site diagram of Lerwick Observatory. During 1993 no major changes were made at the site. Routine maintenance work was carried out on the observatory buildings.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	60°08′N	62°04′N
Longitude	358°49′E	89°27′E
Height above *msl*	85 m	

Geomagnetic coordinates used in this report are relative to a geomagnetic pole position of 79°14′N, 71°17′W, computed from the 6th generation International Geomagnetic Reference Field (Langel, 1992) at epoch 1993.5.

Eskdalemuir (Dumfries & Galloway, Scotland)

Eskdalemuir Observatory is situated on a rising shoulder of open moorland in the upper part of the valley of the river White Esk in the Southern Uplands of Scotland. It is surrounded by moorland and young conifer forest with hills rising to nearly 700m to the NW. The observatory is 100km from Edinburgh and 25km from the towns of Langholm and Lockerbie.

Eskdalemuir is a synoptic meteorological station involved in measurement of solar radiation, levels of atmospheric pollution, and in chemical sampling. The observatory operates a US standard seismograph and an International Deployment Accelerometer Program long-period sensor. BGS has a three-component seismometer set installed at the observatory and records data from four remote sites transmitted to the observatory by radio link. The observatory opened in 1908. It was built because of disruption to geomagnetic measurements at Kew Observatory (London) following the advent of electric tramcars at the beginning of the 20th century. BGS took over responsibility for magnetic observations from the Meteorological Office in 1968.

There are two members of BGS staff stationed at the observatory. Mr W E Scott and Mrs M Scott were responsible for the general maintenance of the observatory during 1993.

Figure 2 is a site diagram of Eskdalemuir observatory. No major changes were made at the observatory during 1993. Routine building maintenance was carried out on the observatory buildings.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	55°19′N	57°56′N
Longitude	356°48′E	84°03′E
Height above *msl*	245 m	

Hartland (Devon, England)

Hartland Observatory is situated on the NW boundary of Hartland village. The site is the southern half of a large meadow which slopes steeply northward into a wooded valley. The sea (Bristol Channel) is about 3 km to both the north and west of Hartland. BGS operates a three-component seismometer set and a LF microphone at the observatory, and data from seismic outstations are transmitted to the observatory by radio link.

The observatory was purpose-built for magnetic work, and continuous operations began in 1957, the International Geophysical Year (IGY). Hartland is the successor to Abinger and Greenwich observatories. The moves from Greenwich to Abinger and then to Hartland were made necessary as electrification of the railways progressed, making accurate geomagnetic measurements impossible in SE England. BGS took over control of Hartland Observatory, from the Royal Greenwich Observatory, in 1968. The observatory also houses an archive of library material consisting of records of geomagnetic measurements and observatory yearbooks from all over the world.

The only member of BGS staff stationed at Hartland is the caretaker, Mr C R Pringle.

Figure 3 is a site diagram of Hartland observatory. Routine maintenance was carried out on all the observatory buildings during 1993.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	51°00′N	54°04′
Longitude	355°31′E	80°21′
Height above *msl*	95 m	

3 INSTRUMENTATION

3.1 Absolute observations

At each observatory absolute measurements are made in a single absolute hut (see the site diagrams). Since 1 January 1990 absolute values of all geomagnetic elements are referred to a single standard pillar at each of the observatories. For continuity with previous records the differences between the new and old standards are quoted in the tables of annual mean values in the sense (new standard - old standard) for all elements of the geomagnetic field. Thus annual mean values prior to 1990.5 can be referred to the new standard by adding the site difference to the old standard values. A detailed account of the change in absolute measurement reference is given by Kerridge and Clark (1991).

The instruments used at each observatory are given below.

	Fluxgate-Theodolite (Inventory Number)	**Proton Vector Magnetometer (PVM)**
Lerwick	ELSEC 810 (LER32)	ELSEC 8801 Proton precession magnetometer mounted in ELSEC 5920 coils
Eskdalemuir	Bartington MAG 01H (ESK43)	ELSEC 8801 Proton precession magnetometer mounted in ELSEC 5920 coils
Hartland	ELSEC 810 (HAD16)	ELSEC 8801 Proton precession magnetometer mounted in ELSEC 5920 coils

3.2 ARGOS: Variometer Measurements

The essential components of the ARGOS systems are a three-component fluxgate magnetometer (EDA FM100C), two proton magnetometers (ELSEC 820M), and a Digital Equipment Corporation PDP 11/23 processor which controls the operation of the system. A block diagram of the ARGOS system is given in Figure 4a. The fluxgate sensors are orientated to measure the north (X), east (Y) and vertical (Z) components of the geomagnetic field. The fluxgate magnetometer is operated in 'full field' mode, providing an analogue output of 5 V in a field of 50,000 nT. The fluxgate sensors are located in a temperature-controlled variometer chamber, on a large single pier, with the individual sensors separated by about 1.5 m. Each sensor is mounted inside a calibration coil which can apply a bias field to the sensor when required. The current to the calibration coil is supplied by a Time Electronics 9818 programmable current supply. The temperature of the variometer chamber is monitored continuously. The proton magnetometers are sited in non-magnetic huts. Proton magnetometer P1 is used to make measurements of total field F every ten seconds which are filtered to produce one-minute values. Proton magnetometer P2 is mounted inside a set of two orthogonal Helmholtz coils which apply bias fields to measure changes in declination and inclination for the baseline reference measurements (see Section 3.3).

A Thaler Corporation VRE 105CA precision reference supply is used to generate a reference signal of 5 V to an accuracy of 0.4 mV. In routine operation the analogue outputs from the three channels of the fluxgate magnetometer, the temperature sensor and the voltage reference are switched in turn, by a Hewlett-Packard HP3488A scanner, to the input of a Datron 1061A digital voltmeter and the five signals are measured. At the same time the PDP 11/23 processor triggers one of the proton magnetometers (P1) which measures the total field strength (F). (The second proton magnetometer (P2) is routinely inhibited.) This measurement sequence is repeated every 10 seconds, with the timing reference provided by a CMOS digital clock connected to the PDP 11/23 through a parallel interface. Communications between the PDP 11/23 processor and the other instruments and peripherals are via an IEEE instrument bus and RS232 serial ports.

A 7-point cosine filter is applied to the 10-second samples to produce one-minute values, centred on the minute, (Green, 1985). At the end of each hour the 60 one-minute values of X, Y, Z and F are written to a DC100 data cartridge together with hourly mean values, one-hour and three-hour activity indices based on the range in the X-component, the temperature of the variometer chamber, the reference voltage, and items of 'housekeeping' information. An hour's data is written, in ASCII, as two 512 byte blocks. The cartridge drive is a TU58 dual drive. The system program is loaded from tape on drive 0, and data are written to the tape mounted on drive 1. The tape capacity is sufficient to store up to ten days' data. At each observatory the data collected are displayed on a VDU, and updated every minute, to enable the status of ARGOS to be monitored locally. A printer, normally disabled, can be switched on to obtain hard-copy of the display.

A British Telecom Datel 4122 modem (operating at 1200 baud) allows remote communication with the ARGOS systems via the public switched telephone network (PSTN). ARGOS can be called up manually by an operator in Edinburgh using the Processing and Remote Interrogation System (PARIS), based on a PDP 11/23 computer. The operator in Edinburgh can examine the system status and control a number of other ARGOS functions which include resetting the system clock, repositioning the data tape, and restarting ARGOS in the event of a system failure.

A second modem connected to a Data Track Technology Tracker 2000 solid state memory transmits data to an IBM PS/2 in Edinburgh, which has been programmed to collect data automatically. Data can be retrieved every hour if necessary, but are normally collected every three hours.

Each ARGOS system is supported by a 500 VA Merlin-Gerin SX500 Uninterruptible Power Supply which has internal batteries capable of powering the full system for 30 minutes in the event of mains failure. Each observatory also has a stand-by diesel generator designed to start automatically within two minutes of loss of mains power. In the event of a sustained mains break and failure of the stand-by generators a further battery supply will maintain power to the fluxgates and the system clock for up to 7 days. This avoids deterioration in data quality due to drifts which are almost always severe when a fluxgate magnetometer is switched on after being powered down. The time from the system clock is essential to restart ARGOS automatically when power is restored.

3.3 ARGOS: Baseline Reference Measurements

A consequence of the automation of the observatories was the removal of observatory scientific staff, and therefore the loss of regular absolute observations made by experienced observers. Baseline reference measurements (BRMs) are designed to compensate for this change in observatory practice, enabling the standards achieved with manned operation to be maintained with an automated system.

The apparatus used to make BRMs is essentially a proton vector magnetometer (PVM), in which a proton precession magnetometer (PPM) sensor is mounted at the centre of a set of coils which are used to apply bias fields. Full PVM absolute observations require a sequence of measurements to be made with the coils rotated into positions which enable errors due to imperfect alignment of the magnetic axis to be eliminated. In a BRM the coils cannot be rotated, so the measurement is not error-free. If the mechanical stability of the coil system is good, and the pier on which it is mounted does not tilt, then the error is (practically) constant. Comparisons of BRM results with measurements made by the ARGOS fluxgates then show up short-term drifts in the fluxgate magnetometers which would not be detected by comparisons made with the less frequent absolute measurements. In effect, BRMs provide a means for interpolating between absolute observations.

The PVM system used for making BRMs at each of the UK observatories consists of a PPM sensor mounted at the centre of two orthogonal sets of Helmholtz coils in a "δD/δI" configuration. The coils are orientated initially so that one set provides a bias field approximately perpendicular to the geomagnetic field vector (F) in the magnetic meridian, and the other provides a bias field approximately perpendicular to F in the horizontal plane. If the resultant magnetic field is measured after applying the bias fields then vector algebra can be used to calculate the change in declination (δD) and the change in inclination (δI) relative to values of declination and inclination (D_0 and I_0) determined by the directions of the magnetic axes of the coils. The values of D_0 and I_0 can be determined by comparing the BRM measurements with absolute observations. This technique is described in full by Alldredge (1960).

In ARGOS, BRMs are made by the proton magnetometer P2 and are controlled by a microprocessor-based BRM controller driven by interrupts from the ARGOS PDP 11/23. Measurements are made every hour and are included in the data transmitted to Edinburgh.

3.4 Summary of Technical Specifications of the ARGOS Equipment

The specifications quoted here are those given by the manufacturers of the equipment.

a) FM100C fluxgate magnetometer

Sensitivity:	0.1 mV/nT
Dynamic range:	±100,000 nT
Temperature coefficient:	(in the range) 0.1 - 1 nT/°C

b) ELSEC 820M proton precession magnetometer

Resolution:	0.1 nT
Accuracy:	±1 nT
Measurement range:	14,000-90,000 nT

c) System clock

Accuracy:	1 second per week

d) Datron 1061A digital voltmeter (DVM)

Accuracy:	1 part in 10^7
Temperature coefficient:	0.2 μV/°C

e) Time Electronics 9818 programmable current supply

Maximum current:	1A
Accuracy:	1μA

f) Thaler Corporation VRE 105CA precision reference supply

Reference voltage:	5V
Accuracy:	±0.4 mV
Temperature coefficient:	0.6 ppm/°C

3.5 Back-up Systems

At each observatory an EDA FM 100B three-axis fluxgate magnetometer, completely independent of ARGOS, is maintained to provide back-up data in the event of a total ARGOS failure. The three fluxgate sensors are aligned with one along magnetic north to measure changes in the horizontal component (H), one along magnetic east to measure changes in declination (D) and one vertically to measure changes in the Z component. The analogue outputs of the magnetometer are input to a 12-bit A/D converter and sampled every 10 seconds. A 7-point cosine filter is used to convert the 10-second samples to one-minute values, which are then recorded on a 3.5" DOS diskette by a GCAT embedded PC. The disk is changed every 14 days and sent by post to BGS, Edinburgh, for archiving. The dynamic range of the magnetometers at Lerwick is ±2000 nT, at Eskdalemuir and Hartland it is ±1000 nT. A block diagram of the back-up system is shown in Figure 4b. A facility is also included in the back-up system to transmit data to Edinburgh via the METEOSAT geostationary satellite. This link can be used to retrieve back-up data quickly in the event of the loss of ARGOS data.

3.6 Calibration of geomagnetic measurements

The physical measurements made by ARGOS are of the analogue DC voltage output from the fluxgate sensors and the precession frequency radiated by the polarised sample in the PPM.

Provided drift in the voltage reference used by the DVM is less than that of the fluxgate magnetometer, long term changes in the measurement of the magnetic field are only due to drift in the magnetometer. The DVM is calibrated every three months by comparing it with a second DVM which is calibrated anually to comply with National Physical Laboratory (NPL) standards. Its accuracy is quoted as 1 part in 10^7. Checks are also made every three months using standard cells which are maintained at each observatory. A check of the fluxgate sensitivity is also carried out by applying a bias field to the sensor. This is done by passing a known current through Helmholtz coils with an accurately known coil constant. The current is supplied by a constant current power supply which is calibrated by measuring the voltage across a standard resistor using a DVM calibrated against NPL standards. The change in the applied magnetic field can then be related to the change in voltage output from the sensor.

The PPM measures the frequency of emitted radiation from a sample of proton rich fluid, which is related to the ambient magnetic field by the proton gyromagnetic ratio. The conversion from frequency to magnetic field value carried out by the PPM is checked by irradiating the sensor with a signal of known frequency from an oscillator. The frequency of this calibration signal is checked by comparing it with an accurate frequency standard transmitted from Rugby. This check on the PPM is carried out every three months at each observatory.

4 DATA PROCESSING

Data are retrieved to Edinburgh from the observatories by a dedicated IBM PS/2 which has been programmed to call the observatories automatically every three hours. The data are then transferred over a local area network to the BGS VAX 6410 mainframe for processing. (In 1993 the PARIS link was still used to collect data manually each day. Since this link was via a different modem this provided a backup communication system in case the automatic collection system should fail.)

Data-processing is carried out automatically on the VAX each day shortly after midnight. The data files are first sorted into Universal Time (UT) day files. Subsequent data processing is carried out on these day files by a single FORTRAN program on the VAX which uses subroutines to generate various data products and derivatives. The data in each day file are first passed through a quality control routine which checks for a range of possible errors. The data products then generated each day are:

a A magnetogram;
b A formatted list of one-minute values of all the geomagnetic elements;
c Hourly mean values and range indices;
d A forecast of geomagnetic activity for the next 27 days;
e Hourly and daily ranges in each geomagnetic element;
f A comparison of F computed from X, Y and Z against F measured by P1;
g A list of missing data;
h K indices;
i An analysis of BRMs;
j An analysis of ARGOS reference voltage and variometer chamber temperature;
k A plot of absolute F measured by P1 at all three observatories.

The final check on the quality of the data is still the responsibility of the operator in Edinburgh who examines the magnetograms each day for erroneous values which may not have been detected by the automatic quality control procedures.

The prompt retrieval of data from the three UK observatories, made possible by ARGOS, immediately generated scientific and commercial demand for rapid access to the data. The VAX is connected to the UK Joint Academic Network (JANET) which enables transfer to academic users worldwide; commercial users can access the VAX using a British Telecom X25 gateway or dial-up modem. The Geomagnetism Information and Forecasting Service (GIFS) was created in 1988 to provide a "user-friendly" interface between enquirers and the data sets, (Kerridge and Harris, 1988). GIFS, originally set up for academic users, now has separate academic and commercial sections. The data sets on GIFS derived from UK observatory data are updated daily.

At the end of each month any gaps in the ARGOS data are filled using data from the back-up magnetometers. The resulting complete day files are archived on magnetic tape (two copies) on the VAX and also on optical disk. A monthly bulletin is issued for each observatory which includes magnetograms (with gaps filled), lists of K indices, the results of absolute observations, BRMs made during the month, tables of hourly mean values of H, D and Z, and a list of events associated with solar activity. The *aa* magnetic activity indices and a forecast of solar and geomagnetic activity are also given in the monthly bulletin. A diary giving details of any changes made during the month at the observatory is included at the end of the bulletin.

The number of missing minute values during 1993 at each observatory, resulting from failure of the ARGOS and back-up systems during the same periods of time, were as follows:

	No. of missing minute values	Date
Lerwick	23	29 Oct
Eskdalemuir	0	-
Hartland	0	-

5 CORRECTION OF FLUXGATE VARIOMETER DATA TO ABSOLUTE VALUES

Where variometer records are made photographically a physical mark, a baseline, is made on the photographic paper. Absolute observations are used to allocate a value to the baseline using the sensitivity of the magnetometer (the scale value, usually expressed in nT/mm), to relate the offset of the trace at the time of an absolute observation (the ordinate) to the baseline. For a fluxgate magnetometer a baseline value may be taken to be the value of the geomagnetic field at an arbitrary output voltage of the magnetometer. An alternative view is that the fluxgate magnetometer sensitivity (usually expressed in mV/nT) is used to, in effect, deduce the magnetometer output in zero magnetic field. The absolute observations enable corrections to be made for any such zero-field offset, (which is likely to vary with time), and the site difference between the location of the fluxgate sensor and the appropriate absolute pier.

The zero-field offset corrections allocated for each observatory for 1993 are shown in Figures 5-7. (The results for each observatory are discussed in detail below.) The zero-field offset correction is derived by comparing the fluxgate measurements with absolute measurements taken simultaneously. In each of the figures the top two panels show the comparison between the absolute measurements and the fluxgate measurements for H (plotted in the sense absolute - fluxgate) and the BRMs and the fluxgate measurements for H (plotted as daily average BRM - fluxgate value). The next two panels show the same for D, in which East is represented by positive values, and the next two panels show the same for Z. The bottom panel shows the daily mean temperature in the fluxgate chamber. In the panels showing the absolute - fluxgate comparison, the symbols represent the observed values and the full line shows the adopted correction. At Lerwick and Hartland the adopted correction is derived from polynomial fits to the observed values computed using the method of least squares. In deriving the polynomials the points immediately before the beginning and after the end of the year were used, but are not shown in the plots. This ensures that unrealistic discontinuities are not introduced at the year boundaries. The plots of the polynomial fits are stepped because the values computed from the polynomials have been rounded to the nearest nT or 0.1 min. The adopted correction at Eskdalemuir consists of the daily mean values of the hourly BRMs (with outliers removed). A correction has been applied to refer the BRMs to the observatory absolute standard.

Lerwick (Figure 5)

Absolute measurements were made by BGS staff during service visits to the observatory in January, April, June, September and December. These show on the plots as clusters of measurements made within a few days. The measurements between service visits were made by Meteorological Office staff.

The ranges of the allocated zero-field offset corrections during the year were 3 nT for H, 0.2 minutes of arc for D and 6 nT for Z. The main deviation in the Z corrections appears to be an annual effect and is probably related to an increase in the temperature of the variometer chamber during the summer. The temperature variation in the variometer chamber was kept to within ±1°C over the year.

The comparison of BRMs with fluxgate measurements shows a significant drift during May and June in the H and D BRMs. It is likely that this drift is related to changes in the outside air temperature causing mechanical deformation of the coils. It is proposed to upgrade the BRM coil system in 1994 with a base similar to that in use at Eskdalemuir.

The table below lists the root mean squared (*rms*) differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1990-92 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1990	1.69 (25)	0.37 (24)	1.95 (25)
1991	0.82 (19)	0.58 (19)	0.74 (20)
1992	1.70 (26)	0.36 (27)	1.21 (26)
1993	1.69 (31)	0.36 (33)	0.93 (30)

Eskdalemuir (Figure 6)

Absolute measurements were made weekly by staff of the Meteorological Office at Eskdalemuir, supplemented by occasional measurements made by BGS staff. The fluxgate measurements have been affected by significant and variable drift this year, but a comparison of the BRMs against the absolute measurements revealed only a very small drift in the BRMs. Thus the BRMs have been used to correct the fluxgate measurements, taking into account the site difference between the BRMs and the absolute standard (determined from the BRM-absolute measurement comparison), and the small drift in this site difference over the year (-2.9 nT in H, 1.7 minutes of arc in D and 0.6 nT in Z).

The ranges in the allocated zero-field offset corrections in 1993 were 14 nT for H, 6 minutes of arc for D and 7 nT for Z. The temperature variation in the variometer chamber was kept to within ±0.25°C over the year.

In Geomagnetic Bulletin 22 (Magnetic Results 1992) it was stated that a problem had been found with the fluxgate-theodolite (ESK43) used to make absolute measurements at Eskdalemuir. It was returned to the manufacturer for examination and some magnetic screws were found, which were replaced with non-magnetic screws. The corrections given in Geomagnetic Bulletin 22 of -2.5 minutes of arc in D (actually quoted in Bulletin 22 as +2.5 minutes of arc for Declination West), +5.5 nT in H and -2.2 nT in Z have to be **subtracted** from the measurements made with ESK43 prior to the removal of the screws. This theodolite has been in use since July 1989 to measure D and since January 1990 to measure D, H and Z. The annual mean values for the years 1989-1992 listed in the table of annual means have had these corrections applied. The previously published annual means are also listed since these are derived from the archived one-minute data which have been distributed to the World Data Centre A for Solar-Terrestrial Physics and also distributed on the INTERMAGNET CD-ROM for 1991 and 1992.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1990-92 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1990	2.63 (38)	0.81 (38)	1.59 (38)
1991	1.67 (42)	0.44 (43)	1.09 (42)
1992	1.43 (36)	0.55 (36)	0.83 (36)
1993	1.44 (40)	0.41 (42)	0.85 (41)

Hartland (Figure 7)

Absolute measurements were made weekly by the caretaker at Hartland Observatory and by Edinburgh staff during service visits.

The ranges of the zero-field offset corrections over the year were 3 nT for H, 0.6 minutes of arc for D and 9 nT for Z. The drift in the Z fluxgate, which appears to be similar to that observed at Lerwick, is probably related to the increase in temperature during the summer. The temperature variation in the variometer chamber was kept to within ±1.25°C over the year.

Significant drift in the H and D BRMs was observed during most of the year. It is proposed to upgrade the BRM coil system in 1994 with a base similar to that in use at Eskdalemuir.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1989-91 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1990	1.88 (55)	0.49 (57)	1.11 (56)
1991	1.03 (48)	0.17 (49)	1.09 (47)
1992	1.11 (48)	0.36 (49)	1.69 (49)
1993	1.16 (43)	0.28 (51)	1.36 (44)

6 PRESENTATION OF RESULTS

The data are organised by observatory in the order Lerwick, Eskdalemuir and Hartland. The results presented for each observatory are:

a Daily magnetograms of H, D and Z;
b Plots of hourly mean values of H, D and Z;
c Plots of daily mean values of H, D and Z;
d Tables of monthly and annual mean values of all geomagnetic elements;
e Tables of K indices;
f A list of rapid variations noted during the year;
g Tables of annual mean values of geomagnetic elements;
h Plots of annual mean values and secular variation for H, D, Z and F.

The daily magnetograms of H, D and Z are plotted 16 to a page, the data for days 1 to 16 of each month on one page, and the data for the remaining days of the month on the facing page. The D trace is plotted positive (east) upwards. The absolute level in each plot is indicated by the value shown to the left of the plots, in degrees for D and in nanoteslas for H and Z. The magnetogram scale values, shown to the right of the plots, are varied (by multiples of two) where necessary, and when changes are made this is indicated at the top of the magnetogram. This accounts for the occasional discontinuities in the traces at day boundaries.

The hourly mean data are plotted at a constant scale in 27-day batches, according to the Bartels rotation number. These plots show a number of features of geomagnetic field variations including diurnal variation, and seasonal changes in its magnitude, and periods of geomagnetic disturbance. By plotting the data in 27-day batches recurrent disturbances caused by active regions on the Sun which persist for more than one solar rotation are highlighted. Changes due to secular variation at the UK observatories over the course of a year are small compared to diurnal variations and disturbances. However, the gradual drift eastwards in D is discernible in the plots. In the plots of daily mean values secular variation is quite clear in H, D and Z, as shorter period variations are attenuated by the averaging. The reference values shown on the left sides of the daily mean plots are the annual mean values.

ARGOS data are corrected using BRMs and absolute observations to produce a series of absolute minute values of H, D and Z centred on the minute. Hourly mean values, centred on the UT half-hour, are computed from minute values, daily mean values from hourly means, and monthly mean values from daily means. (Hourly means are not computed if there are more than six one-minute values missing; daily means are not computed if there are more than two hourly means missing.) Annual mean values are calculated from the monthly mean values weighted according to the number of days in the month. At each stage of processing the mean values of the remaining geomagnetic elements are calculated from the corresponding mean values of H, D and Z. The monthly mean and annual mean values for all the geomagnetic elements are tabulated. Declination and inclination are expressed in degrees and decimal minutes of arc, the units of all the other elements are nanoteslas.

The K index summarises geomagnetic activity at an observatory by assigning a code, an integer from 0 to 9, to each 3-hour UT interval. The index values are determined from the ranges in H and D (scaled into nT), with allowance made for the regular diurnal variation. The method for computing K indices is described by Clark (1992). The K index has a Local Time and seasonal dependence associated with the geographic and geomagnetic coordinates of the observatory. The K indices for each of the UK observatories are tabulated.

A number of 3-hour geomagnetic indices are computed by combining K indices from networks of observatories to characterise global activity levels and to eliminate Local Time and seasonal effects. K indices from each of the three UK observatories are used in deriving the planetary geomagnetic activity indices Kp, Kn and Km, sanctioned by the International Association of Geomagnetism and Aeronomy (IAGA). The K indices from Hartland and Canberra (approximately antipodal to Hartland) are used to produce the aa index, a further planetary activity index. (Definitive values of the indices recognised by IAGA are published by the International Service for Geomagnetic Indices, Paris.) Daily, monthly and annual mean values of the aa index are listed following the tables of K indices for Hartland. The derivation of the geomagnetic activity indices mentioned here is described in great detail by Mayaud (1980).

The scaling of rapid variations is performed according to the guidelines given in the IAGA Provisional Atlas of Rapid Variations (1961). Occurrences of Solar Flare Effects (SFE), Sudden Impulses (SI) and Storm Sudden Commencements (SSC) are given along with the time, amplitude and quality of the event.

The annual mean values at each observatory since operations began are tabulated. Declination and inclination are expressed in degrees and decimal minutes of arc, the units of all the other elements are nanoteslas. Plots of the annual mean values of H, D, Z and F, and of first differences of the annual means, representing secular variation at the observatories are presented. In the case of Hartland, annual mean values from Abinger observatory for 1925.5-56.5 have been included in the table. The plots for Hartland also include values from Abinger, taking into account the site differences between the two observatories determined during 1957 when both observatories operated simultaneously for a period of time.

7 DATA AVAILABILITY

One-minute mean values of geomagnetic elements at each of the UK observatories from 1983 onwards are available in digital form. Hourly mean values are available in digital form for Lerwick (1926-92), Eskdalemuir (1911-92), Abinger (1926-56) and Hartland (1957-92). K indices from the UK observatories are available in digital form from 1954 onwards. In its role as the World Data Centre C1 for Geomagnetism, the Geomagnetism Group also holds a selection of hourly mean values and annual mean values from observatories worldwide. Digital data can be transferred by electronic mail over JANET, or supplied on IBM compatible 3.5 inch diskettes. For more information contact:

Data Services		
Geomagnetism Group		
British Geological Survey		
Murchison House		
West Mains Road	☎:	031 667 1000
Edinburgh EH9 3LA	Fax:	031 668 4368
Scotland UK	Telex:	727343 SEISED G

8 GEOMAGNETISM GROUP STAFF LIST 1993

Edinburgh

Group Manager (Grade 7)	Dr D J Kerridge
PSec	Mrs M Milne
Grade 7	D R Barraclough J C Riddick
SSO	Dr T D G Clark
HSO	S M Flower T J Harris Dr S Macmillan E M Reader Dr A W P Thomson
SO	J G Carrigan A Carruthers Ms E Clarke M D Firth C W Turbitt
ASO	F J Campbell (Contract finished in April 1993)
Craftsman	J McDonald

Eskdalemuir

Craftsman	W E Scott
Cleaner	Mrs M Scott

Hartland

PGS E	C R Pringle

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Alldredge, L R. 1960. A proposed automatic standard magnetic observatory. *Journal of Geophysical Research*, **65**, 3777-3786.

Clark, T D G. 1992. Computer generated K indices adopted by the British Geological Survey. *Journal of Atmospheric and Terrestrial Physics*, **54**, 447-456.

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I.A.G.A. 1961. Provisional atlas of rapid variations. *Annals of the International Geophysical Year, Volume IIB.*

Kerridge, D J and Clark, T D G. 1991. The new standard for absolute observations at the UK geomagnetic observatories. *British Geological Survey Technical Report*, WM/91/17.

Kerridge, D J and Harris, T J. 1988. GIFS: the Geomagnetism Information and Forecast Service. *British Geological Survey Technical Report*, WM/88/16.

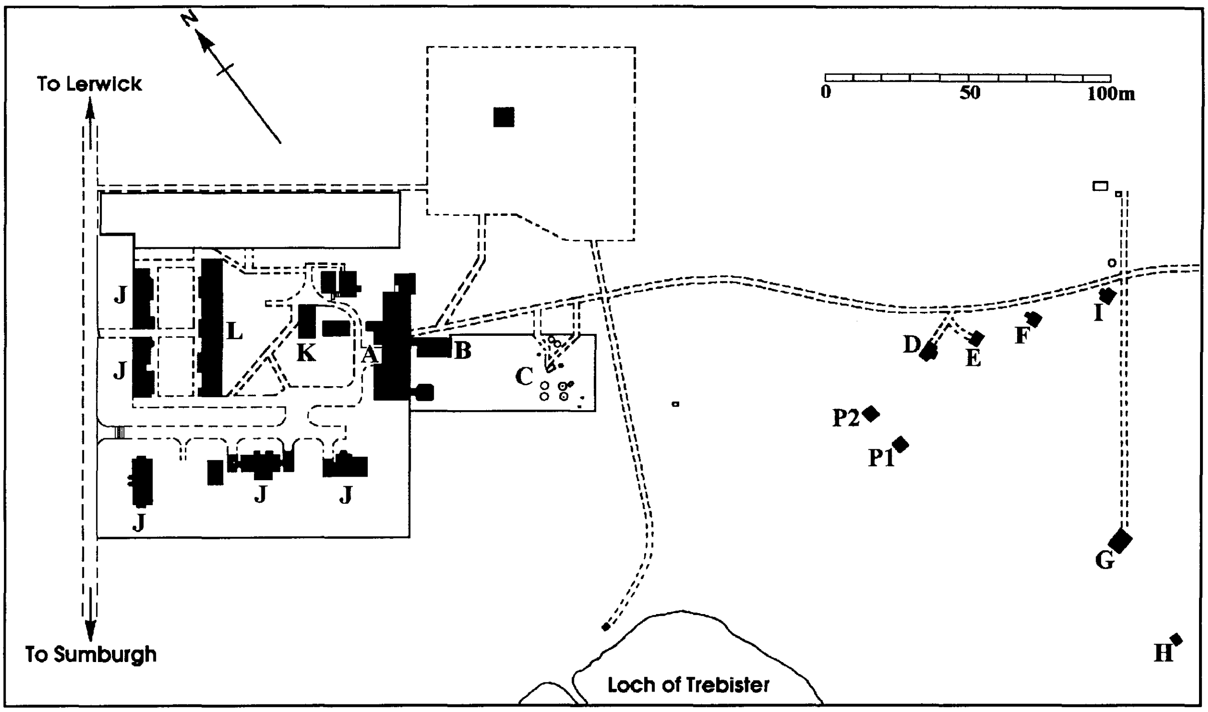
Langel, R A. 1992. International Geomagnetic Reference Field: The sixth generation. *Journal of Geomagnetism and Geoelectricity*, **44**, 679-707.

Mayaud, P N. 1980. Derivation, meaning, and use of geomagnetic indices, *American Geophysical Union, Geophysical Monograph 22*, Washington DC: American Geophysical Union, 154pp.

Riddick, J C, Greenwood, A C, and Stuart, W F. 1990. The automatic geomagnetic observatory system (ARGOS) operated in the UK by the British Geological Survey. *Physics of the Earth and Planetary Interiors*, **59**, 29-44.

Robinson, P R. 1982. Geomagnetic observatories in the British Isles. *Vistas in Astronomy*, **26**, 347-367.

Lerwick Observatory



Observatory Layout

A	Main observatory building
B	BGS office, seismic recorders
C	Meteorological instrument enclosure
D	Absolute Hut
E	Instrument Hut
F	Variometer House
G	West Hut
H	Azimuth mark
I	Back-up fluxgate data-logger & Meteosat Tx
J	Staff houses
K	Standby generator
L	Staff hostel
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2

Instrument Deployment

Absolute Hut
PVM (used for H/Z/F measurements)
D/I Fluxgate Theodolite

The fixed mark (azimuth 8° 38' 02" E of S) is viewed through a small sliding panel in the hut door.

Instrument Hut
PVM electronics
ARGOS electronics
ARGOS uninterruptible power supply (UPS)

Variometer House
ARGOS fluxgate sensors (X,Y,Z)
Back-up fluxgate sensors (H,D,Z)

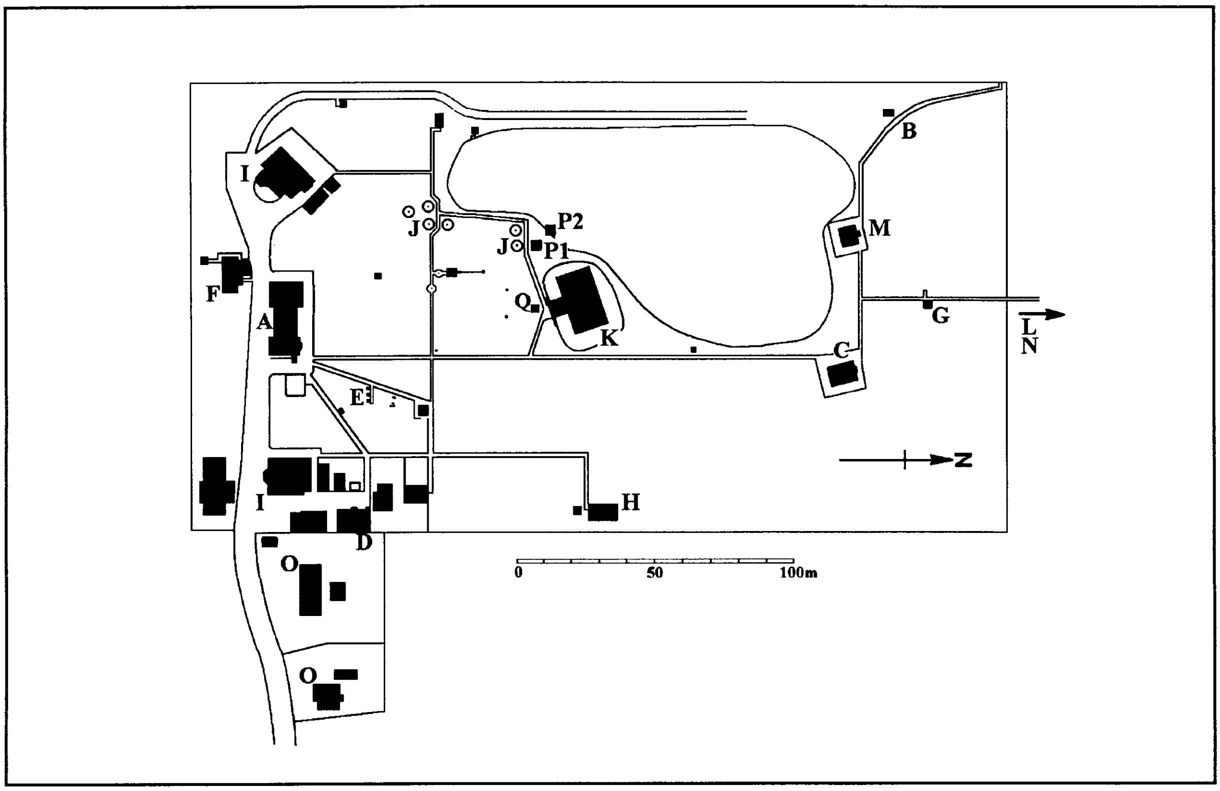
The Variometer House is constructed from non-magnetic concrete and has internal dimensions of 4.9 by 3 metres. The roof is semi-circular in cross section. The temperature of the house is controlled to a diurnal range of ± 1 °C. The meridian at the time of construction is defined on the north and south walls.

Previous descriptions

Harper, W.G. 1950 Lerwick Observatory. *Meteorological Magazine,* **79**, 309-314.
Tyldesley, J.B. 1971. Fifty years of Lerwick Observatory. *Meteorological Magazine,* **100**, 173-179.

Figure 1. Lerwick observatory site diagram

Eskdalemuir Observatory



Observatory Layout

A	Main observatory building
B	Atmospheric pollution sampling
C	East Absolute Hut
D	Garage and standby generator
E	Meteorological instruments
F	Seismic laboratory, seismic recorders, offices, electronics laboratory.
G	Hut G
H	Non-magnetic laboratory
I	Staff accommodation
J	Rain gauges
K	Underground variometer chamber, instrument room containing data loggers
L	Seismic vault, 280 metres from boundary wall
M	West Absolute Hut
N	Chemical sampling by Warren Spring Laboratory, 75 metres from boundary wall
O	Private houses, formerly housing observatory staff
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2
Q	METEOSAT satellite transmitter, 300 metres from boundary wall

Instrument Deployment
Hut G contains the PVM electronics, the digital clock and the printer used to record values during absolute observations.

East Absolute Hut
PVM (used for H/Z/F measurements)
D/I Fluxgate Theodolite

The fixed mark (azimuth 8° 12' 35" W of S) is viewed through a shutter on the south wall of the hut.

Underground Variometer Chamber
ARGOS fluxgate sensors (X,Y,Z)
Back-up sensors (H,D,Z)

The variometer chamber comprises two separate rooms inside a domed chamber covered with a thick layer of earth to form a mound. The instruments and the greater part of the rooms are thus below the level of the surrounding ground. The temperature of the chamber is controlled to a diurnal range of $\pm$0.5°C. The instrument room has been created by extending the former porch back into the stairwell and entrance, leaving a compartment under the floor for standby batteries. The entrance to the room is protected by an external porch.

West Absolute Hut
The hut contains three instrument piers. The fixed mark is viewed from the central pillar at a bearing of 4° 36' 08" through a shutter in the south wall of the hut.

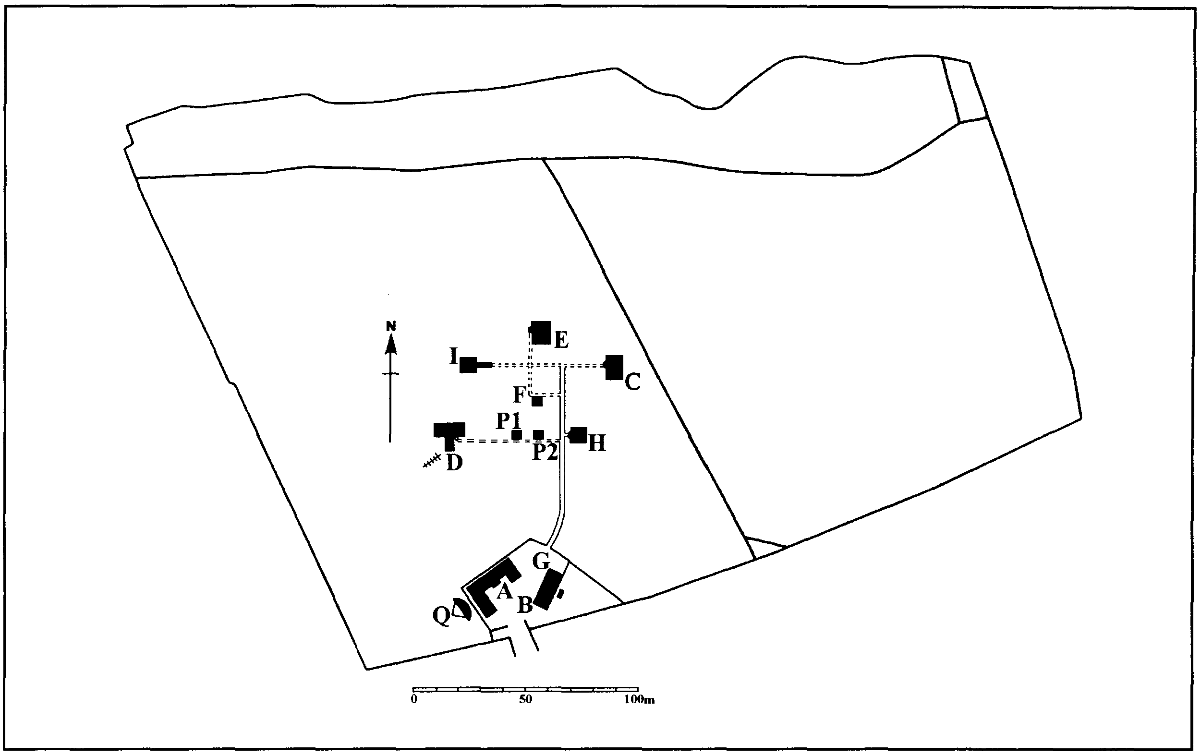
The Non-Magnetic Laboratory
The laboratory is used for instrument development and testing. It contains two rooms, a sensor room with three piers and a larger instrument room with a single pier.

Previous descriptions

Blackwell, M.J. 1958. Eskdalemuir Observatory - the first 50 years. *Meteorological Magazine London* **87**, 129.
Crichton, J. 1950. Eskdalemuir Observatory. *Meteorological Magazine London*. **79**, 337.

Figure 2. Eskdalemuir observatory site diagram

Hartland Observatory



Observatory Layout

A	Main observatory building
B	Caretakers house
C	Absolute Hut
D	Non-Magnetic Laboratory, Back-up Fluxgate, Meteosat transmitter
E	Variometer House
F	Instrument Hut
G	Garage
H	Test 2 Hut
I	Test 1 Hut
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2
Q	GOES Satellite receiver

Instrument Deployment

Absolute Hut
PVM (used for H/Z/F measurements)
D/I Fluxgate Theodolite

The fixed mark (azimuth 11° 27' 54" E of N) is viewed through a window in the north wall of the hut.

Non-Magnetic Laboratory
The laboratory was built in 1972 to provide accommodation for a rubidium-vapour magnetometer digital recording system.It comprises an instrument room and a sensor room with five instrument piers. At present, a 3-component fluxgate (H,D,Z) is in operation. This is connected to a data collection platform transmitting data to the METEOSAT satellite.

Variometer House
ARGOS fluxgate sensors (X,Y,Z)
Back-up sensors (H,D,Z)

The Variometer House comprises an entrance porch and a main room, which contains two separate internal rooms, each divided into three compartments. The temperature of the house is controlled to a diurnal range of ± 0.5°C. Two cable ducts connect the Variometer House to the Instrument Hut.

Instrument Hut
PVM electronics
ARGOS electronics
Standby batteries and ARGOS uninterruptible power supply (UPS)

Test Hut 1
The hut contains an orthogonal coil system and its power supply. The inner coil, a vertical-axis square coil, was previously used for BMZ calibration. Two additional 2 metre square coils, for creating horizontal fields parallel and normal to the meridian, were added in 1983 to create a near zero field facility for investigating the magnetic signature of the AMPTE satellite.

Test Hut 2
Auxiliary measurement position

The fixed mark (azimuth 12° 52' 08" E of N) is viewed through a window in the north wall from the northeast theodolite position.

Previous descriptions

Finch, H.F. 1960 Geomagnetic measurement. *Journal of the Royal Naval Scientific Service*. **15**, No. 1, 26-31.

Figure 3. Hartland observatory site diagram

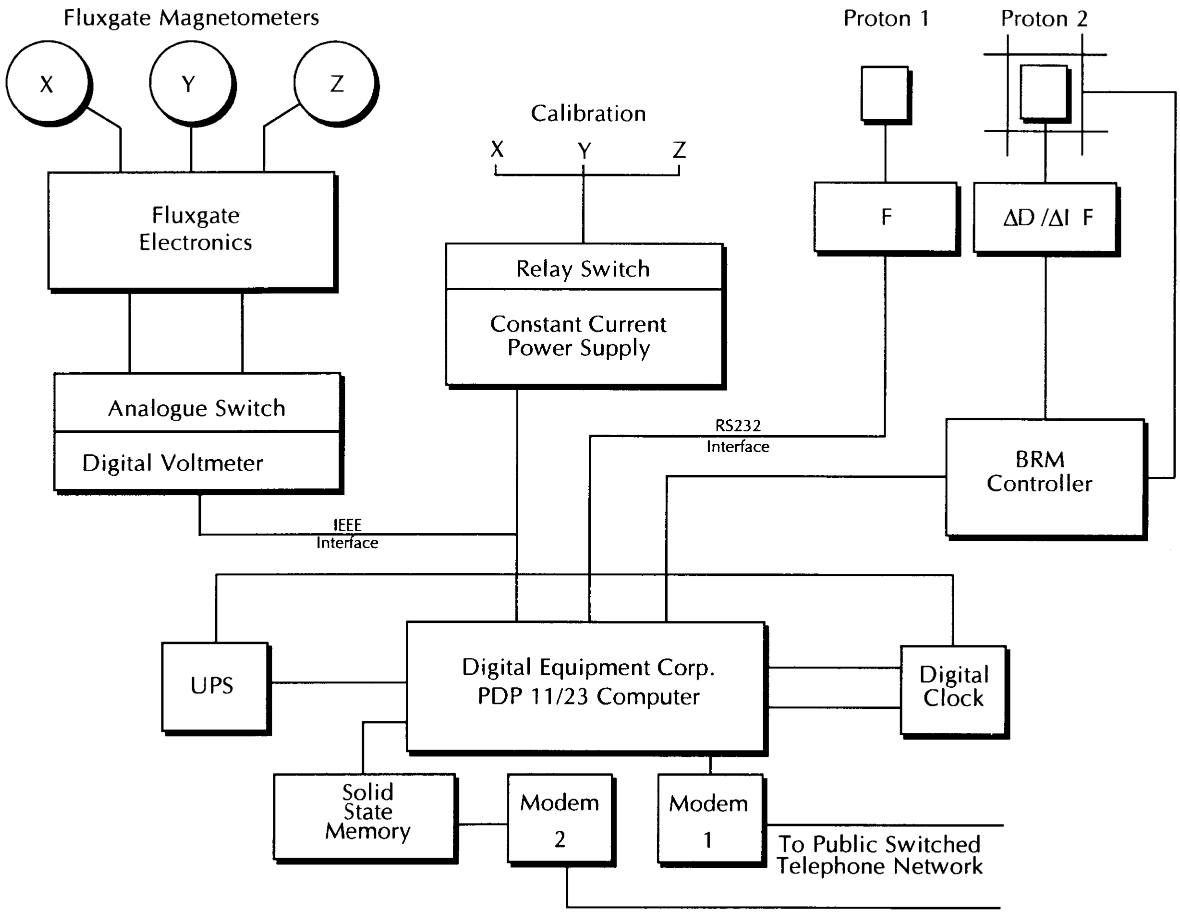


Figure 4a. Block diagram of ARGOS

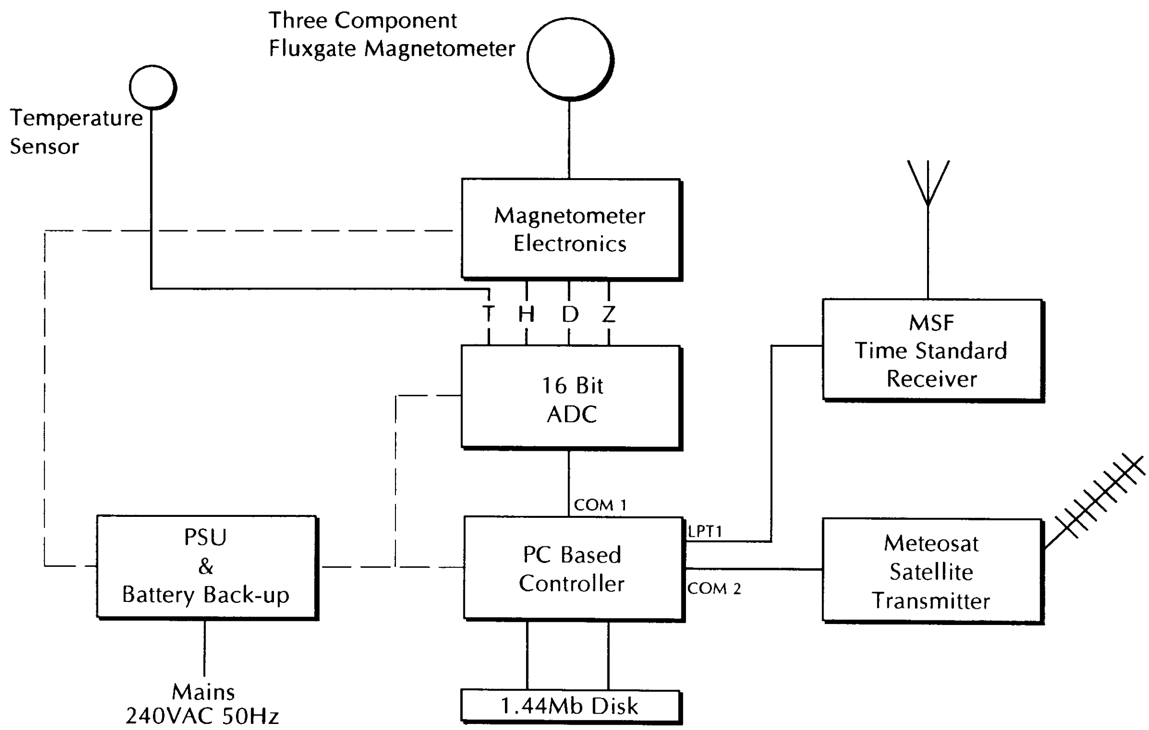


Figure 4b. Block diagram of back-up system

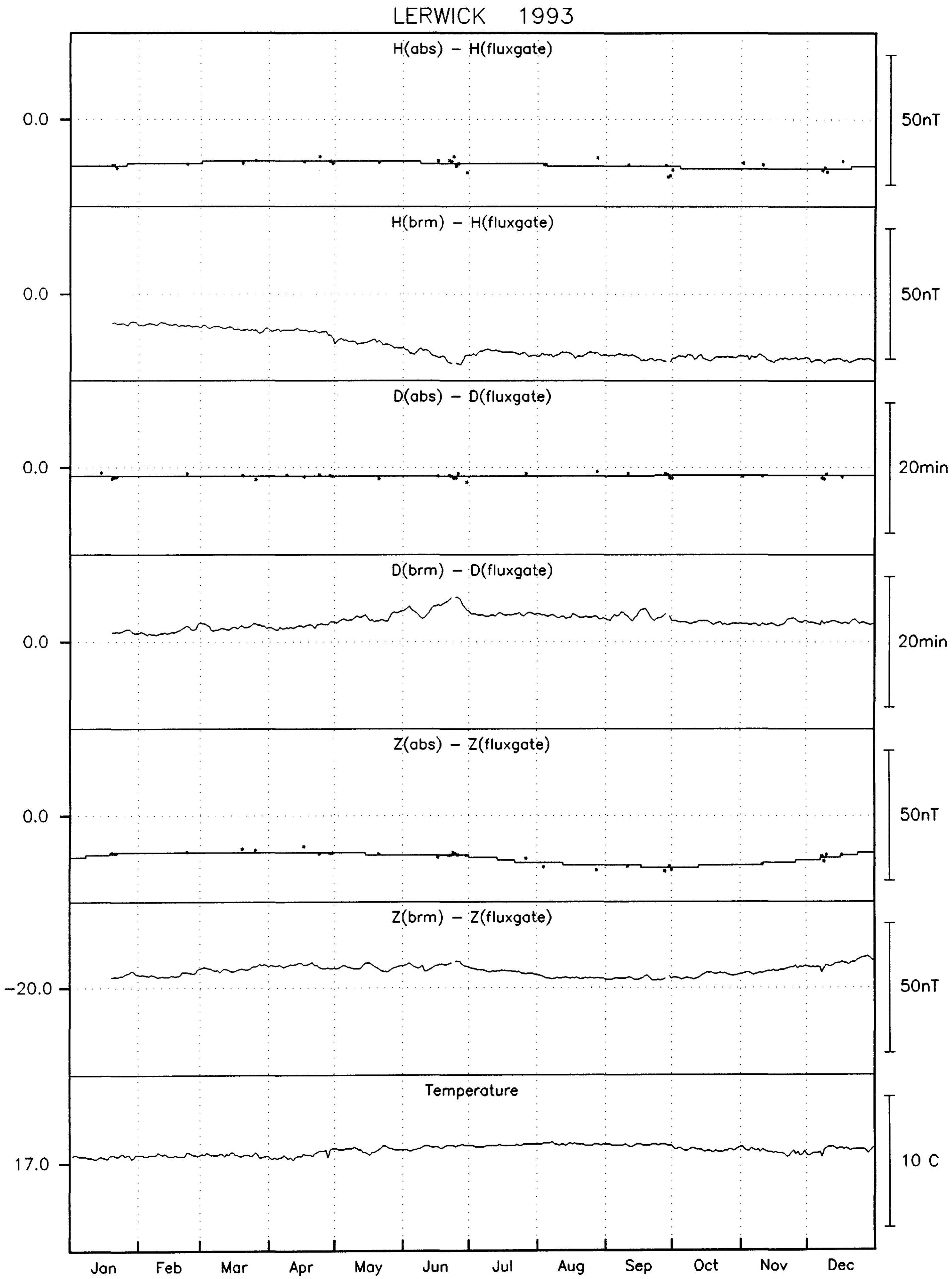


Figure 5. **Zero-field corrections and BRMs, Lerwick 1993**

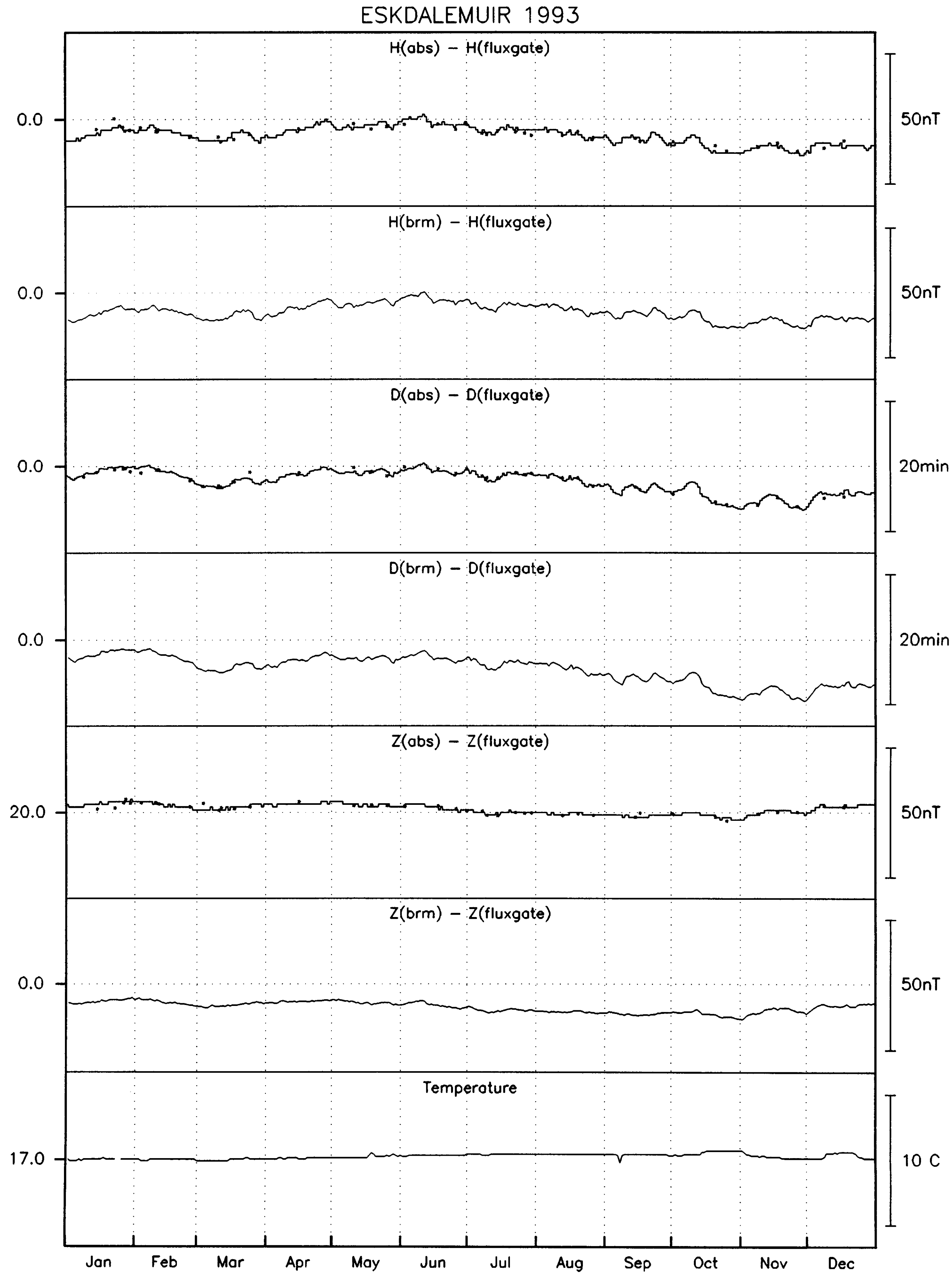


Figure 6. **Zero-field corrections and BRMs, Eskdalemuir 1993**

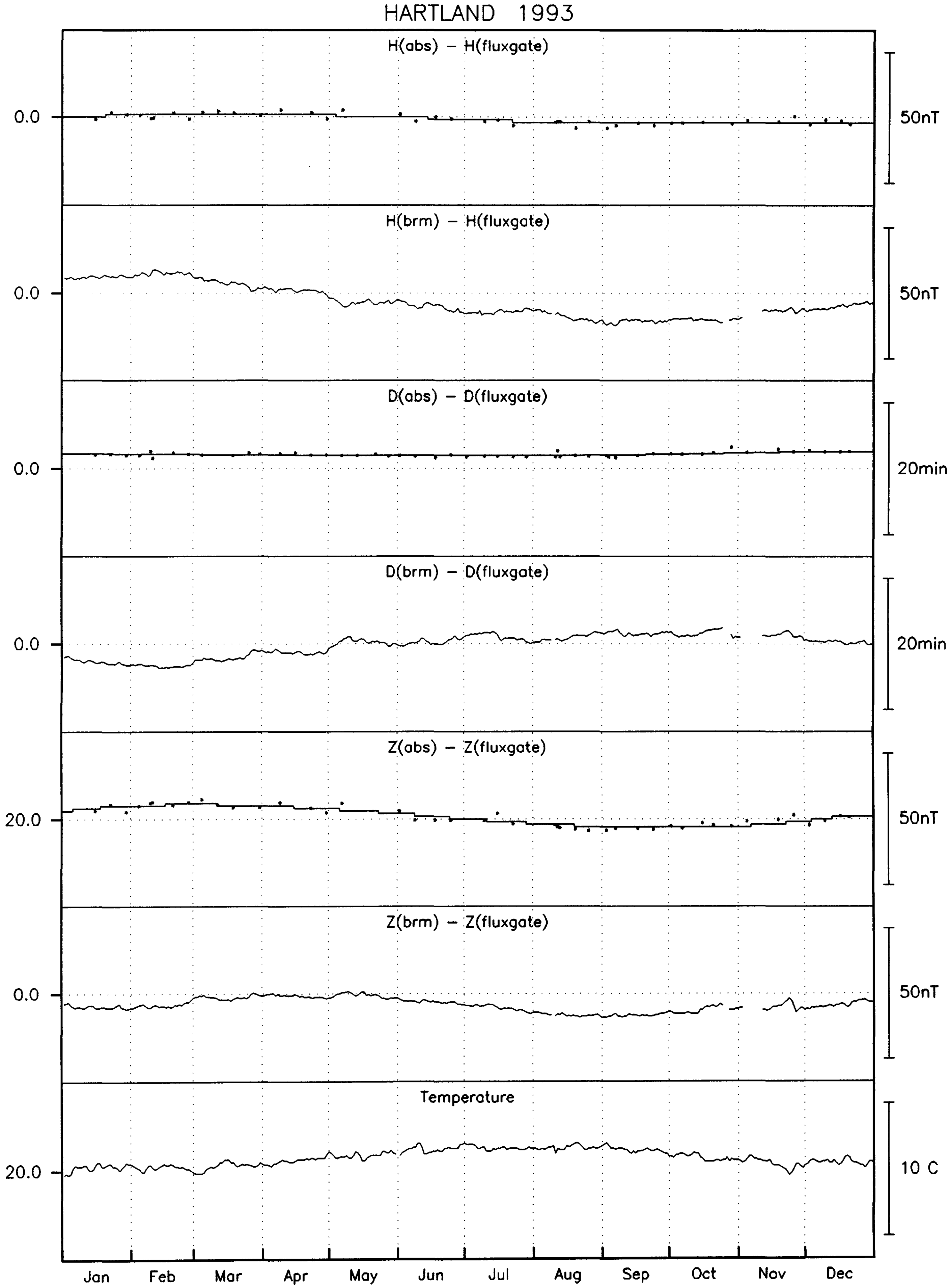
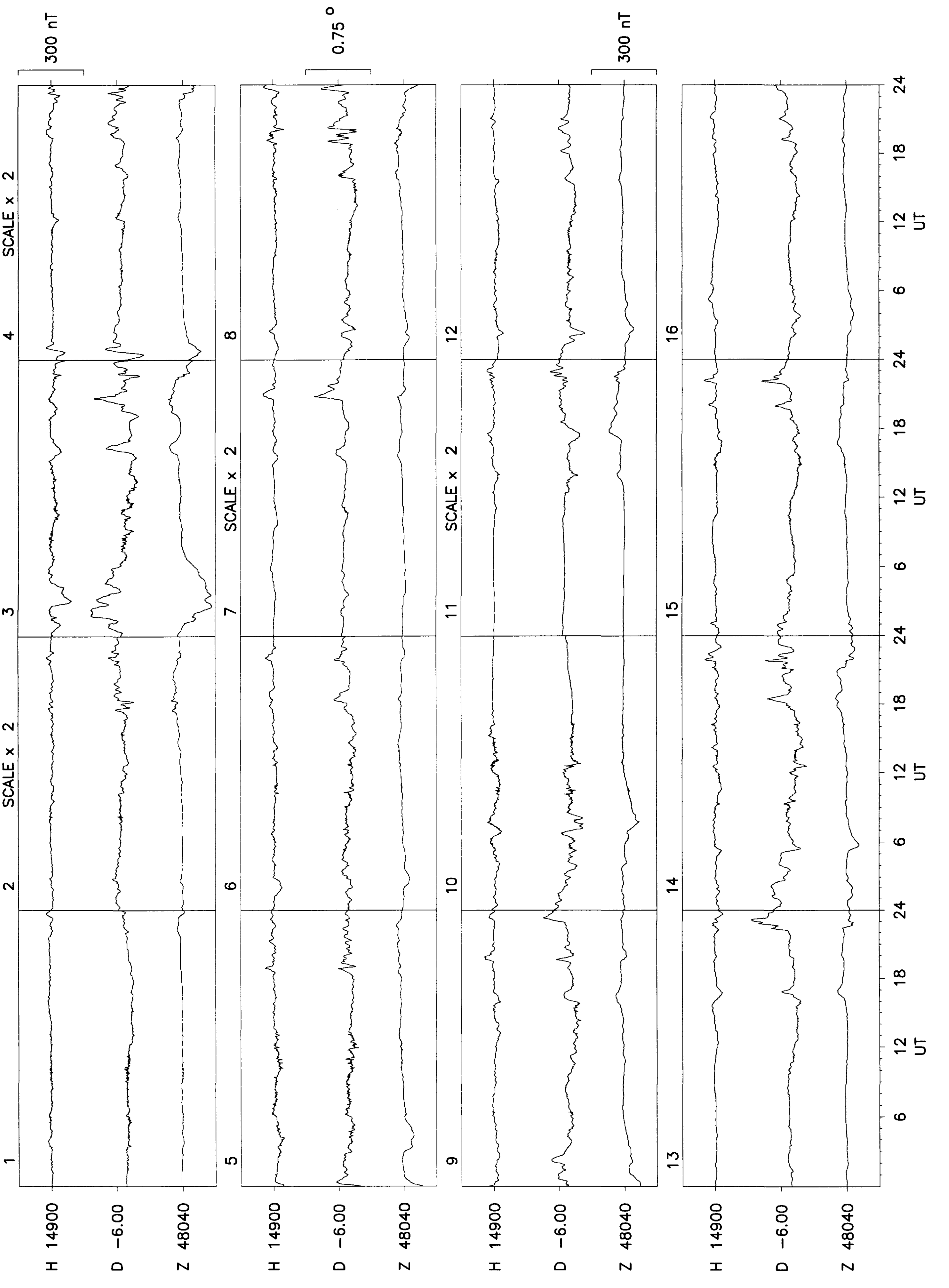
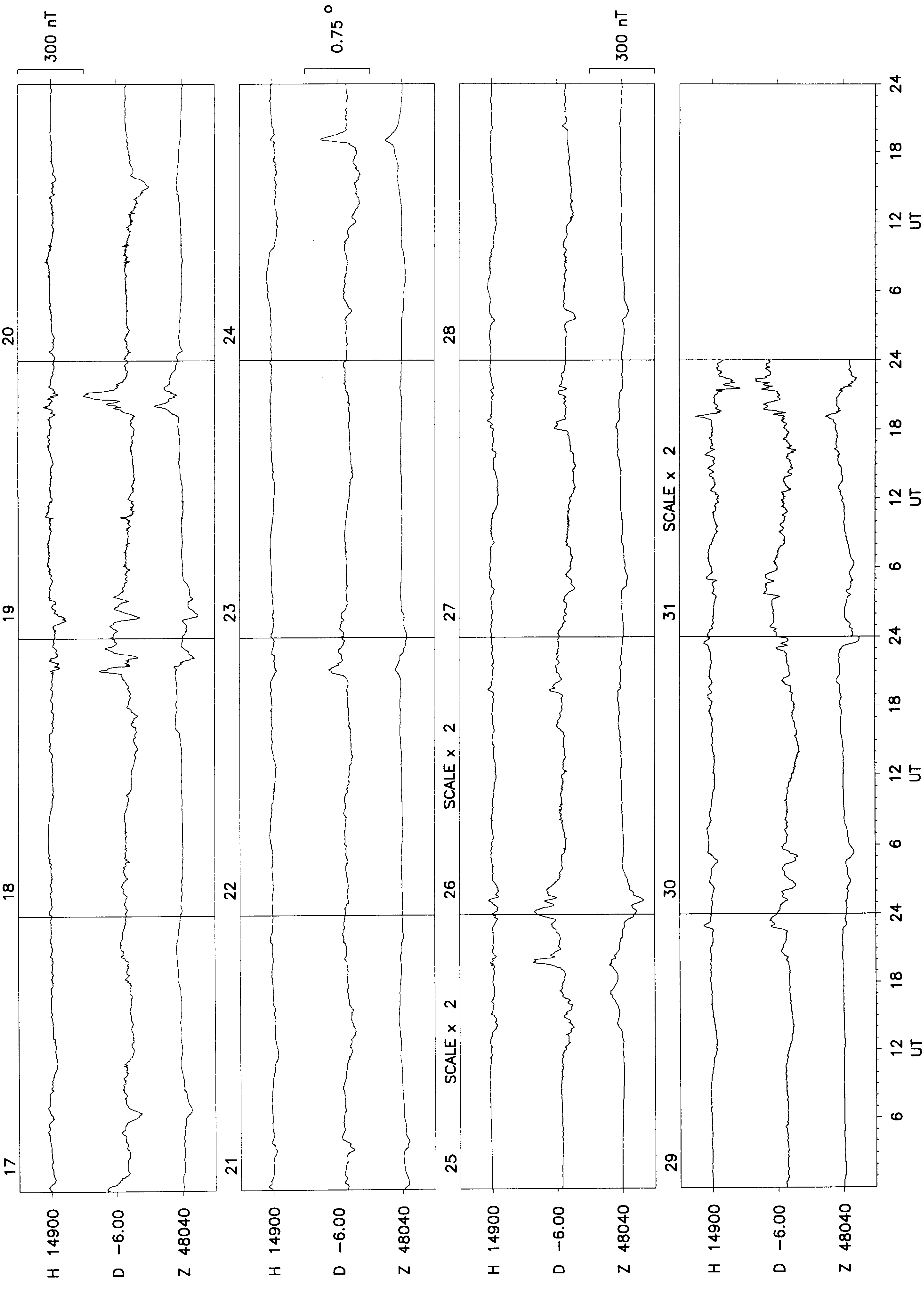


Figure 7. **Zero-field corrections and BRMs, Hartland 1993**

Lerwick 1993



Lerwick January 1993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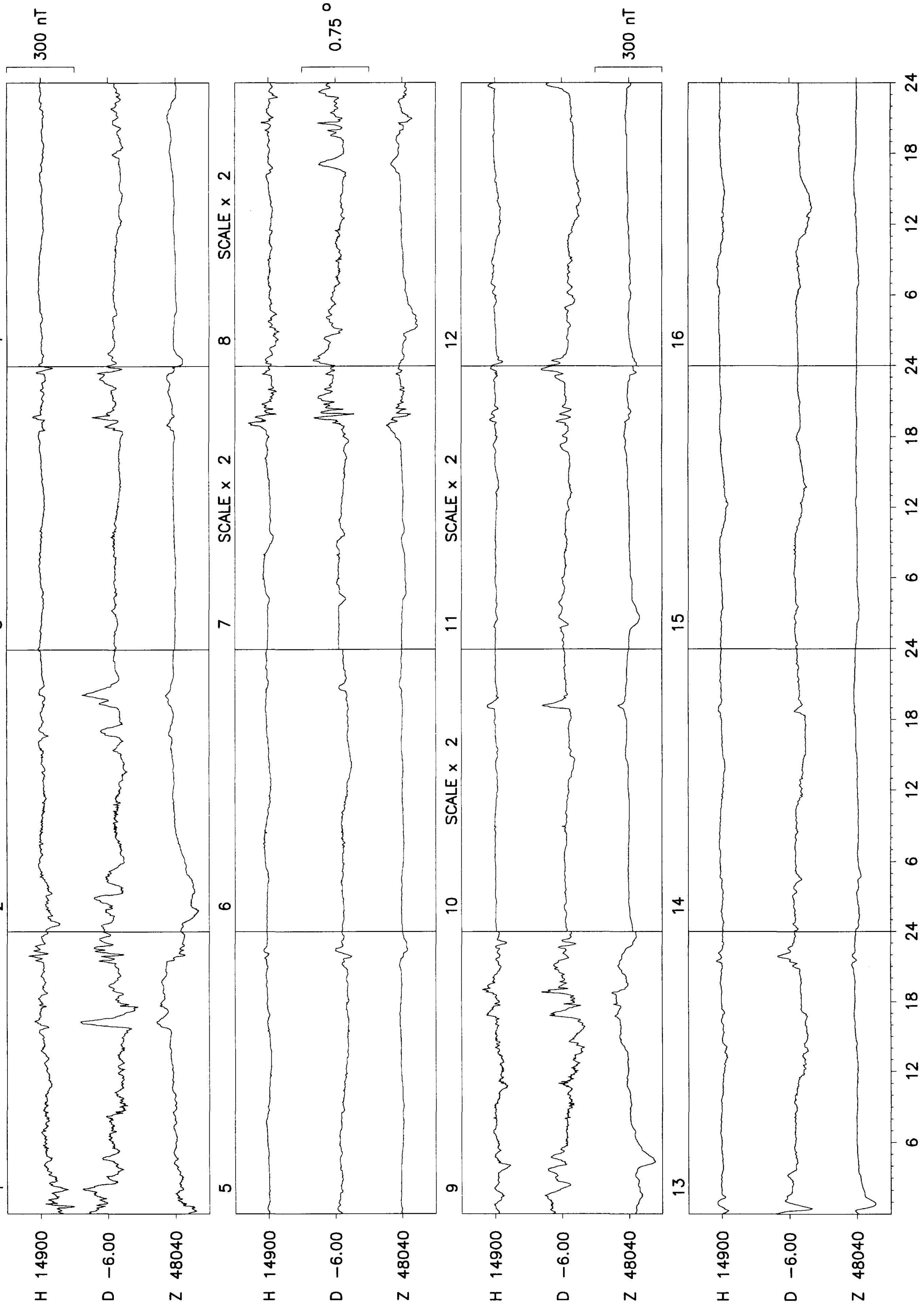

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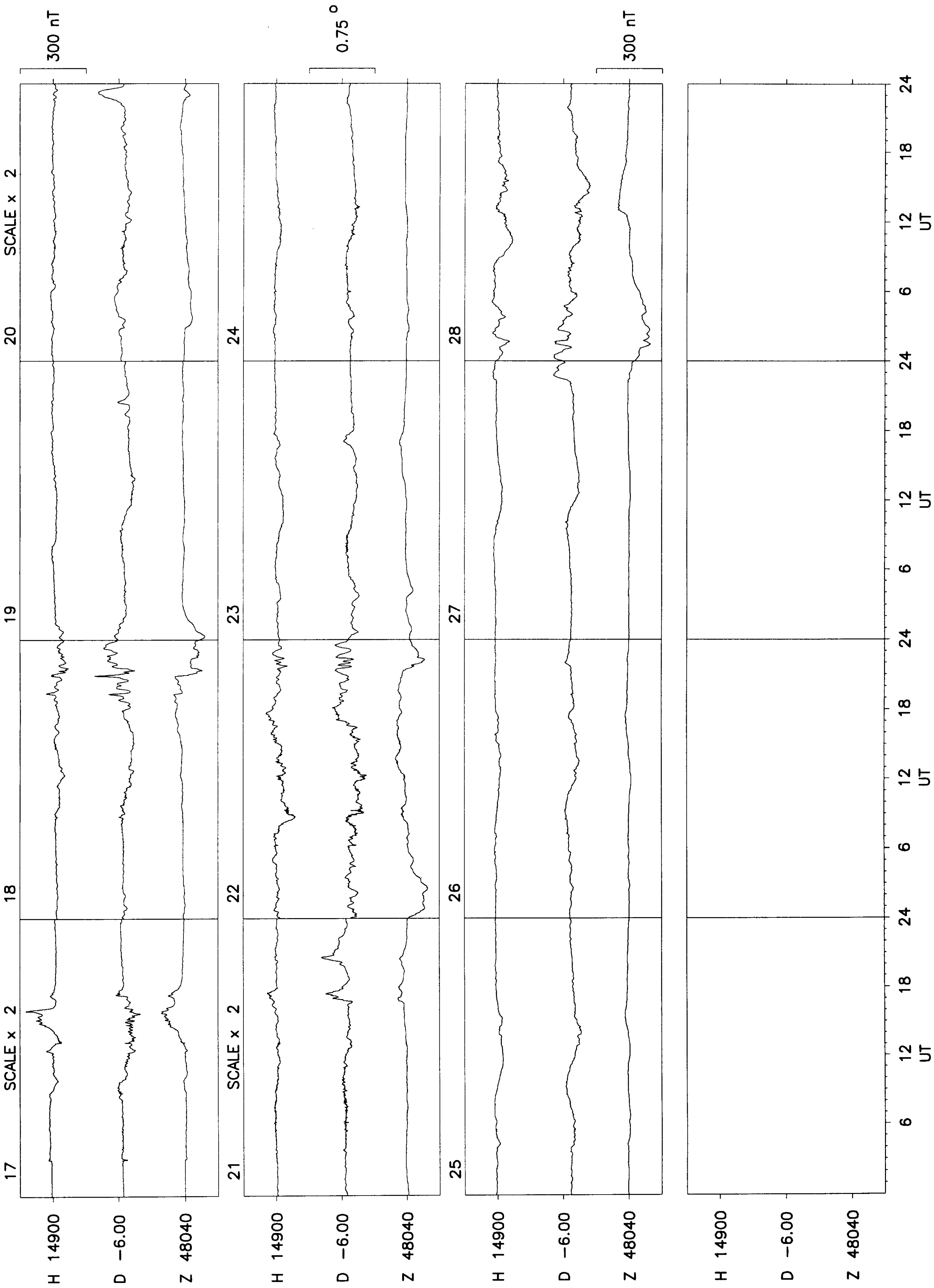

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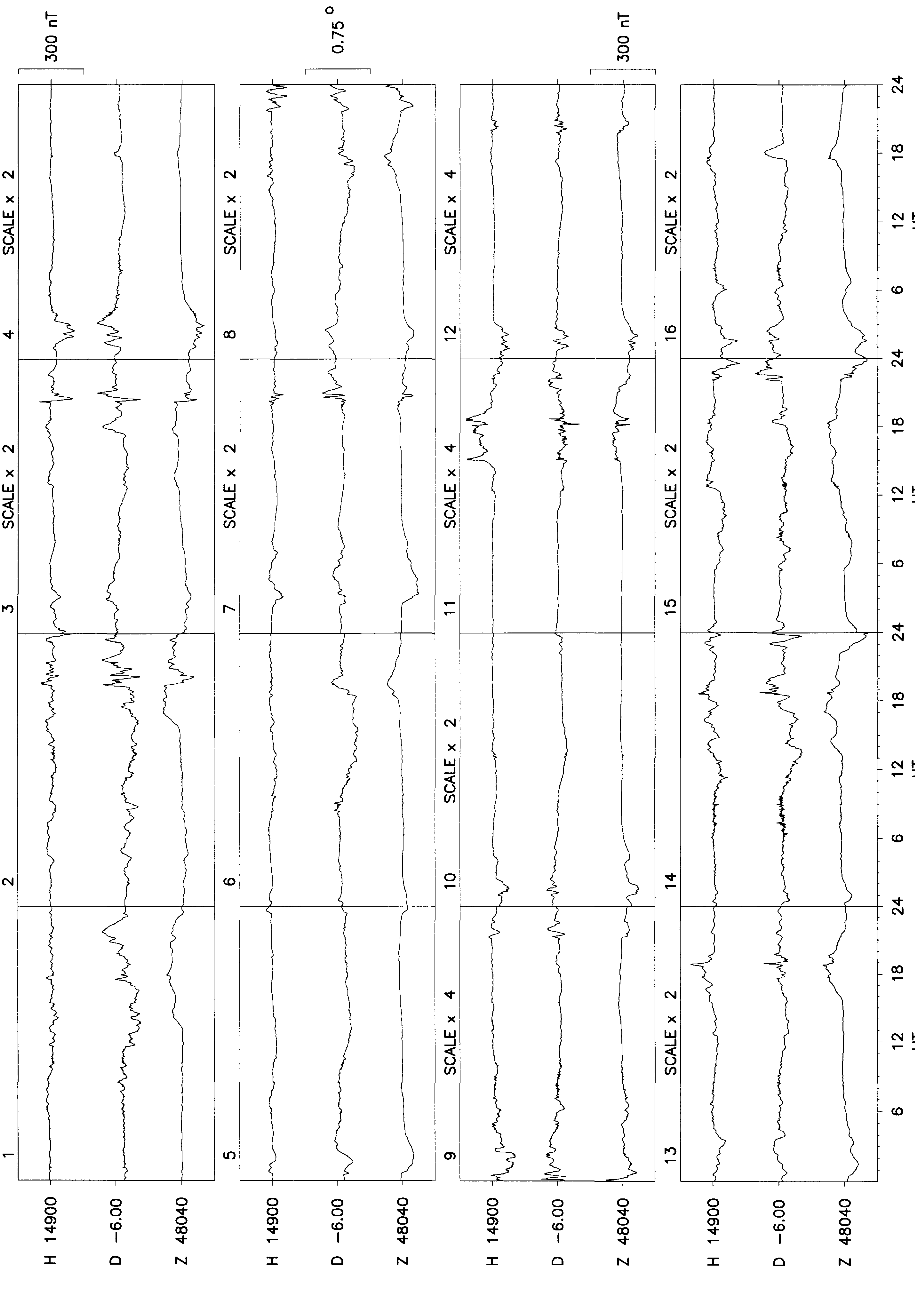

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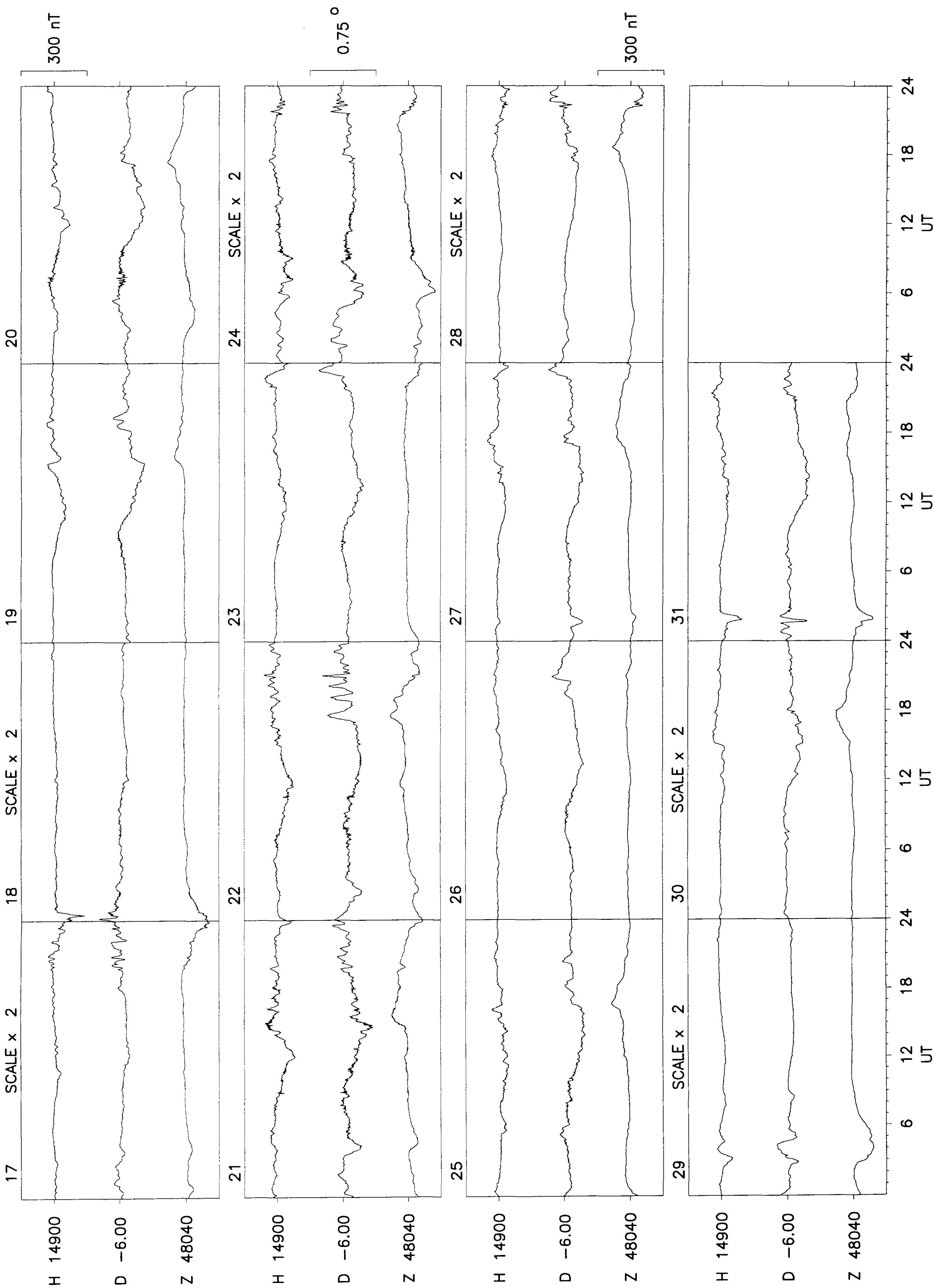
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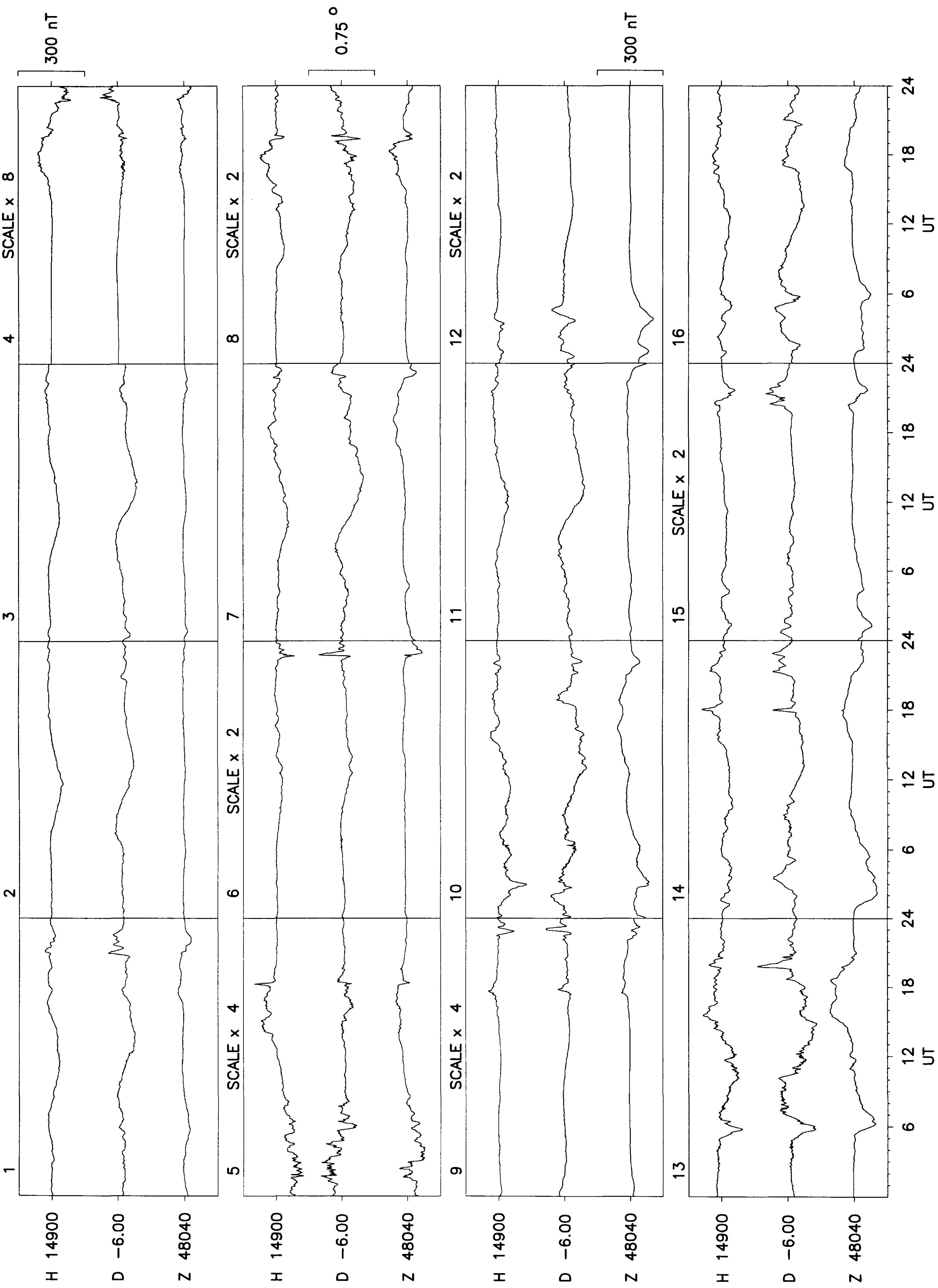

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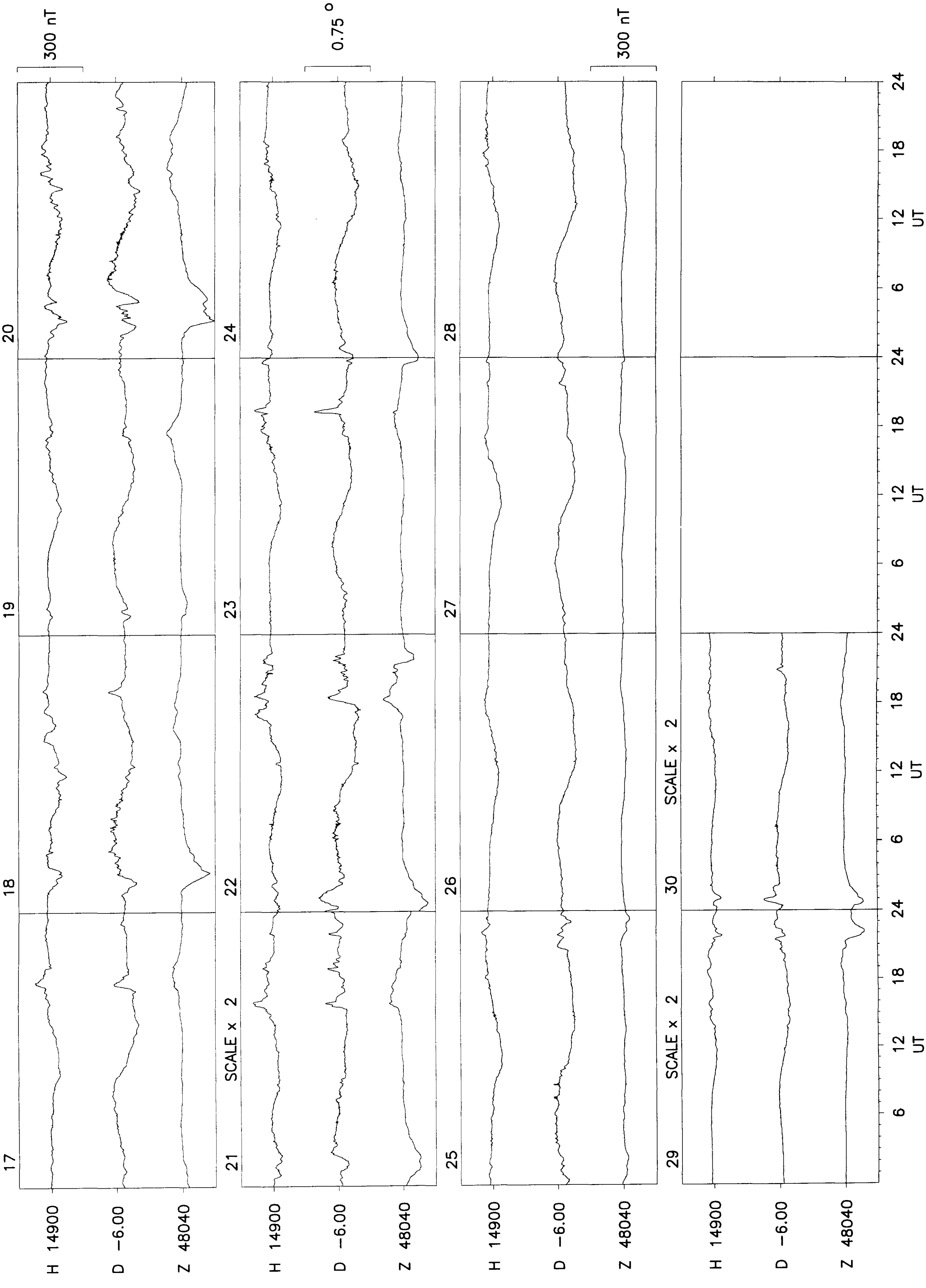
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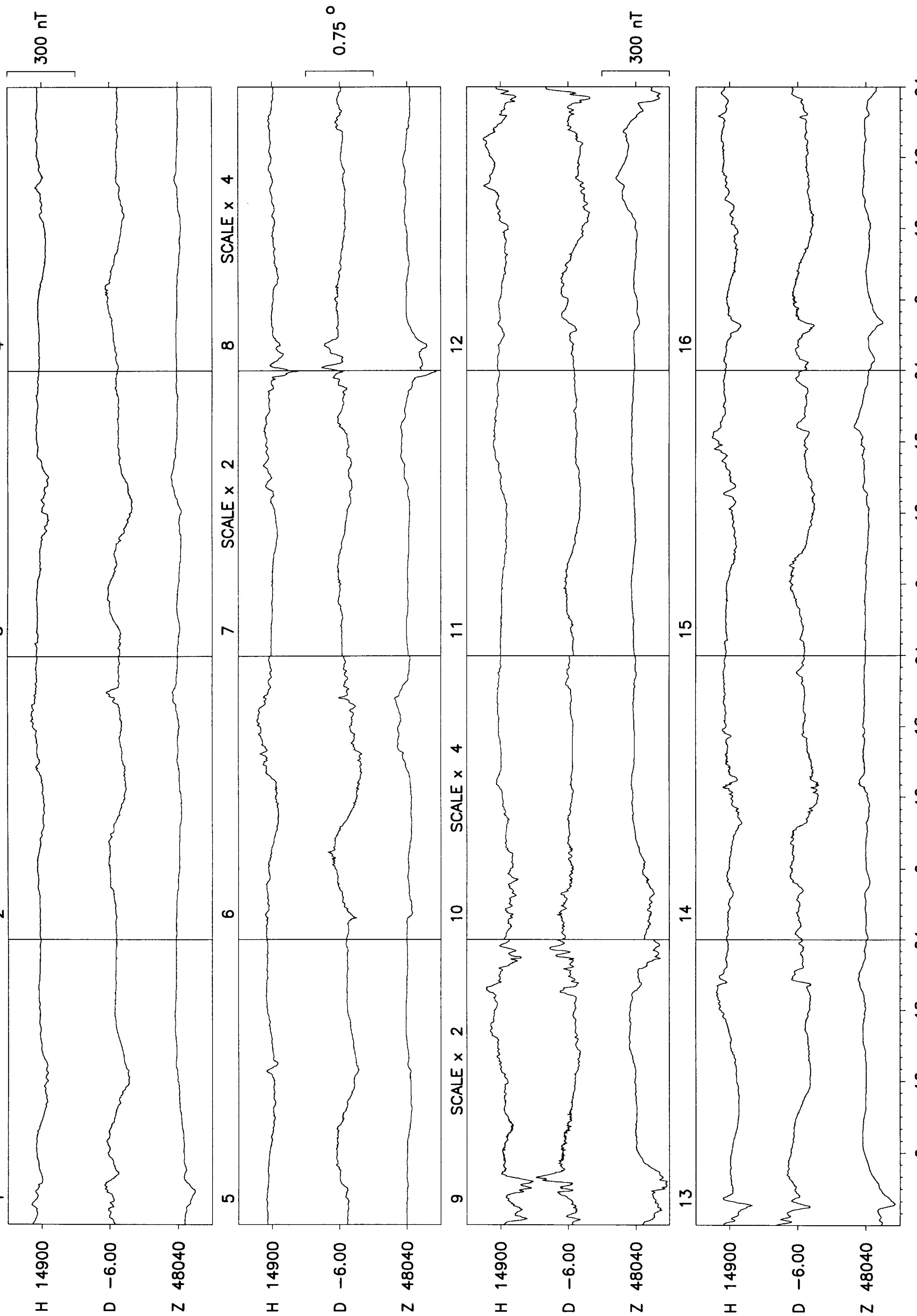

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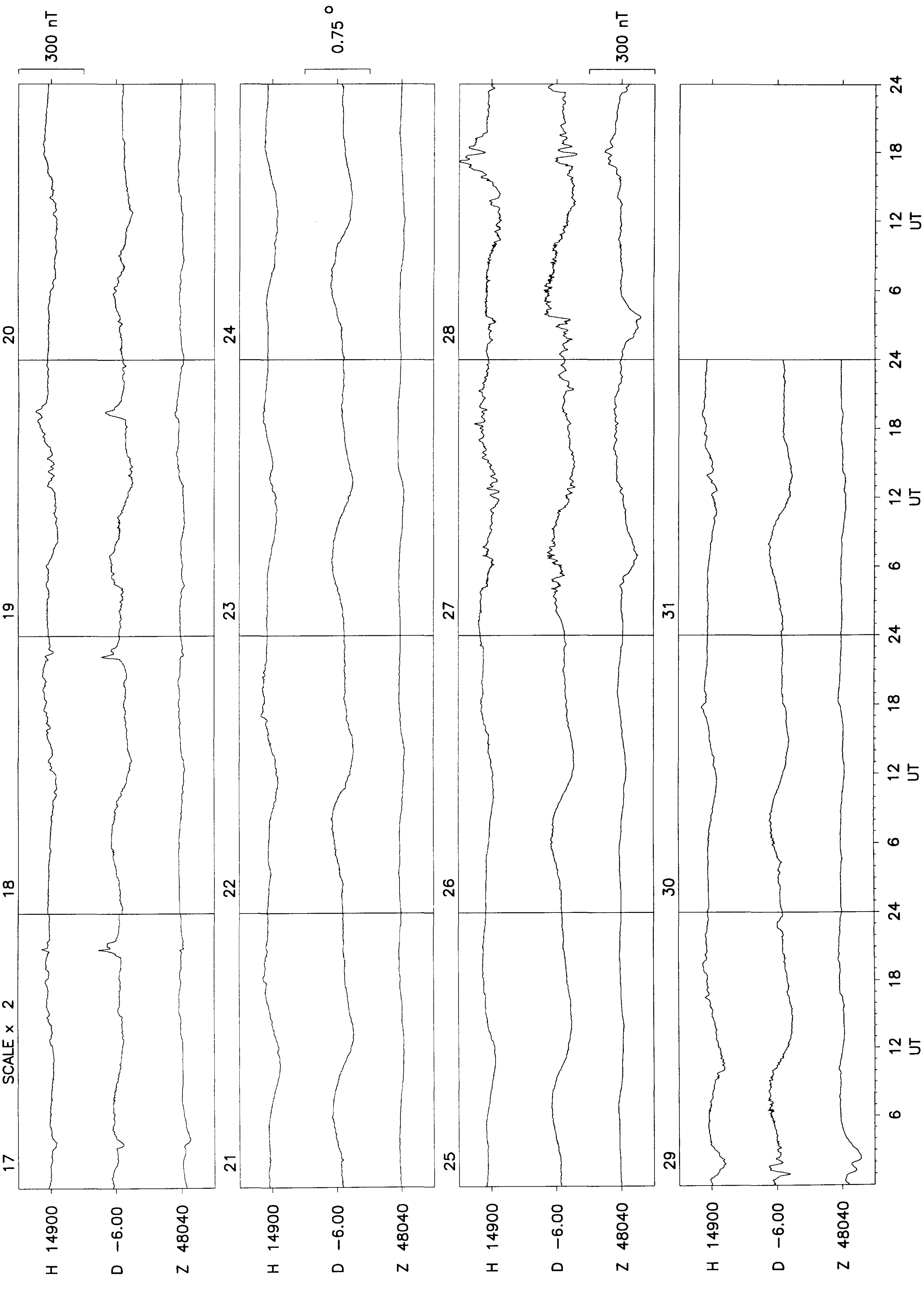
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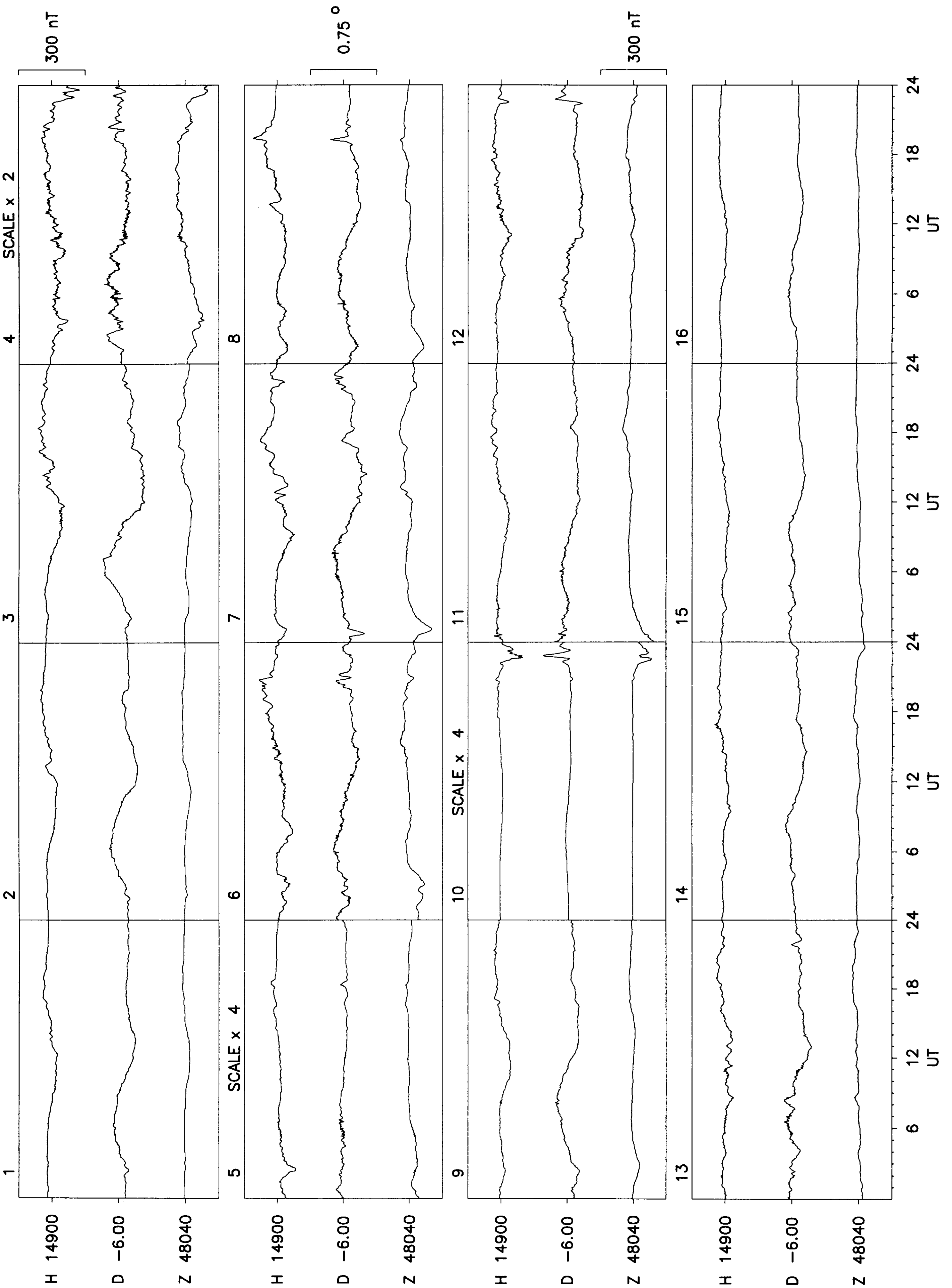
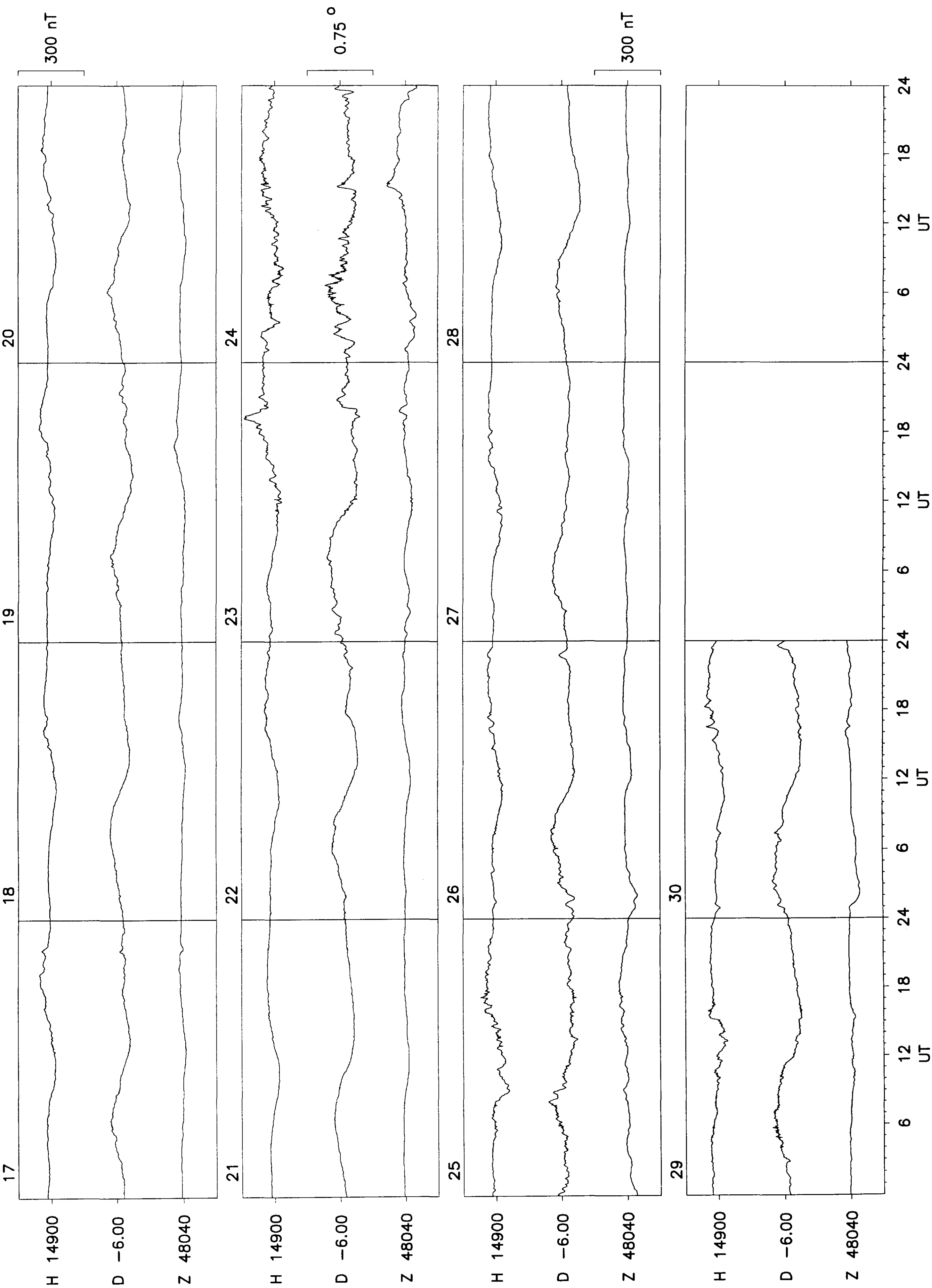


Lerwick June 1993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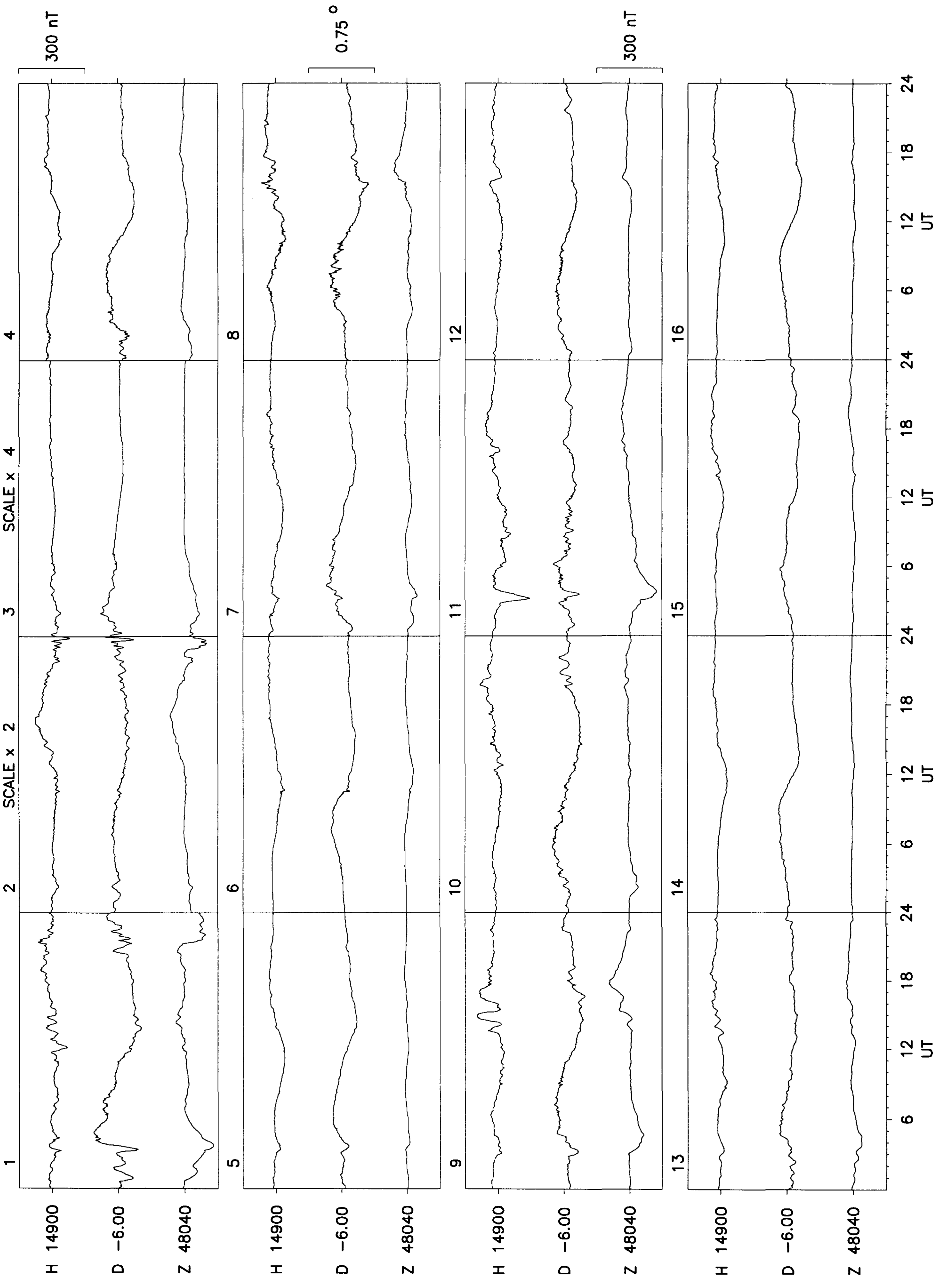
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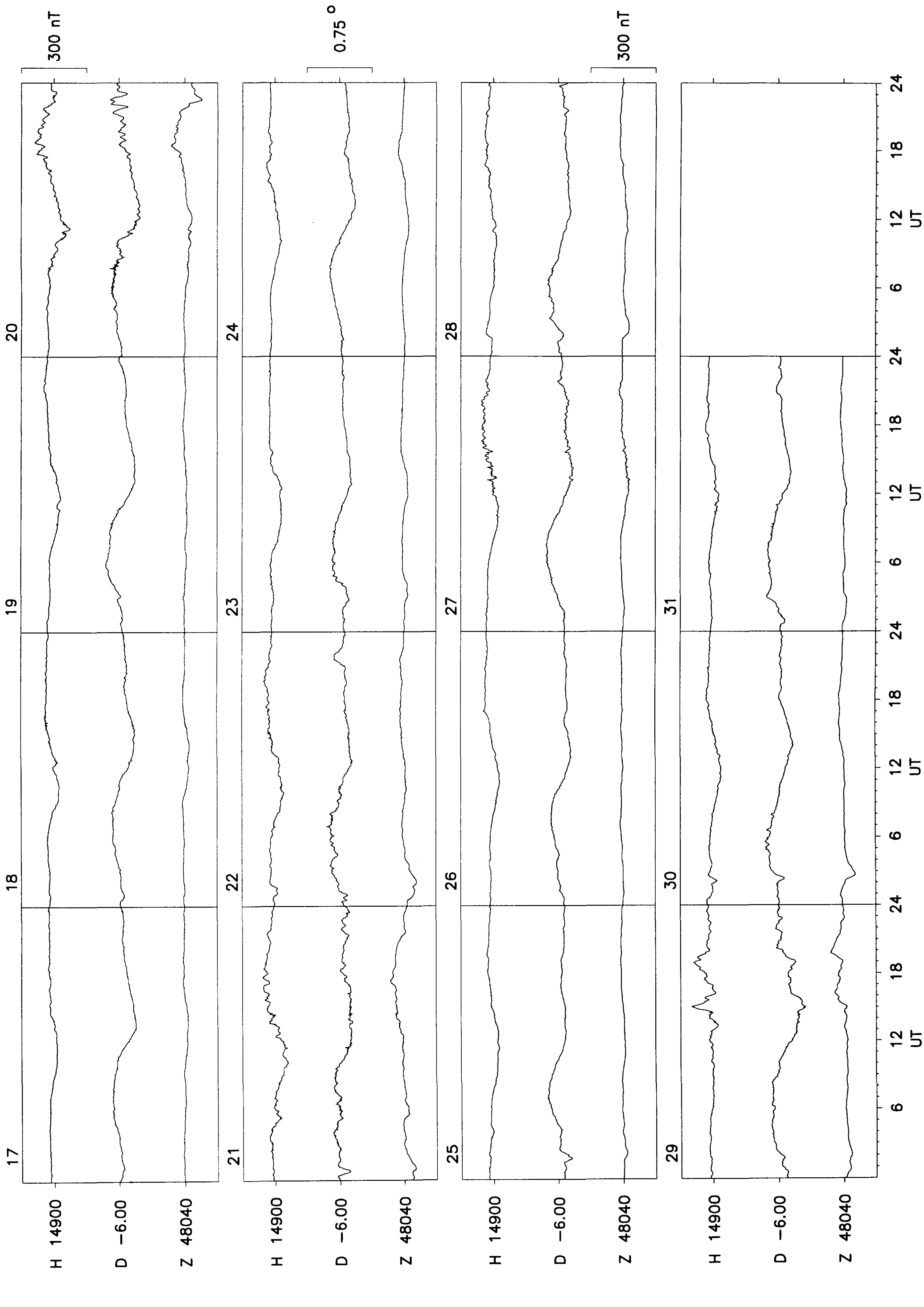
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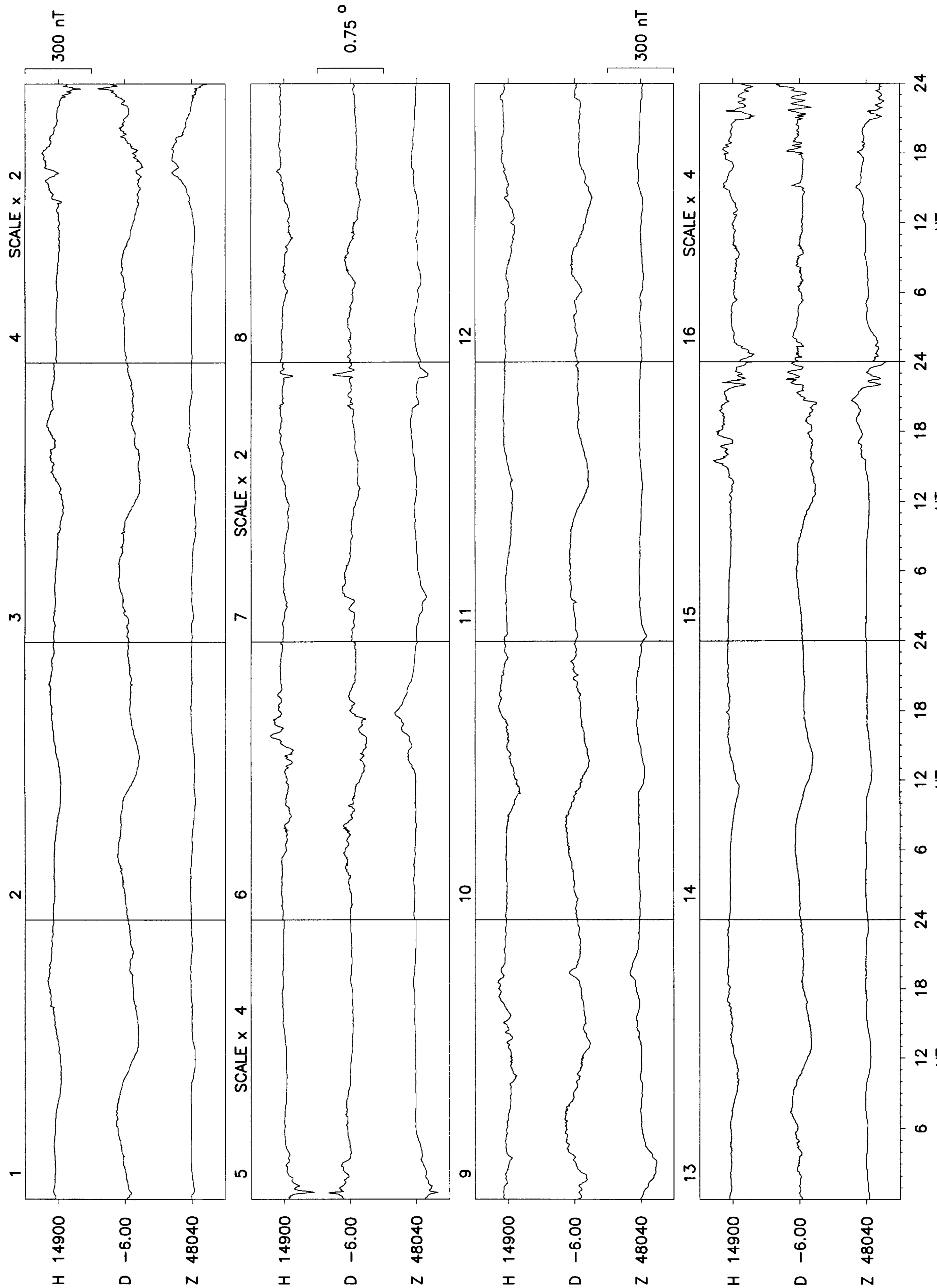

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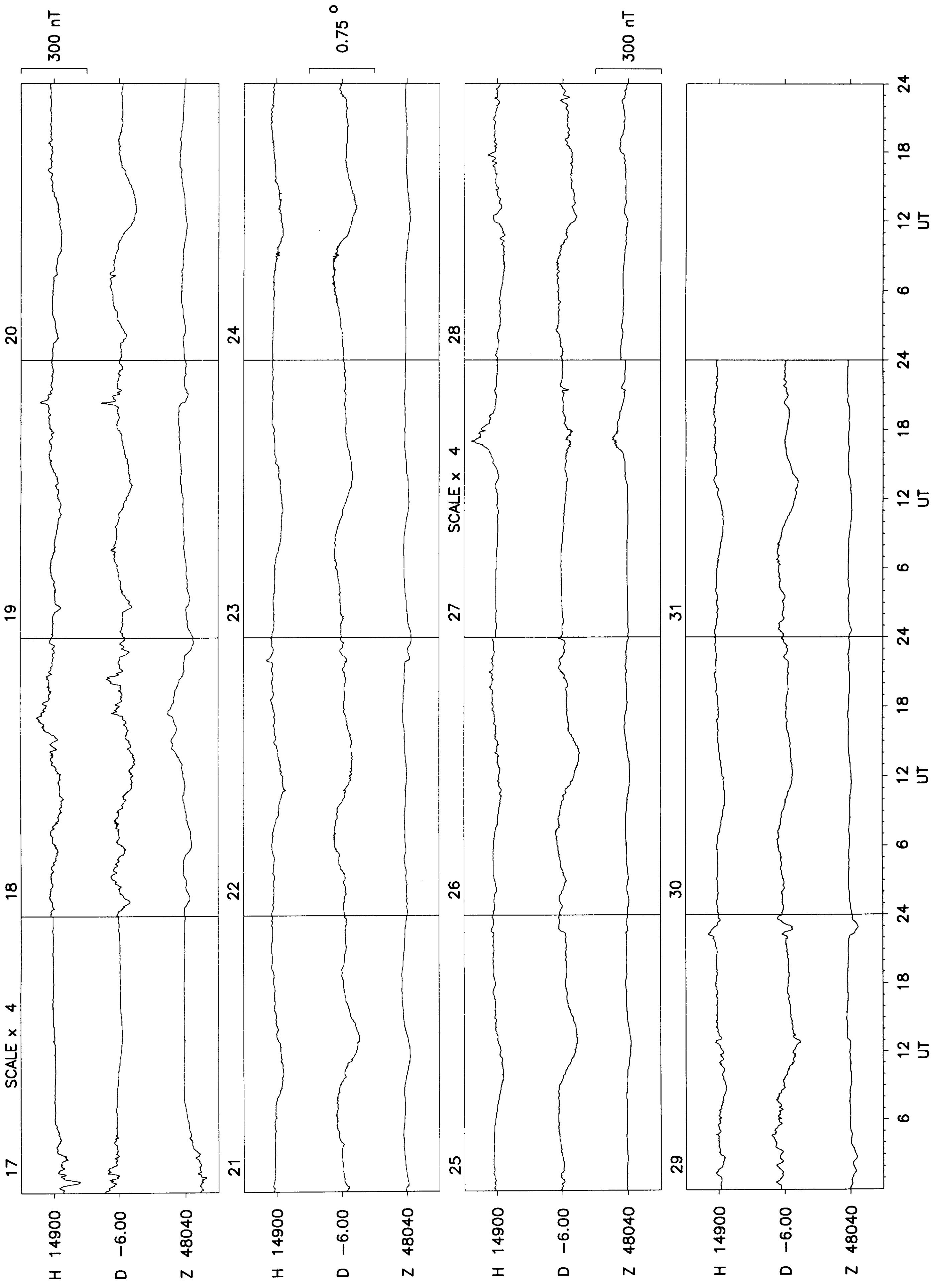
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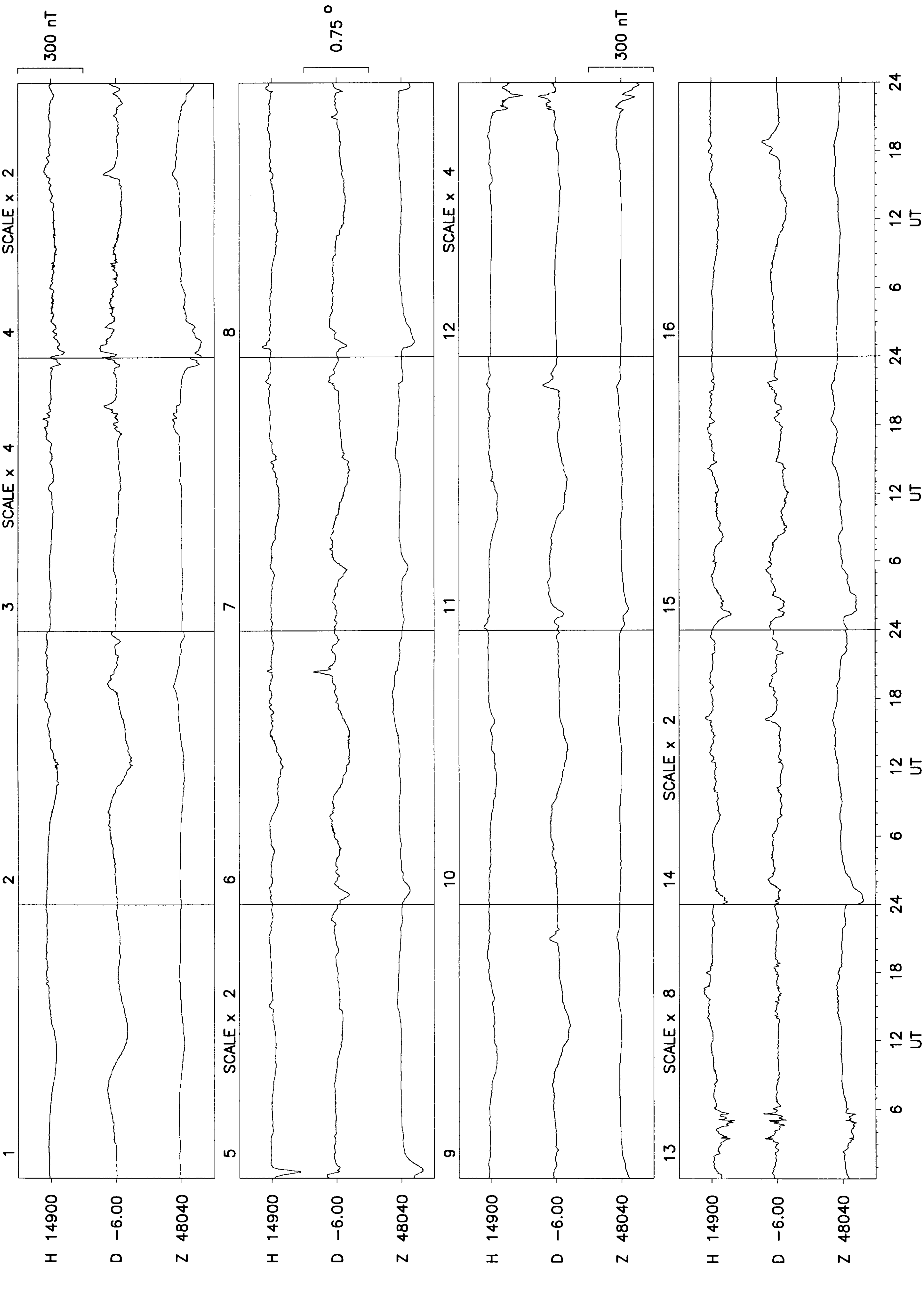

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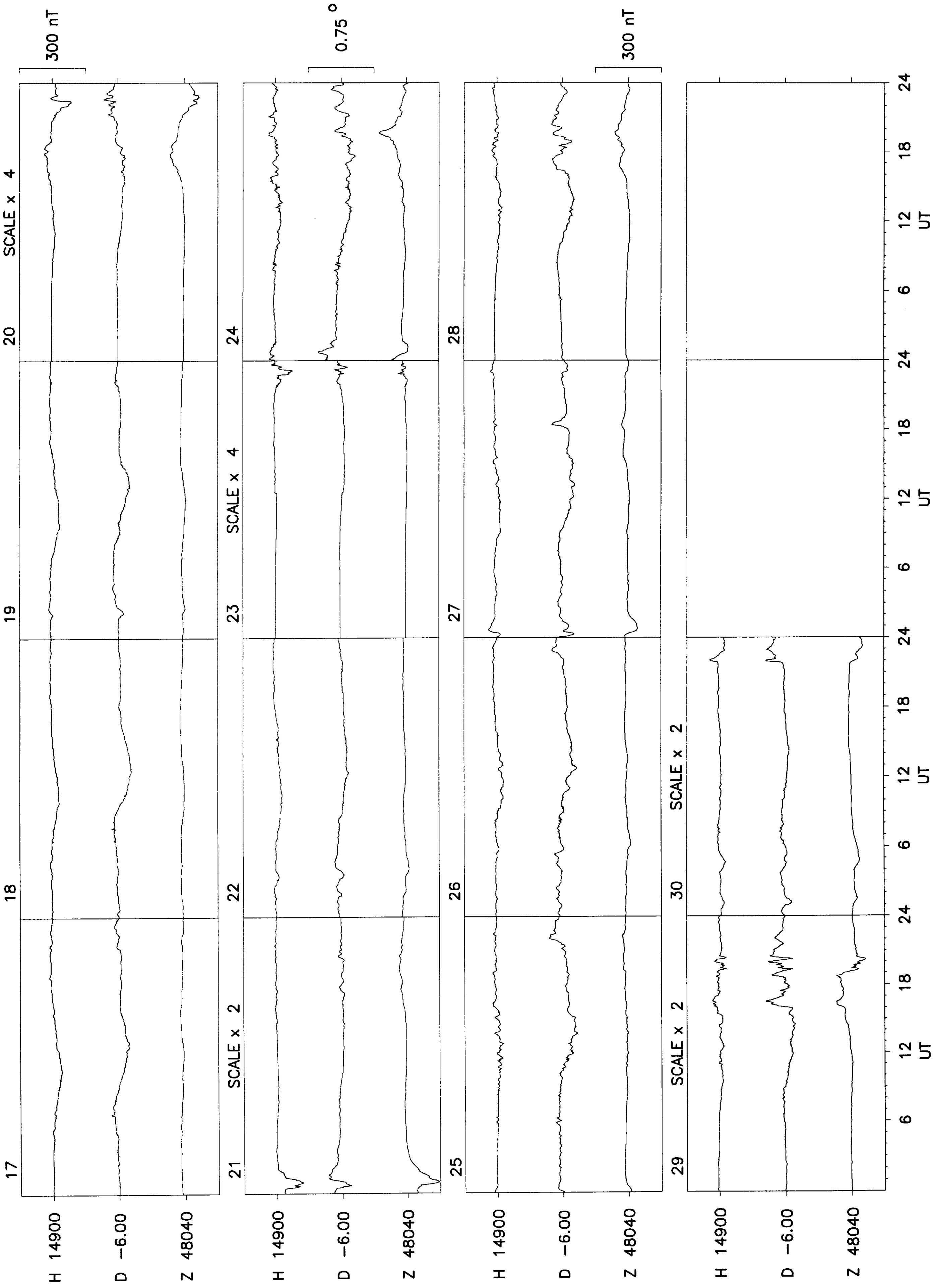
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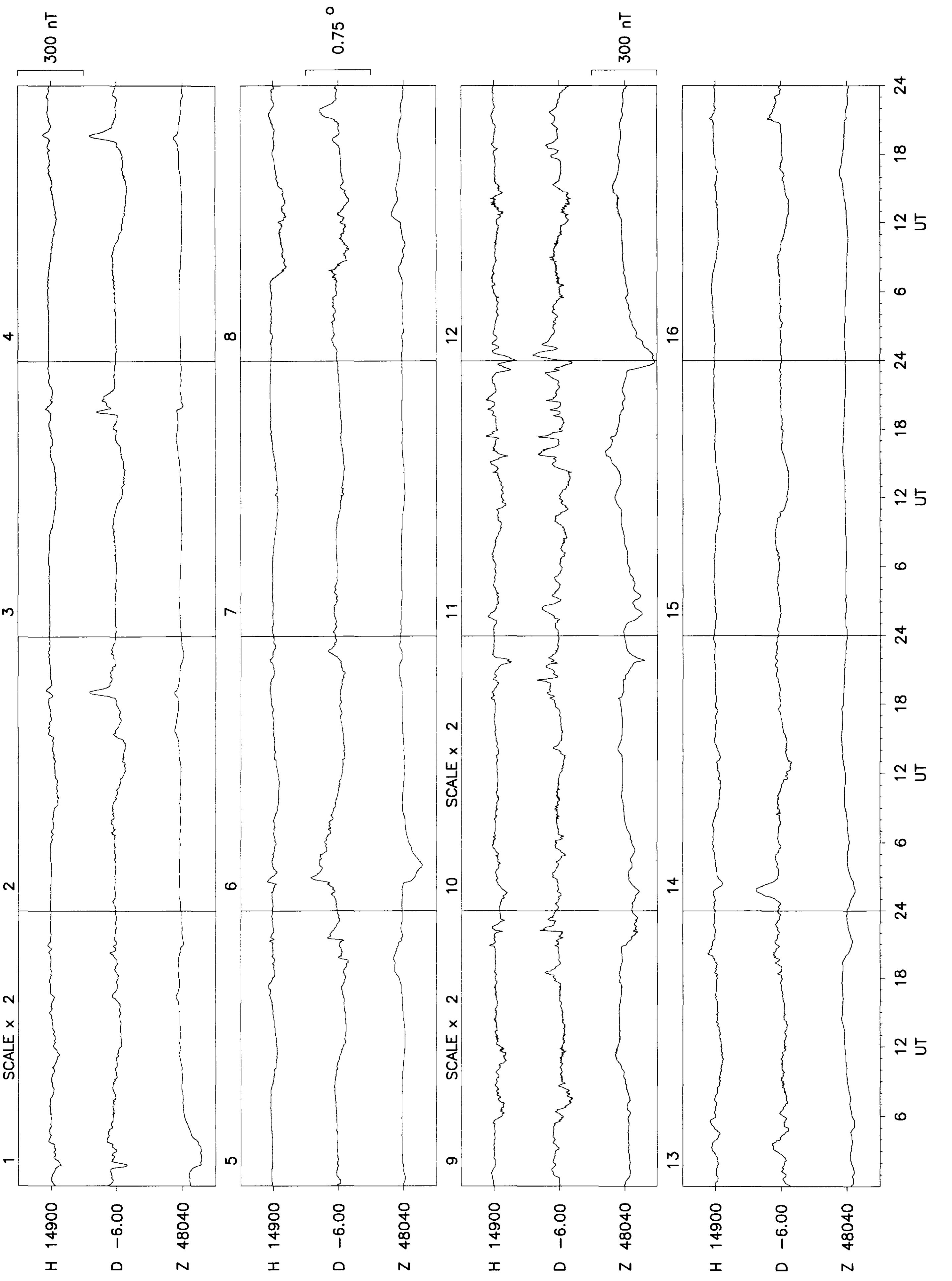

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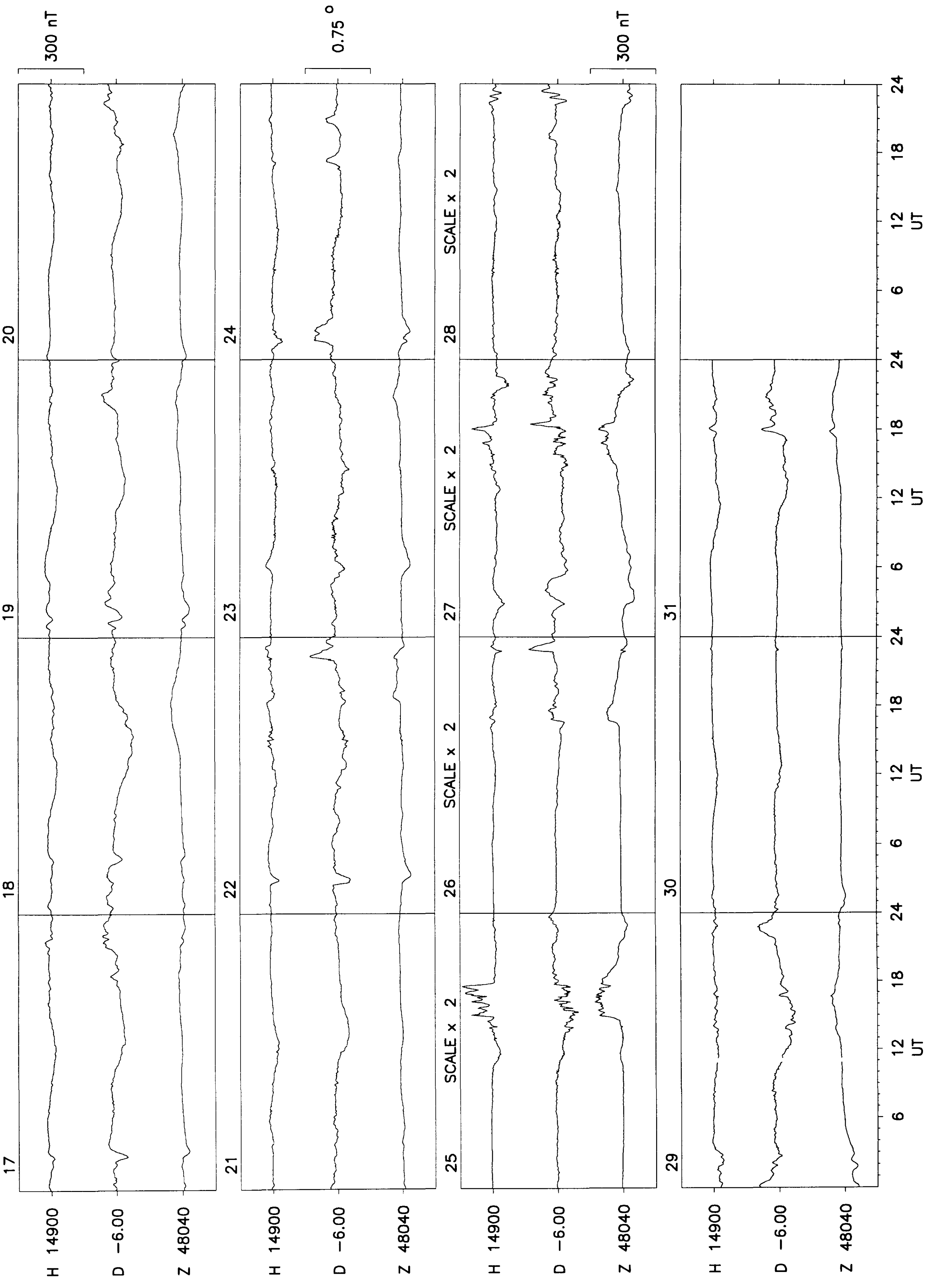

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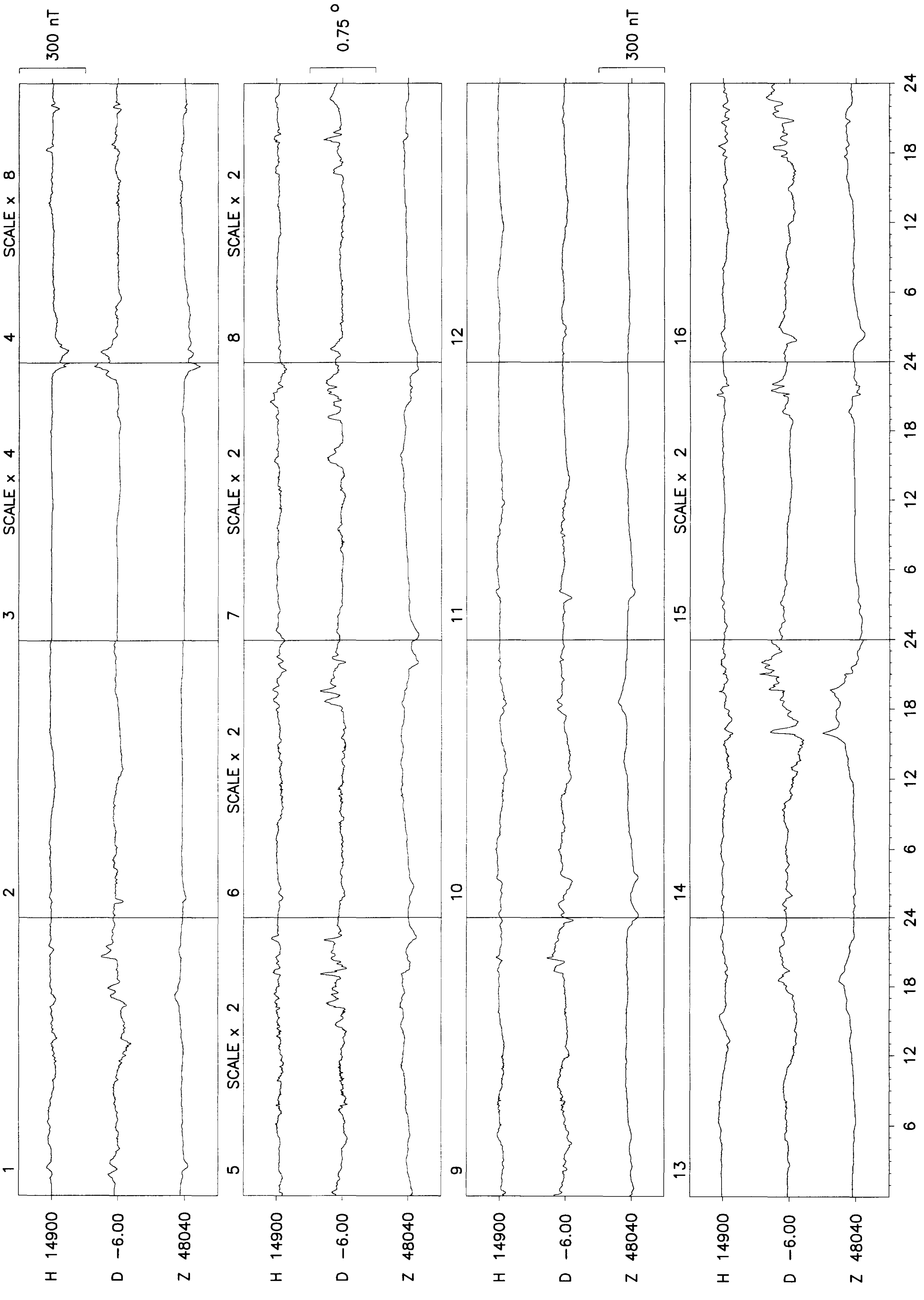
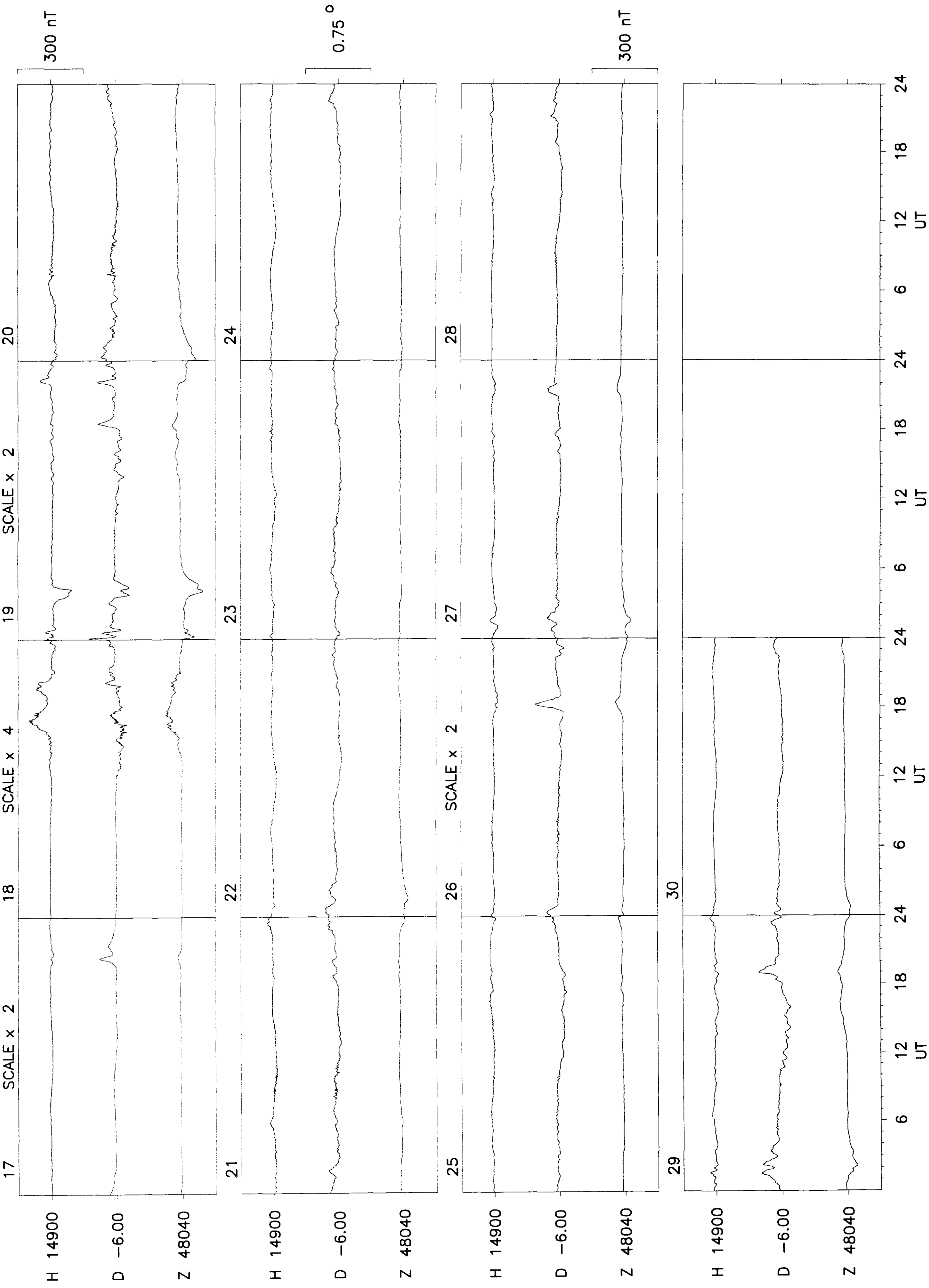


Lerwick November 1993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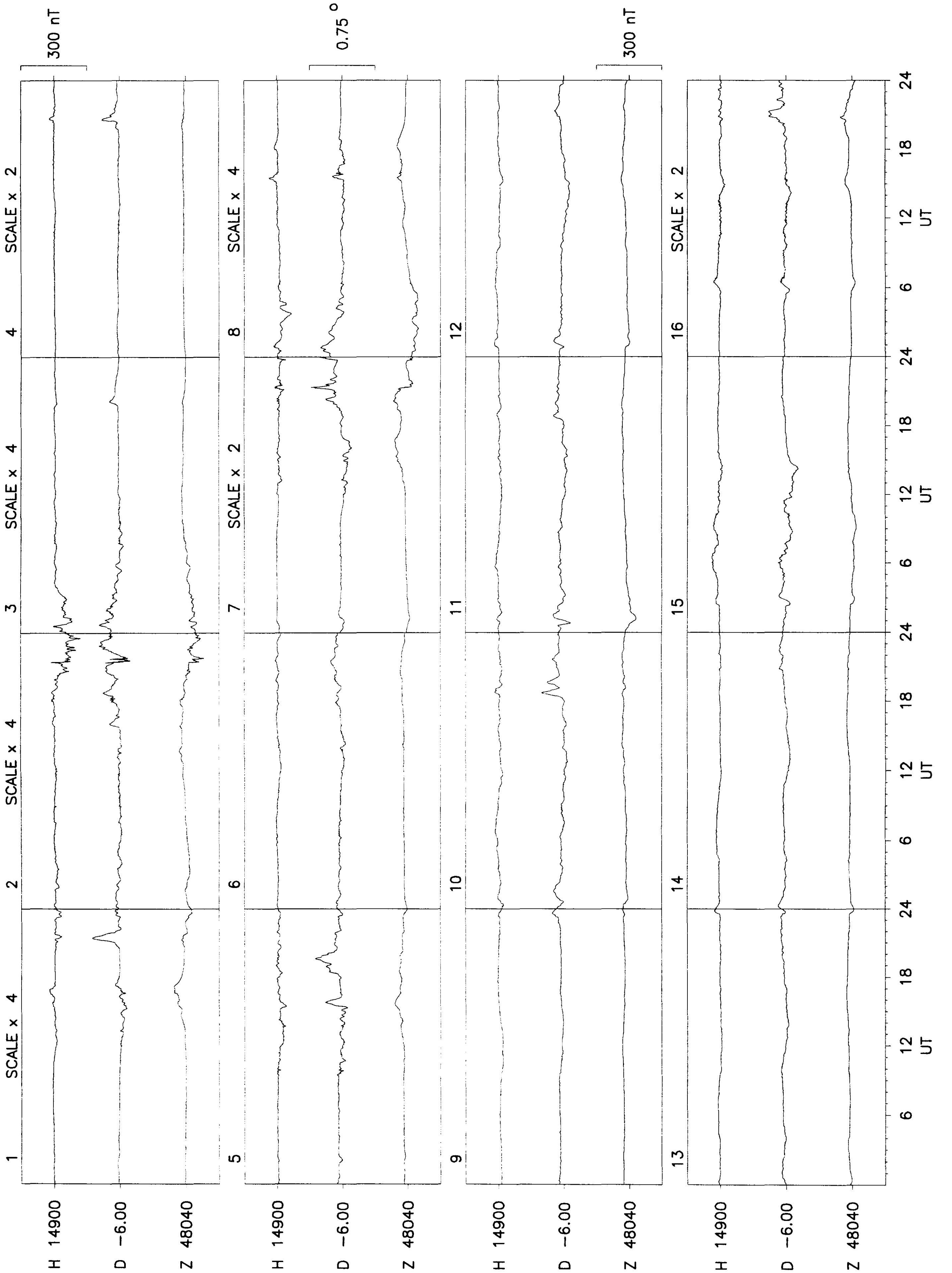
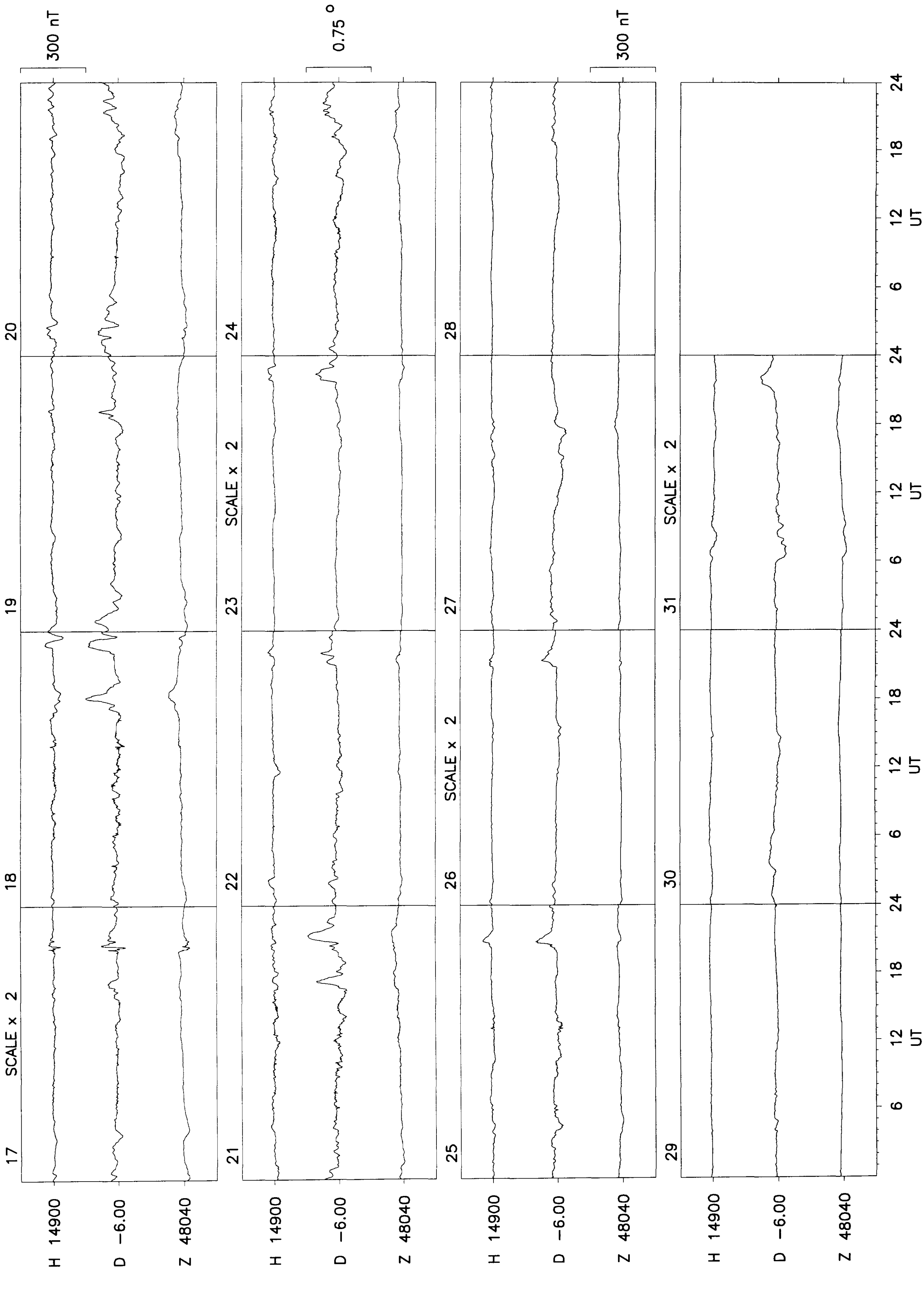


Lerwick December 1993



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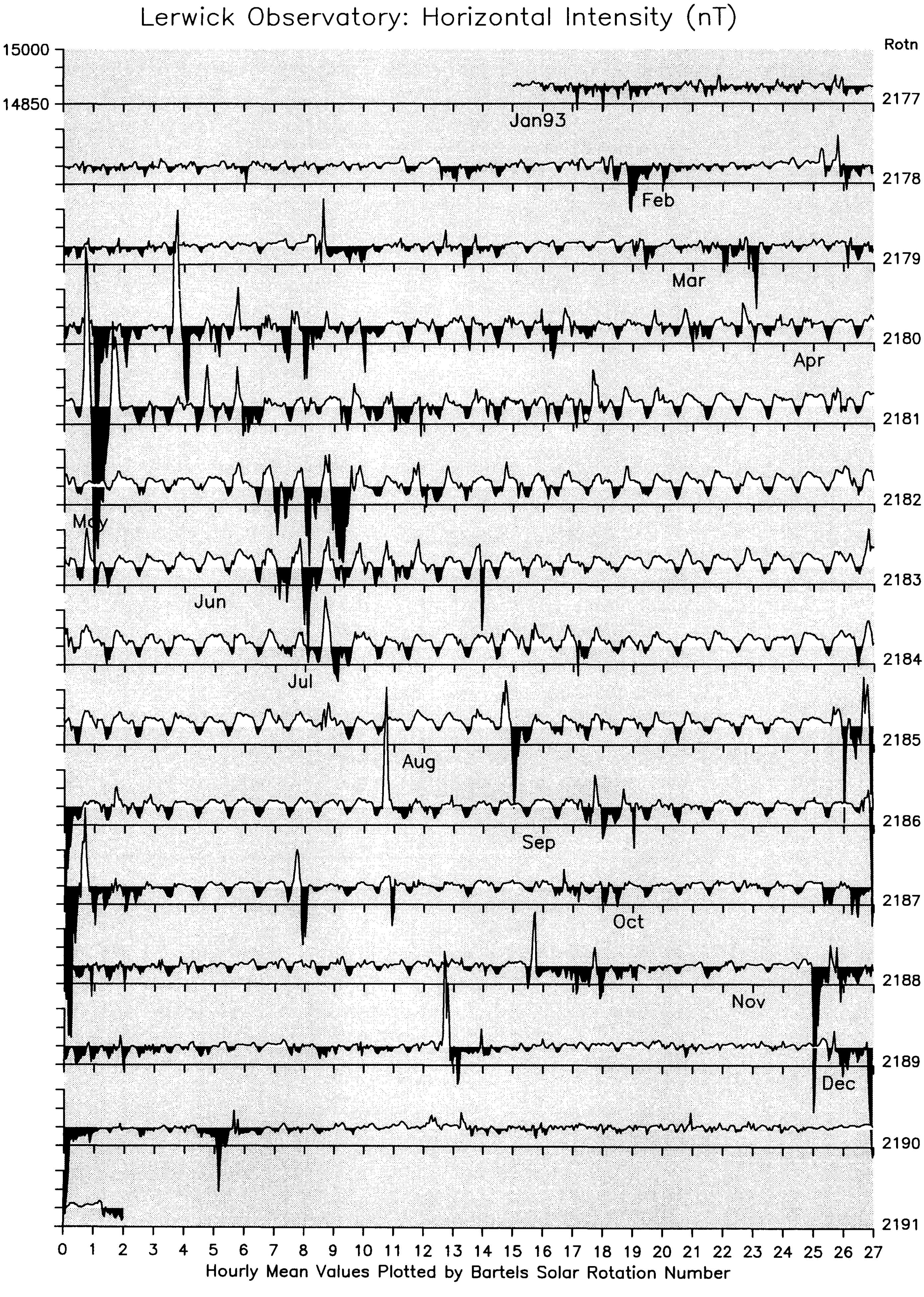
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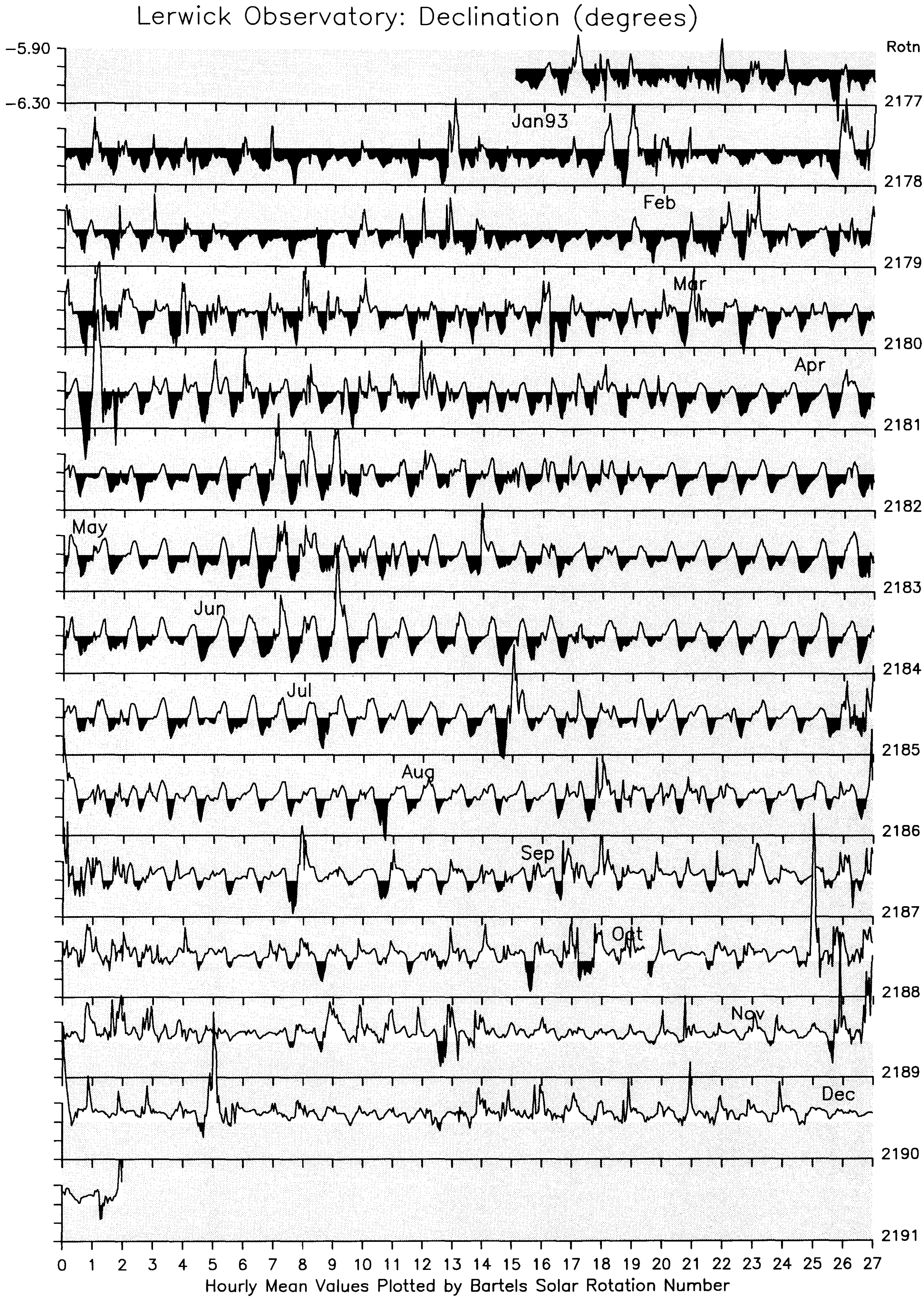
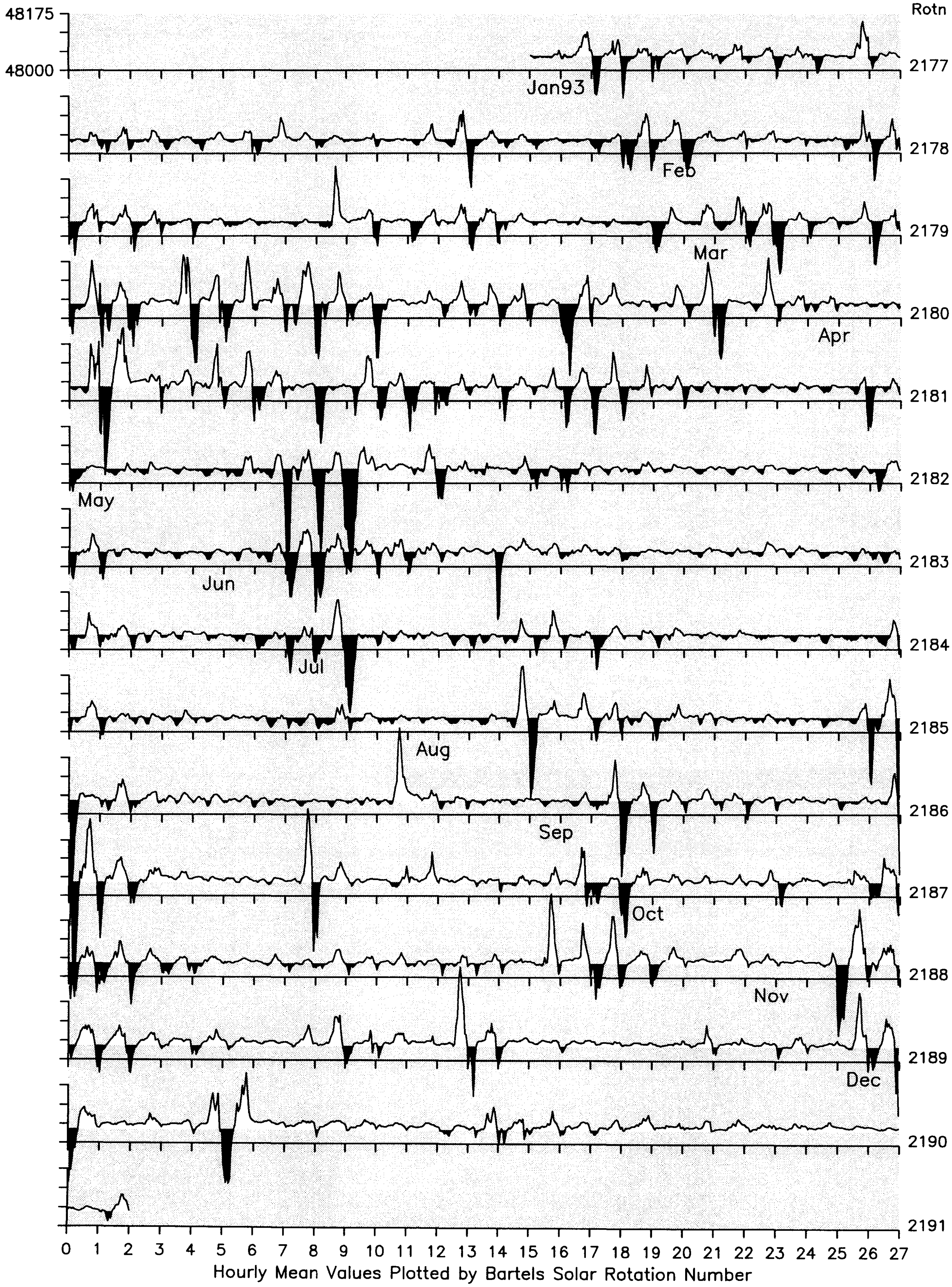
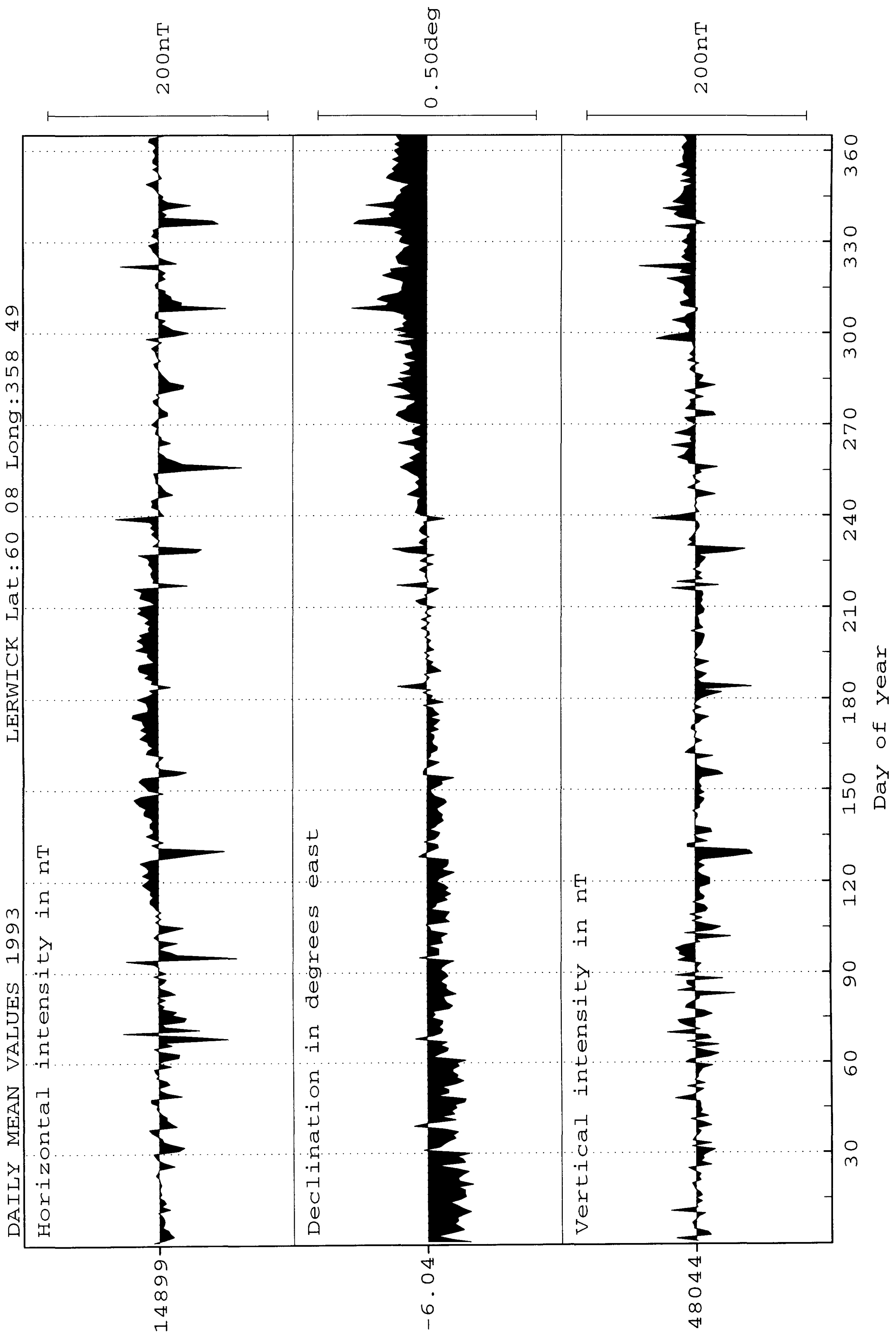
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number


Lerwick Observatory: Declination (degrees)
-5.90
-6.30
Rotn
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
Jan93
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

Lerwick Observatory: Vertical Intensity (nT)




DAILY MEAN VALUES 1993
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
200nT
0.50deg
200nT
14899
-6.04
48044
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Lerwick 1993

Month	D		H	I		X	Y	Z	F
Jan	-6	6.6	14896	72	46.4	14811	-1585	48042	50298
Feb	-6	5.4	14895	72	46.4	14811	-1580	48041	50297
Mar	-6	4.6	14890	72	46.8	14806	-1576	48043	50298
Apr	-6	4.2	14898	72	46.3	14814	-1575	48042	50299
May	-6	3.9	14904	72	45.8	14821	-1575	48036	50295
Jun	-6	3.3	14908	72	45.6	14825	-1573	48040	50300
Jul	-6	2.3	14910	72	45.4	14827	-1568	48038	50299
Aug	-6	1.7	14903	72	45.9	14821	-1565	48042	50300
Sep	-6	0.4	14894	72	46.6	14812	-1559	48046	50302
Oct	-5	59.4	14895	72	46.6	14814	-1554	48048	50304
Nov	-5	58.0	14896	72	46.7	14815	-1548	48055	50311
Dec	-5	57.6	14895	72	46.7	14814	-1547	48056	50311
Annual	-6	2.3	14899	72	46.2	14816	-1567	48044	50301

D and I are given in degrees and decimal minutes
H, X, Y, Z and F are given in nanoteslas

Lerwick Observatory K Indices 1993

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0211 1102	4332 2534	1122 3333	1110 1233	2312 1000	2100 2210	3423 4234	1000 0111	0000 0110	4323 2332	2212 2332	1002 3536
2	3223 3443	3422 2342	1232 2344	0111 1111	0000 1132	1101 3111	3223 4435	0100 0011	0001 2222	0011 1241	2100 1000	4433 3467
3	4423 2443	1111 1143	5432 3564	2101 1111	2111 2210	2222 3322	6431 3222	1011 2221	2322 4555	0010 0132	0000 1136	6533 2243
4	5222 3344	2100 1222	5522 1331	1102 4778	0010 1300	4545 4346	3212 2211	1121 4555	4232 2424	0001 1141	7533 5566	1001 1143
5	3223 2132	1010 0113	3211 1002	6654 6572	1111 3000	6533 4343	1200 1100	7422 2220	6211 3322	1000 1223	3233 3454	1001 2332
6	3222 2233	0110 0021	1012 1232	2111 3225	3121 2232	3332 2233	0002 1111	0122 3321	3211 3232	3320 1122	3223 2344	1010 1112
7	2313 2354	1333 1264	3431 1254	1111 1223	0211 4336	3123 3333	2210 1220	3322 2224	1211 2112	1100 1100	3222 2444	2010 3345
8	3211 2343	5433 2554	3221 3426	2122 4553	6343 3444	3311 3241	2222 4321	1122 1200	3101 1122	1132 2223	3112 2343	5633 2531
9	3121 2333	3323 3443	7554 3335	4221 2546	5643 4345	2011 1211	3321 4422	2212 2320	1001 1122	3444 3344	2222 1133	0000 0001
10	2332 3200	1121 2251	4311 3203	4431 2332	5554 4323	0001 1237	2221 3233	1012 1212	0100 1201	4332 3245	2211 2221	2111 1132
11	1102 3434	3222 2345	2023 5675	1111 2112	1100 1111	3211 1221	3532 2321	1100 1000	2101 2113	3223 3434	1201 1100	3210 1121
12	3211 1222	3211 1113	5322 2453	4410 2111	2222 2344	1223 2223	2111 2312	1111 2112	1000 2347	4232 3223	1100 0000	2001 0112
13	1001 2314	4201 2113	4432 3453	1444 4342	4200 1232	2223 2222	2211 2221	1111 2110	6855 5654	2321 1131	0110 2222	1000 0002
14	3322 3234	1201 1020	2123 3344	3322 1443	2213 3212	0212 2212	0000 1110	0001 0110	4233 3433	3111 2201	2112 2433	1100 0011
15	2211 2234	0001 1110	4243 4446	4322 1145	1111 3332	1211 1110	0110 2121	0001 2434	4332 3222	1001 0100	2201 1134	2122 2100
16	1310 1232	0011 1100	5443 2442	3321 2333	2321 2112	1110 0000	0000 1212	7444 5577	0101 2230	1010 1122	3211 2233	1232 3244
17	3232 1122	1223 5612	3313 2235	1111 1331	2311 2243	1100 1122	1000 1100	7522 2221	0110 1101	3300 1123	2000 0043	2322 2343
18	1101 1224	1012 3244	6222 2112	3323 4330	0001 2223	0000 1200	1001 2110	3322 3432	0011 0010	2300 1211	1100 4764	2222 2444
19	4313 1254	2011 1120	1011 3332	2112 2311	2221 2231	0111 2211	1211 1111	3211 1232	2001 1101	3211 1133	5512 3344	3221 1232
20	2022 3300	2333 3225	2323 3332	3422 3322	1221 2210	1111 2110	1123 2333	2121 1210	0002 3456	2000 1122	2221 1101	3211 1223
21	2211 1111	1222 3554	3324 4333	4332 3544	1000 0111	0000 0100	2322 3222	1111 1111	6210 1221	1101 1101	2211 1012	3112 2444
22	1000 1133	2243 3333	4223 3444	3221 2343	0101 1210	1110 1222	2221 2222	1111 1112	1200 1101	3321 2223	2000 1011	2112 2012
23	1000 1001	2211 1210	2111 2124	2201 1342	0000 2110	2112 3242	2210 2100	1000 0100	0000 2227	1321 2121	2211 1111	2111 1224
24	0212 1241	1211 1001	4555 3434	2012 2221	1101 0000	3332 4323	1001 1210	0011 2111	3011 2233	3211 0332	0100 0102	2112 2232
25	0002 3454	1211 1100	2222 2321	2121 1123	0100 1100	2243 3322	2100 1100	1001 1111	1112 3223	1114 5623	1101 1212	1211 2133
26	4232 2332	1111 1202	0111 1233	0000 1111	0000 1211	2211 2212	1100 0200	2111 2112	1222 2102	2111 1435	3121 1453	2010 1224
27	1211 2222	0001 1013	2111 2323	1001 1212	2332 3233	2112 1211	1002 3322	2002 4764	3111 1232	4432 4555	2100 0112	2100 1210
28	1211 1010	3323 3311	3211 1344	1110 1210	3322 3543	0111 1110	2211 1212	1113 3322	0001 1333	3222 2235	0000 1112	0000 0011
29	0001 1113		4431 1012	0001 3334	3212 1222	2212 3301	1111 4432	2222 2013	1022 3543	321 2313	3111 1232	0100 0000
30	3311 1122		2122 3422	4221 2232	0100 1210	2120 1323	3111 1110	1000 0111	3321 1125	1000 0001	2000 0001	1100 1000
31	3443 4455		4110 2223		1001 3210		2211 2111	1110 1111		0001 1322		2133 1223

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
7	1	11	09	SI*	B	-12	4.8	-8
19	1	10	22	SI*	C	32	4.4	-6
3	2	18	31	SSC	C	-22	5.3	13
17	2	03	01	SSC*	A	28	-7.8	4
17	2	13	09	SSC	A	-56	8.3	-14
27	2	22	20	SSC*	B	14	-0.4	-7
8	3	21	37	SSC*	A	48	-2.4	-18
11	3	06	40	SSC*	A	-18	2.3	-3
15	3	05	26	SSC*	B	-15	-4.2	-3
21	3	08	58	SI*	C	31	-4.8	-8
23	3	21	56	SSC*	A	26	-1.2	-15
4	4	14	34	SSC*	B	29	2.7	8
29	4	11	45	SSC*	B	-3	0.9	-2
10	6	17	27	SSC*	B	31	-1.9	-13
15	8	15	14	SSC*	B	15	-1.2	4
17	8	13	06	SI*	C	-24	3.3	-10
24	8	14	15	SI*	B	-12	1.1	4
23	9	10	28	SSC*	C	-5	0.7	-2
23	9	12	31	SSC*	A	33	-4.8	+7/-8
23	9	22	45	SI*	B	-174	-13.5	128
3	11	17	55	SSC*	B	17	2.4	-6
18	11	12	12	SSC*	A	21	-5.5	-2
7	12	12	03	SSC	B	10	-0.3	3

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.

The quality of the event is classified as follows :

A = very distinct

B = fair, ordinary, but unmistakable

C = doubtful

The amplitudes given are for the first chief movement of the event.

SFEs

Day	Month	Universal Time						H(nT)	D(min)	Z(nT)
		Start		Maximum		End				
26	4	12	49	12	52	12	55	13	1.3	-5

Notes

The amplitudes given are for the first chief movement of the event.

Annual Values of Geomagnetic Elements

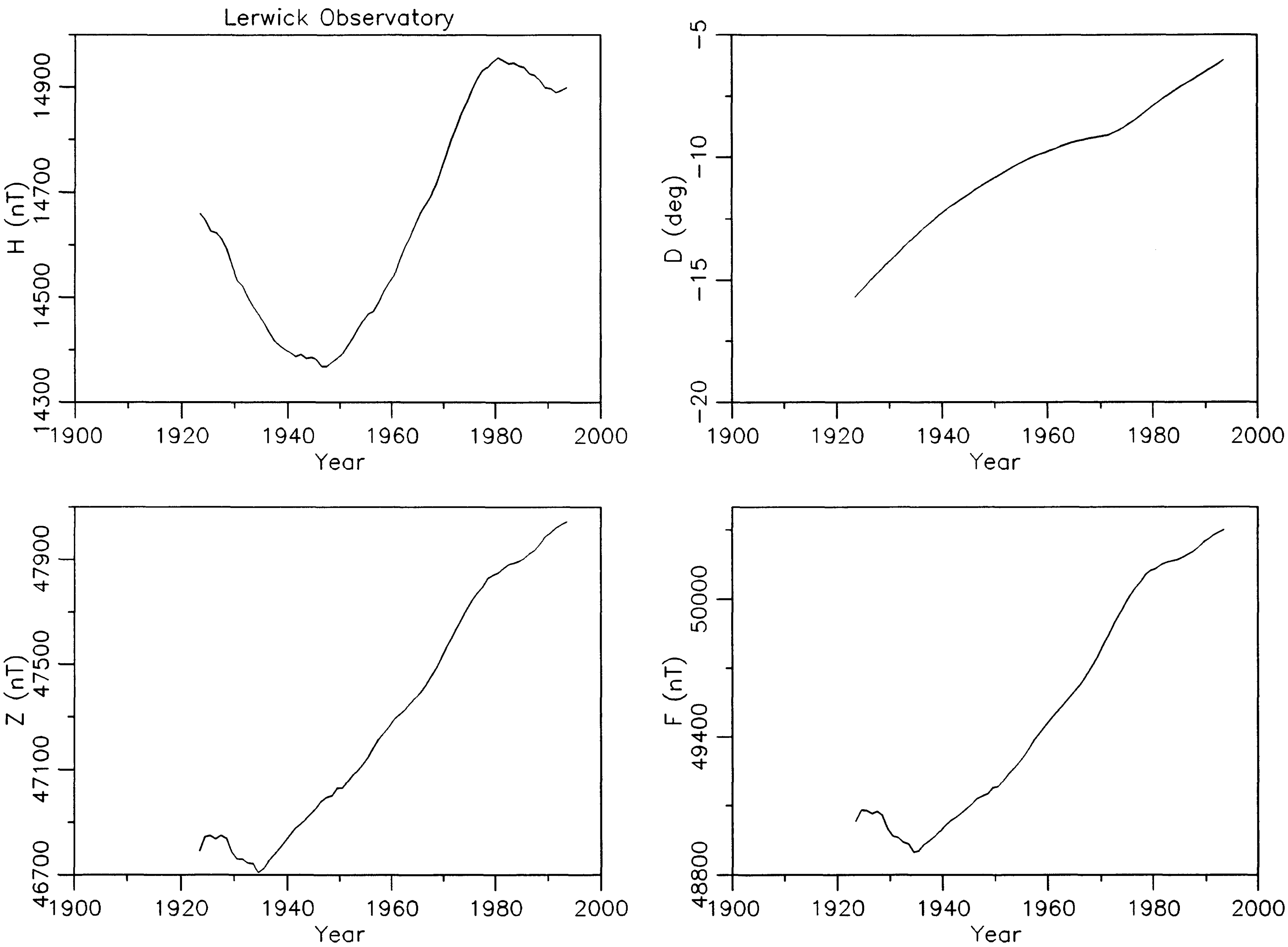
Lerwick

Year	D	H	I	X	Y	Z	F
1923.5	-15 40.3	14655	72 33.7	14111	-3959	46655	48902
1924.5	-15 26.5	14642	72 35.7	14113	-3899	46708	48950
1925.5	-15 13.5	14621	72 37.2	14108	-3840	46713	48948
1926.5	-14 58.6	14618	72 37.1	14121	-3778	46699	48933
1927.5	-14 45.7	14607	72 38.1	14125	-3722	46713	48944
1928.5	-14 32.9	14585	72 39.4	14117	-3664	46702	48926
1929.5	-14 19.4	14556	72 40.3	14104	-3601	46651	48869
1930.5	-14 7.0	14527	72 41.6	14088	-3543	46624	48835
1931.5	-13 55.4	14517	72 42.3	14090	-3493	46623	48830
1932.5	-13 41.9	14495	72 43.5	14083	-3433	46608	48809
1933.5	-13 29.8	14477	72 44.6	14077	-3379	46605	48802
Note 1	0 0.0	0	0 3.0	0	0	144	138
1934.5	-13 17.7	14462	72 48.0	14074	-3326	46716	48903
1935.5	-13 5.3	14445	72 49.4	14070	-3271	46730	48911
1936.5	-12 53.6	14428	72 51.2	14064	-3220	46763	48938
1937.5	-12 42.4	14411	72 52.8	14058	-3170	46785	48955
1938.5	-12 31.6	14401	72 54.0	14058	-3123	46809	48974
1939.5	-12 21.4	14394	72 54.9	14061	-3080	46833	48995
1940.5	-12 11.1	14389	72 55.8	14065	-3037	46860	49019
1941.5	-12 1.0	14382	72 56.8	14067	-2994	46884	49040
1942.5	-11 52.5	14386	72 56.8	14078	-2960	46899	49056
1943.5	-11 43.5	14378	72 57.8	14078	-2922	46919	49073
1944.5	-11 35.1	14380	72 58.1	14087	-2888	46940	49093
1945.5	-11 26.3	14376	72 58.8	14090	-2851	46963	49114
1946.5	-11 17.1	14363	73 0.2	14085	-2811	46989	49135
1947.5	-11 8.7	14363	73 0.5	14092	-2776	47002	49148
1948.5	-11 0.9	14371	73 0.1	14106	-2746	47009	49157
1949.5	-10 53.1	14378	73 0.2	14119	-2715	47037	49185
1950.5	-10 45.5	14388	72 59.5	14135	-2686	47039	49190
1951.5	-10 37.7	14402	72 59.1	14155	-2656	47061	49215
1952.5	-10 29.9	14417	72 58.6	14176	-2627	47087	49245
1953.5	-10 22.8	14435	72 57.8	14199	-2601	47106	49268
1954.5	-10 15.6	14450	72 57.3	14219	-2574	47129	49294
1955.5	-10 9.2	14464	72 56.9	14237	-2550	47156	49324
1956.5	-10 2.8	14469	72 57.3	14247	-2524	47191	49359
1957.5	-9 57.5	14486	72 56.8	14268	-2505	47225	49397
1958.5	-9 52.7	14507	72 55.8	14292	-2489	47246	49423
1959.5	-9 48.1	14523	72 55.3	14311	-2472	47271	49452
1960.5	-9 43.4	14538	72 54.9	14329	-2455	47299	49483
1961.5	-9 39.1	14565	72 53.5	14359	-2442	47318	49509
1962.5	-9 33.3	14591	72 52.1	14389	-2422	47336	49534
1963.5	-9 28.5	14610	72 51.3	14411	-2405	47359	49561
1964.5	-9 24.4	14634	72 50.2	14437	-2392	47382	49590
1965.5	-9 21.1	14656	72 49.2	14461	-2382	47403	49617
1966.5	-9 17.8	14672	72 48.7	14479	-2370	47431	49648
1967.5	-9 14.2	14688	72 48.3	14498	-2358	47464	49685
1968.5	-9 12.1	14712	72 47.4	14523	-2353	47496	49722
1969.5	-9 10.3	14740	72 46.2	14552	-2349	47531	49764
1970.5	-9 7.9	14766	72 45.4	14579	-2343	47573	49812
1971.5	-9 5.2	14796	72 44.1	14610	-2337	47607	49853
1972.5	-8 59.5	14820	72 43.3	14638	-2316	47646	49898
1973.5	-8 53.6	14844	72 42.4	14666	-2295	47680	49937
1974.5	-8 46.5	14866	72 41.8	14692	-2268	47719	49981
1975.5	-8 38.4	14890	72 40.9	14721	-2237	47753	50021
1976.5	-8 29.9	14911	72 40.1	14747	-2204	47780	50053
1977.5	-8 20.9	14927	72 39.5	14769	-2167	47803	50079
1978.5	-8 10.1	14933	72 39.8	14782	-2122	47835	50112
1979.5	-8 0.3	14944	72 39.3	14798	-2081	47850	50129
1980.5	-7 50.4	14952	72 39.0	14812	-2039	47858	50139
1981.5	-7 40.9	14946	72 39.7	14812	-1998	47875	50154
1982.5	-7 31.6	14940	72 40.4	14812	-1957	47890	50166
1983.5	-7 22.6	14942	72 40.4	14818	-1918	47895	50172

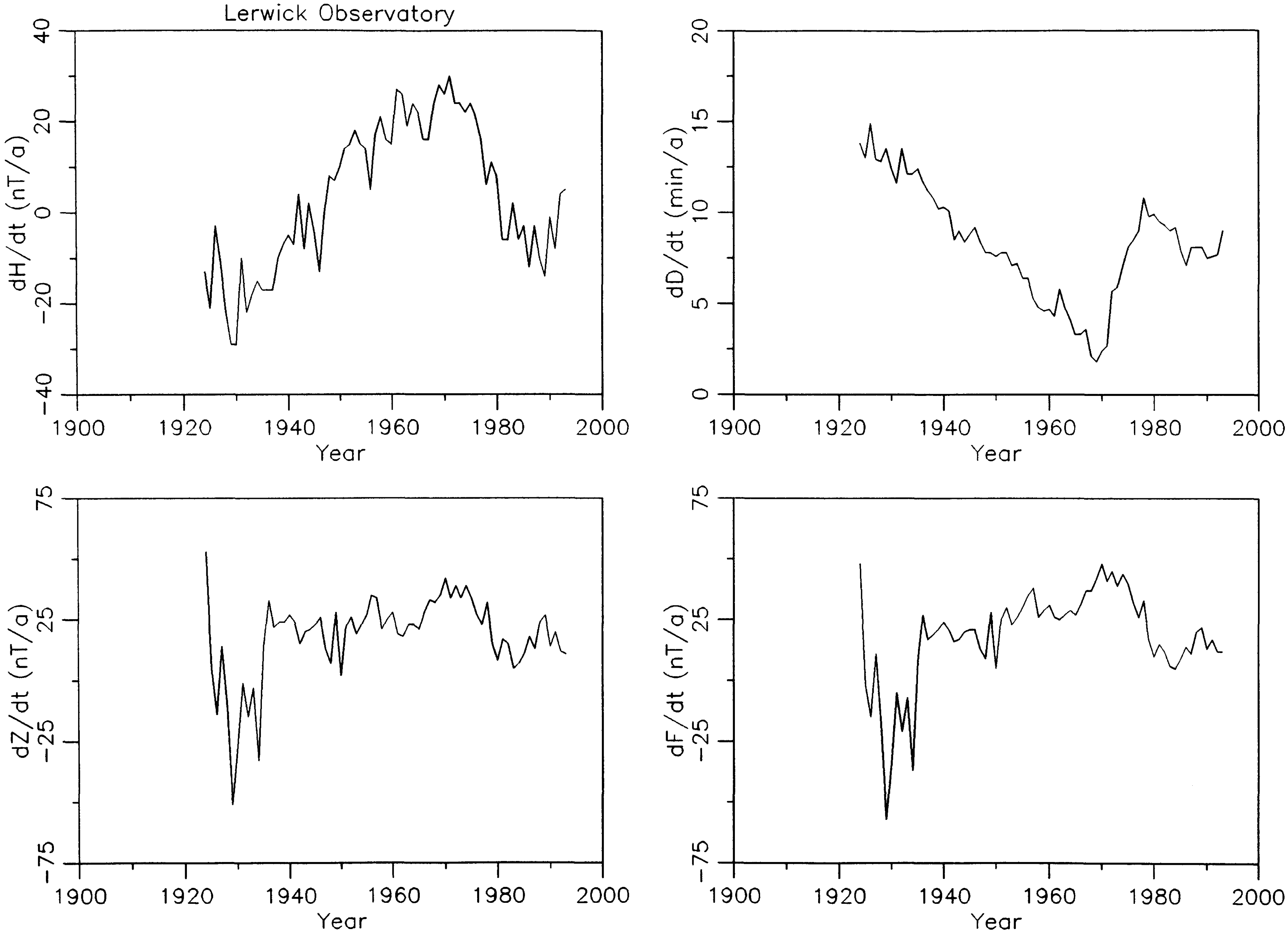
	Year	D		H	I		X	Y	Z	F
	1984.5	-7	13.4	14936	72	40.9	14818	-1878	47902	50177
	1985.5	-7	5.5	14933	72	41.3	14819	-1844	47913	50186
	1986.5	-6	58.4	14921	72	42.5	14811	-1811	47931	50200
	1987.5	-6	50.3	14918	72	43.0	14812	-1776	47944	50211
	1988.5	-6	42.2	14908	72	44.1	14806	-1740	47968	50231
	1989.5	-6	34.1	14894	72	45.6	14796	-1704	47995	50253
Note 2		0	0.0	5	0	-0.5	5	-1	-8	-6
	1990.5	-6	26.6	14898	72	45.4	14804	-1672	48001	50260
	1991.5	-6	19.0	14890	72	46.4	14800	-1638	48021	50277
	1992.5	-6	11.3	14894	72	46.3	14807	-1606	48033	50289
	1993.5	-6	2.3	14899	72	46.2	14816	-1567	48044	50301

1 Site differences 1 Jan 1934 (new value - old value)
2 Site differences 1 Jan 1990 (new value - old value)

D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

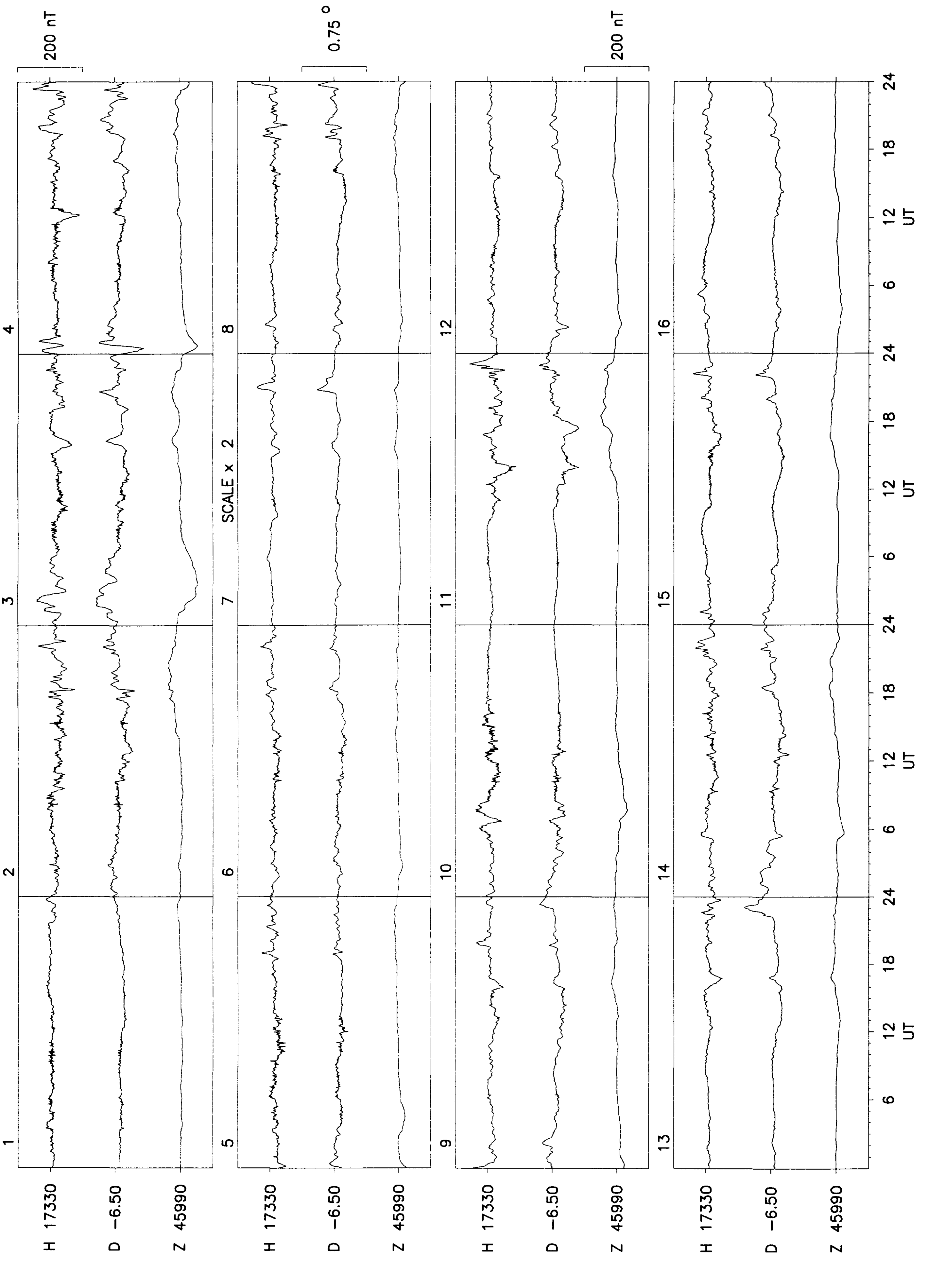


Annual mean values of H, D, Z & F at Lerwick

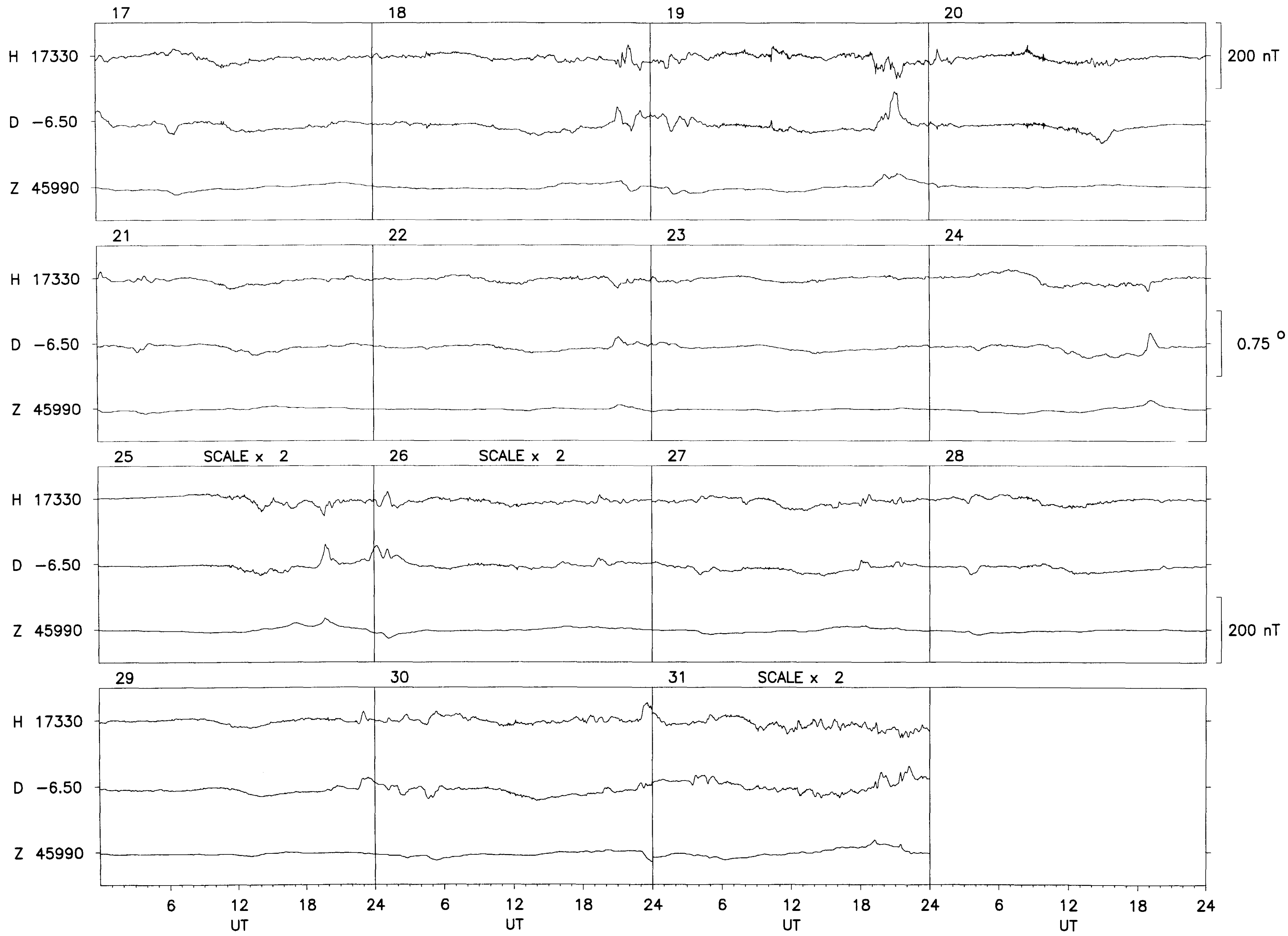


Rate of change of annual mean values for H, D, Z & F at Lerwick

Eskdalemuir 1993



Eskdalemuir January 1993



17
18
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23
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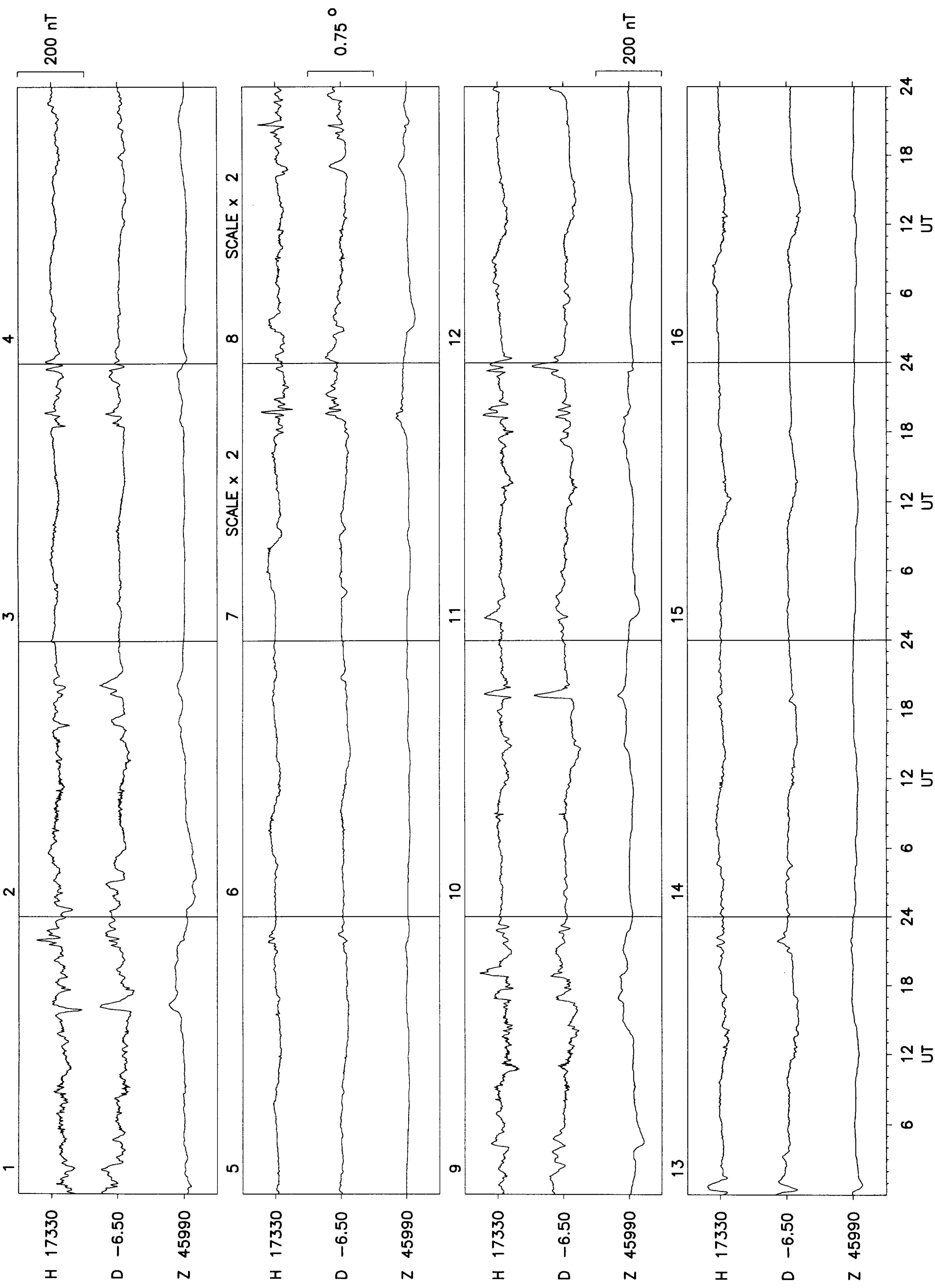
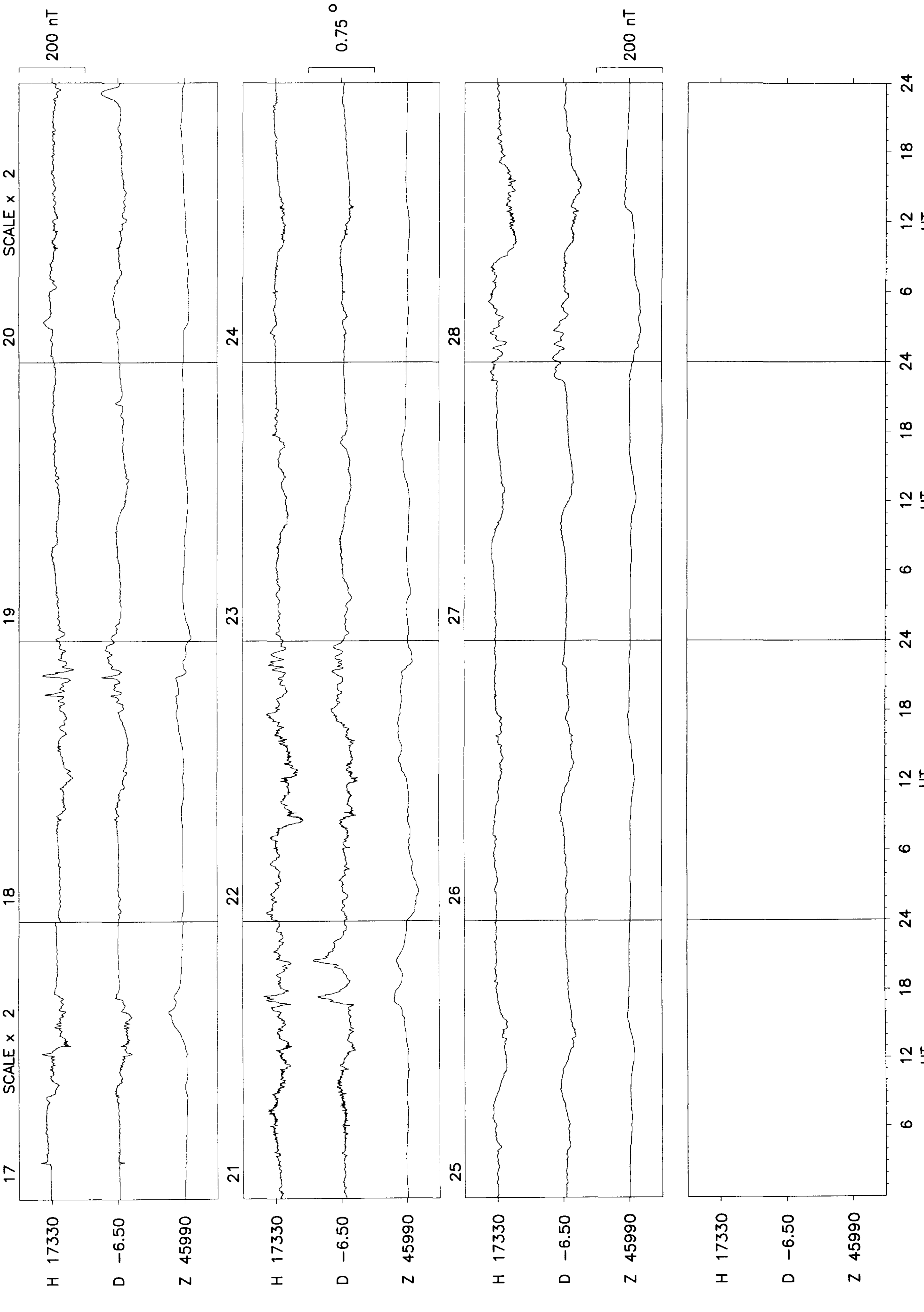
25
SCALE x 2
26
SCALE x 2
27
28
29
30
31
SCALE x 2
H 17330
D −6.50
Z 45990
200 nT
0.75 °
200 nT
6
12
18
24
UT

ES 1 93



Eskdalemuir February 1993


200 nT
0.75 °
200 nT
SCALE x 2
SCALE x 2
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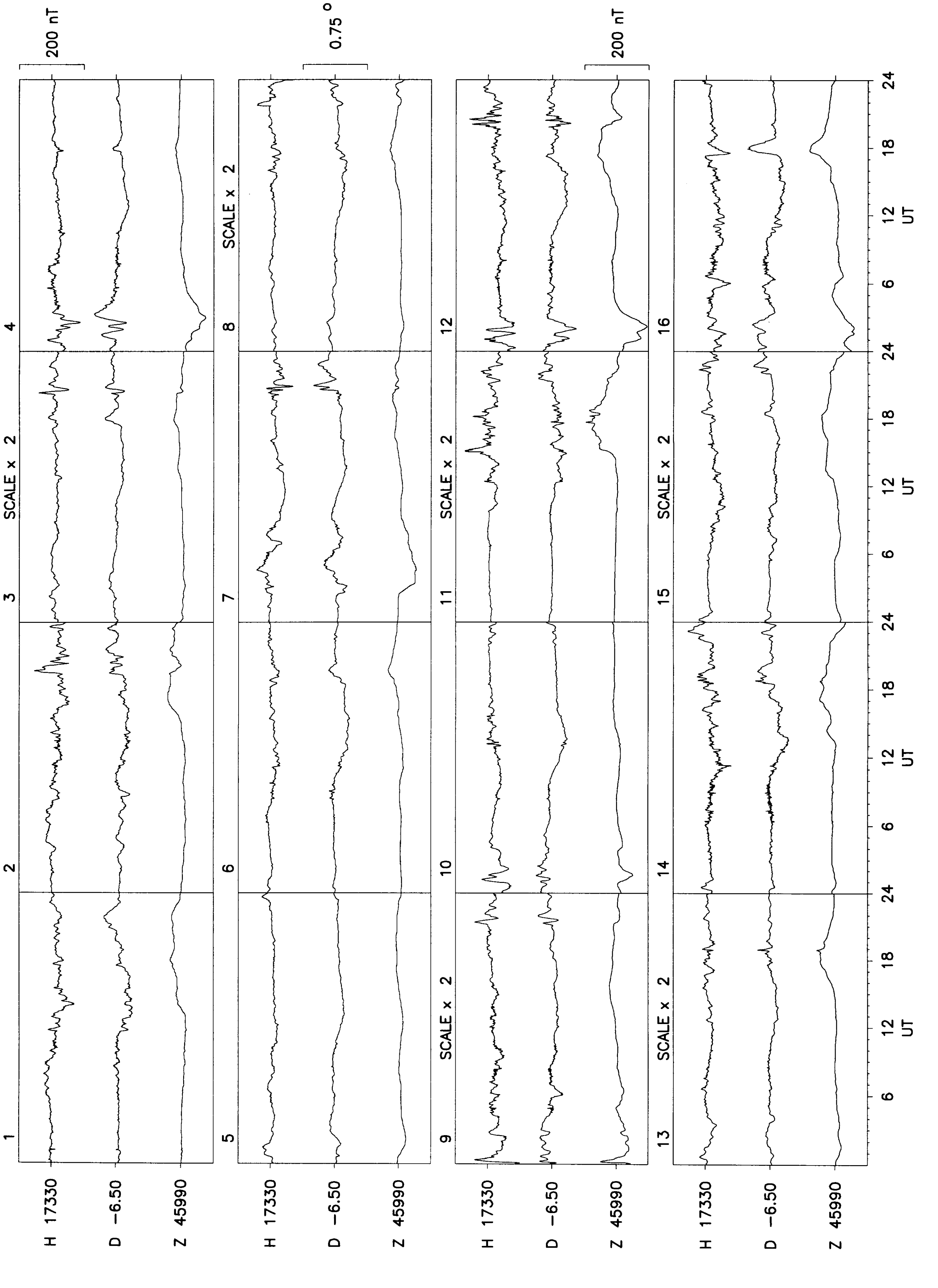
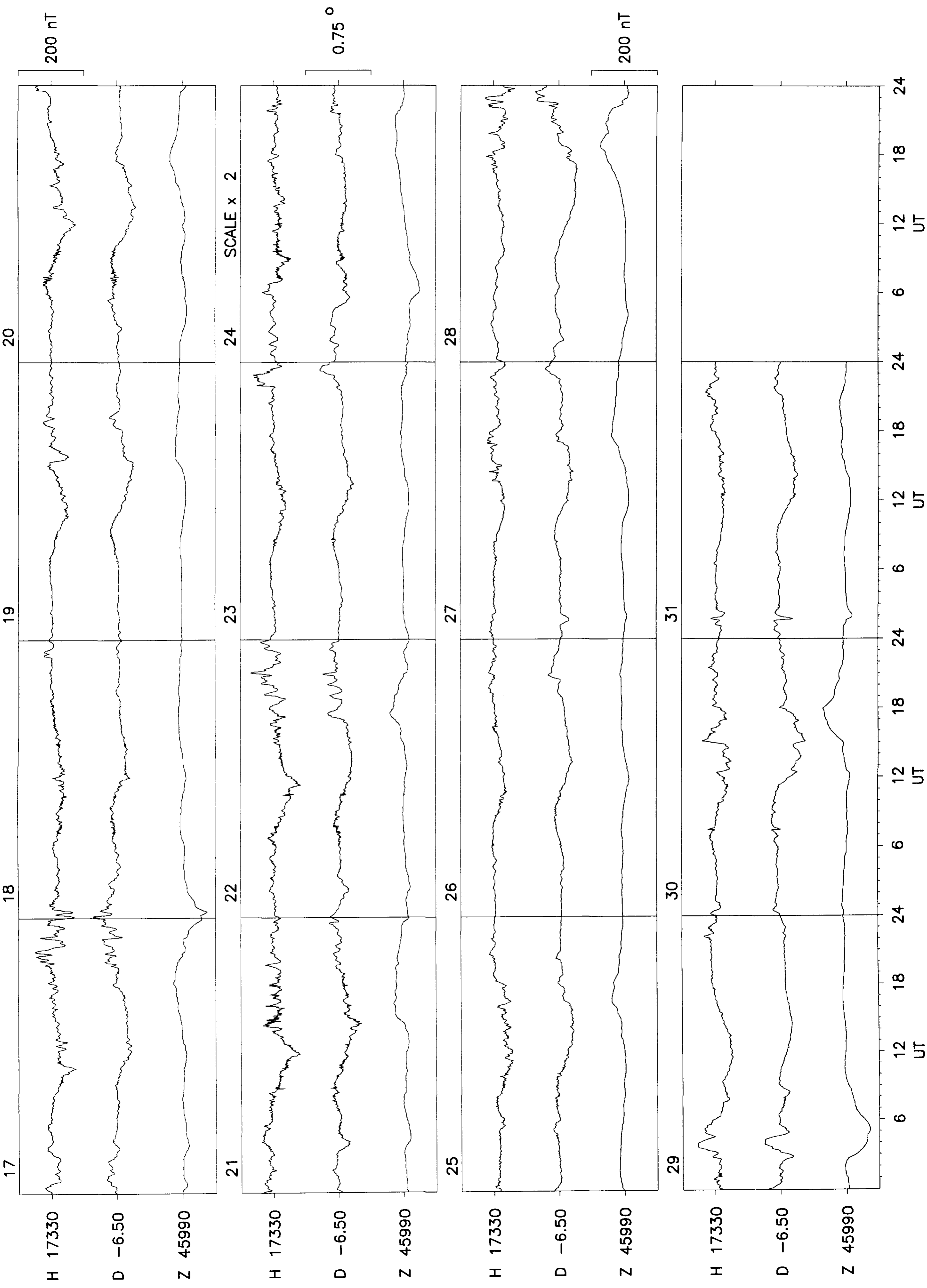
28
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
6
12
18
24
UT

ES 2 93



Eskdalemuir March 1993


200 nT
0.75 °
200 nT
SCALE x 2
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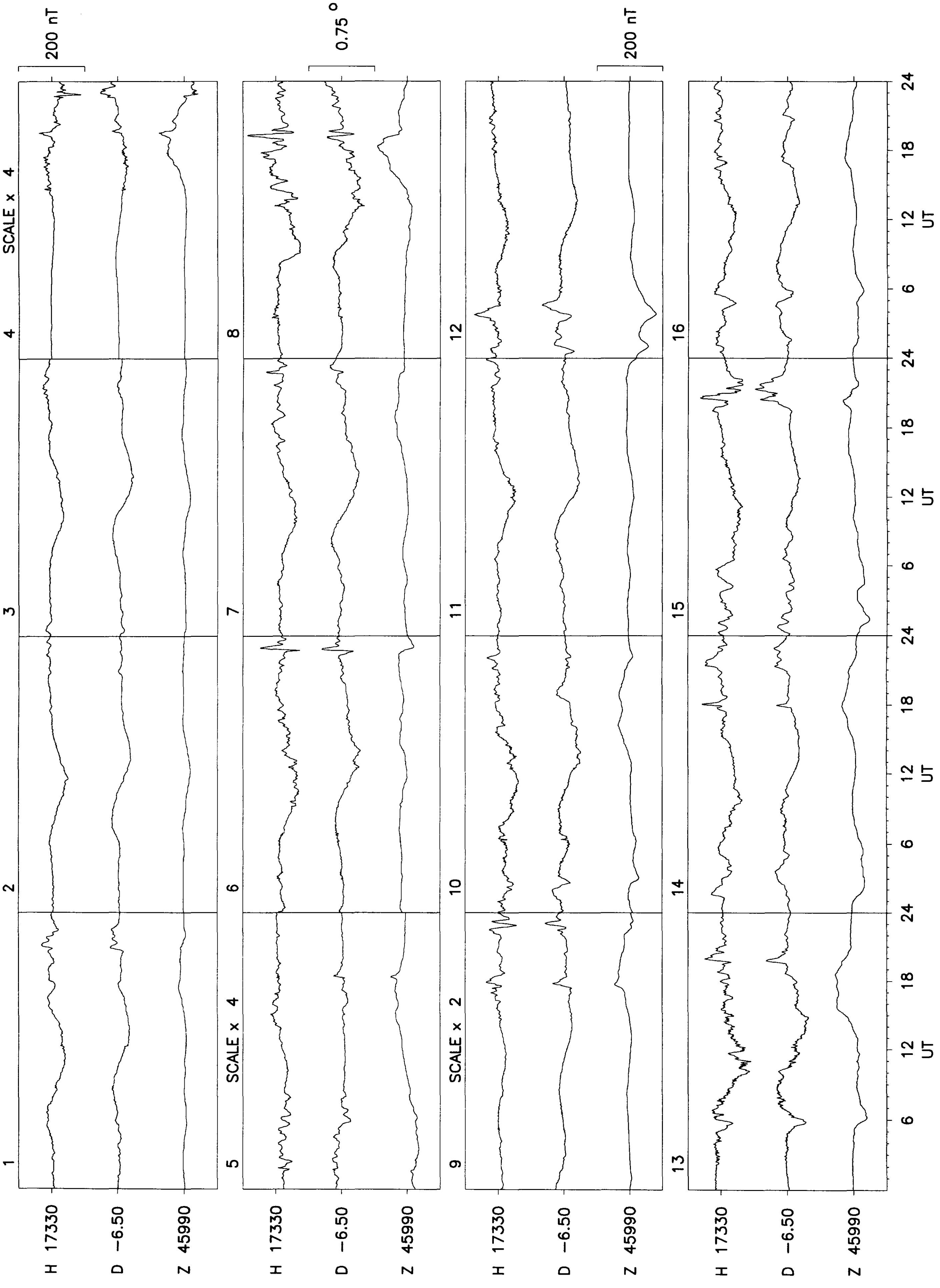
30
31
H 17330
D −6.50
Z 45990
UT
6
12
18
24

ES 3 93


200 nT
0.75 °
200 nT
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SCALE x 4
SCALE x 2
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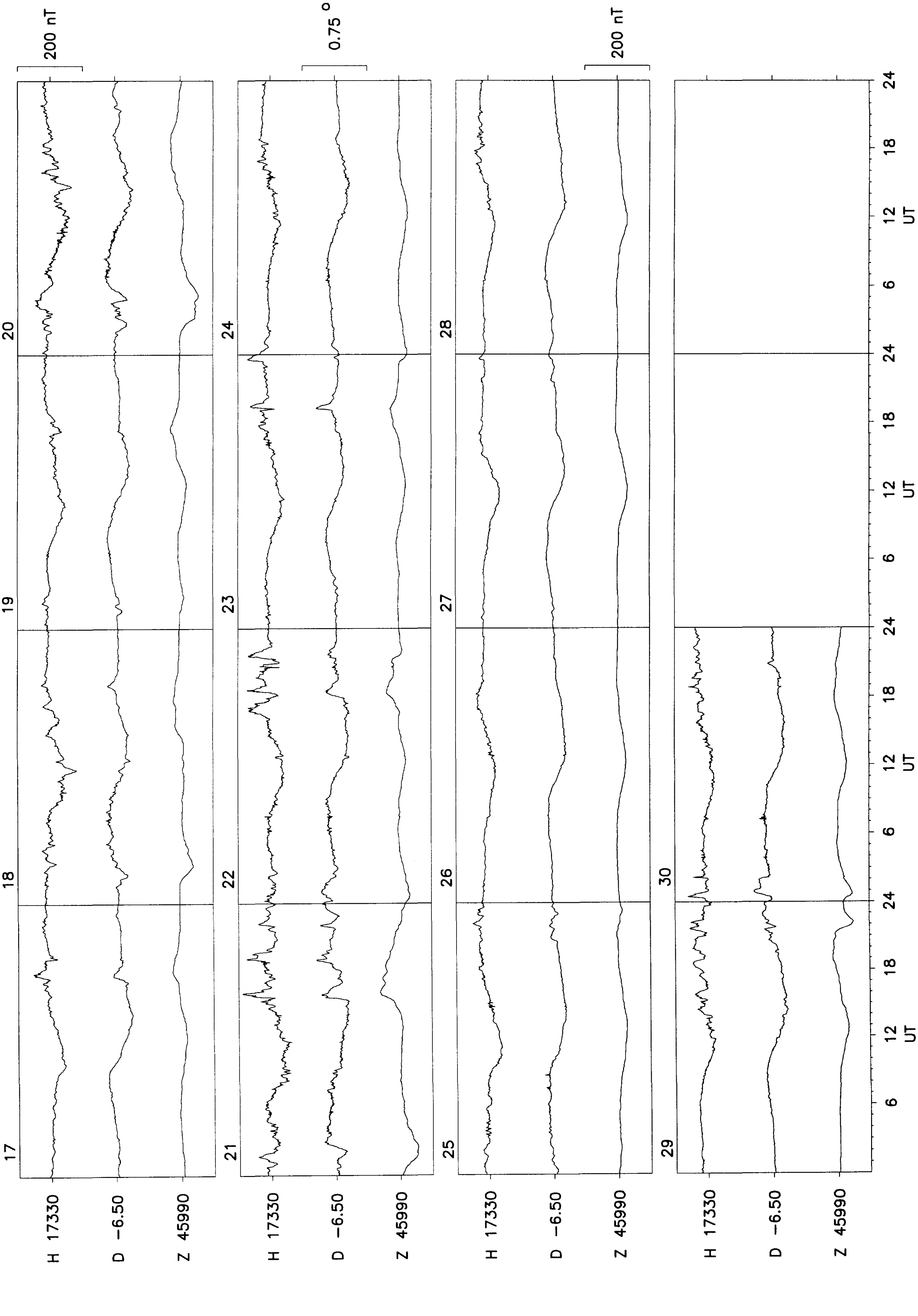
12
13
14
15
16
H 17330
D −6.50
Z 45990
UT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H 17330
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200 nT
0.75 °
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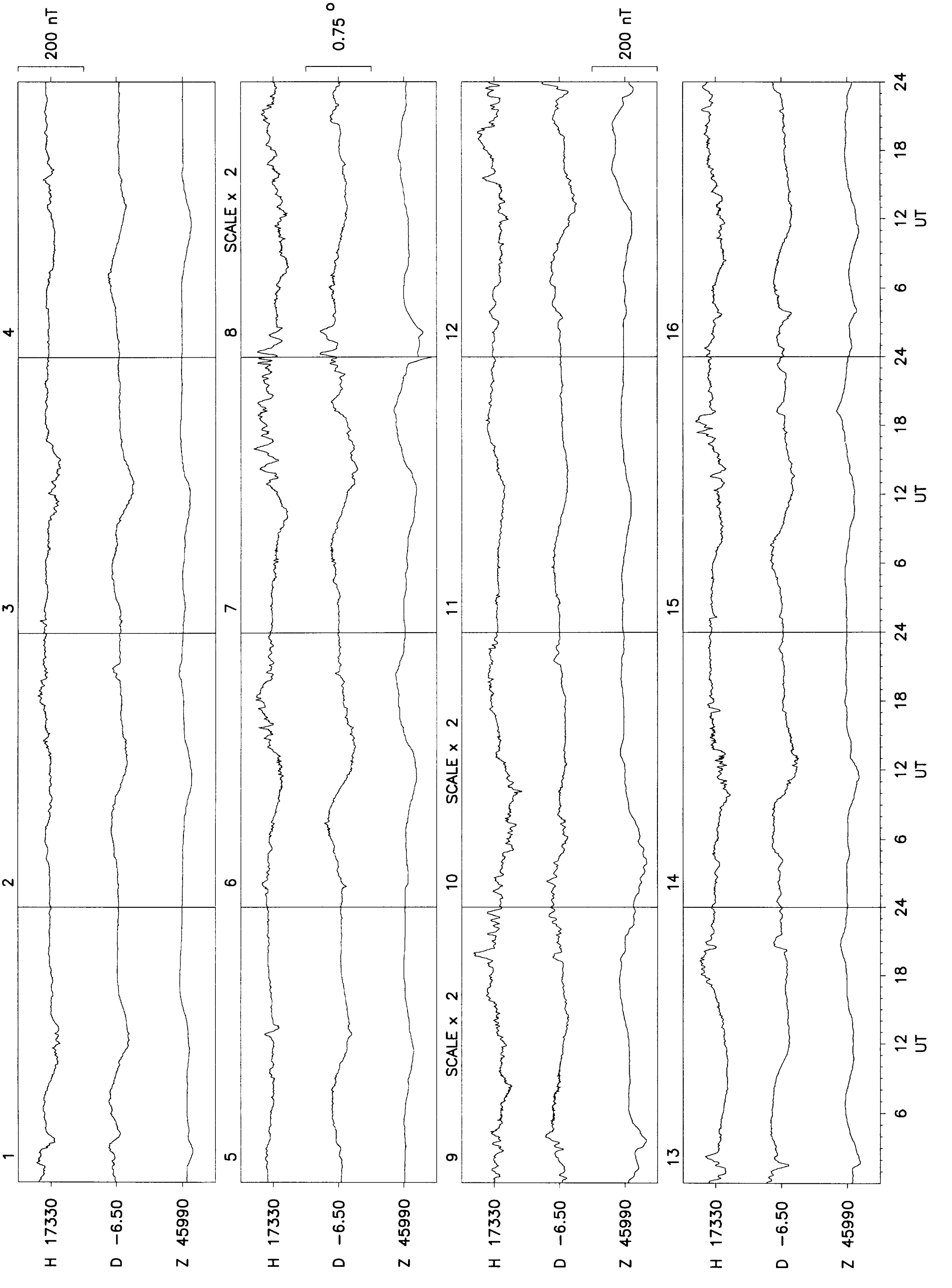
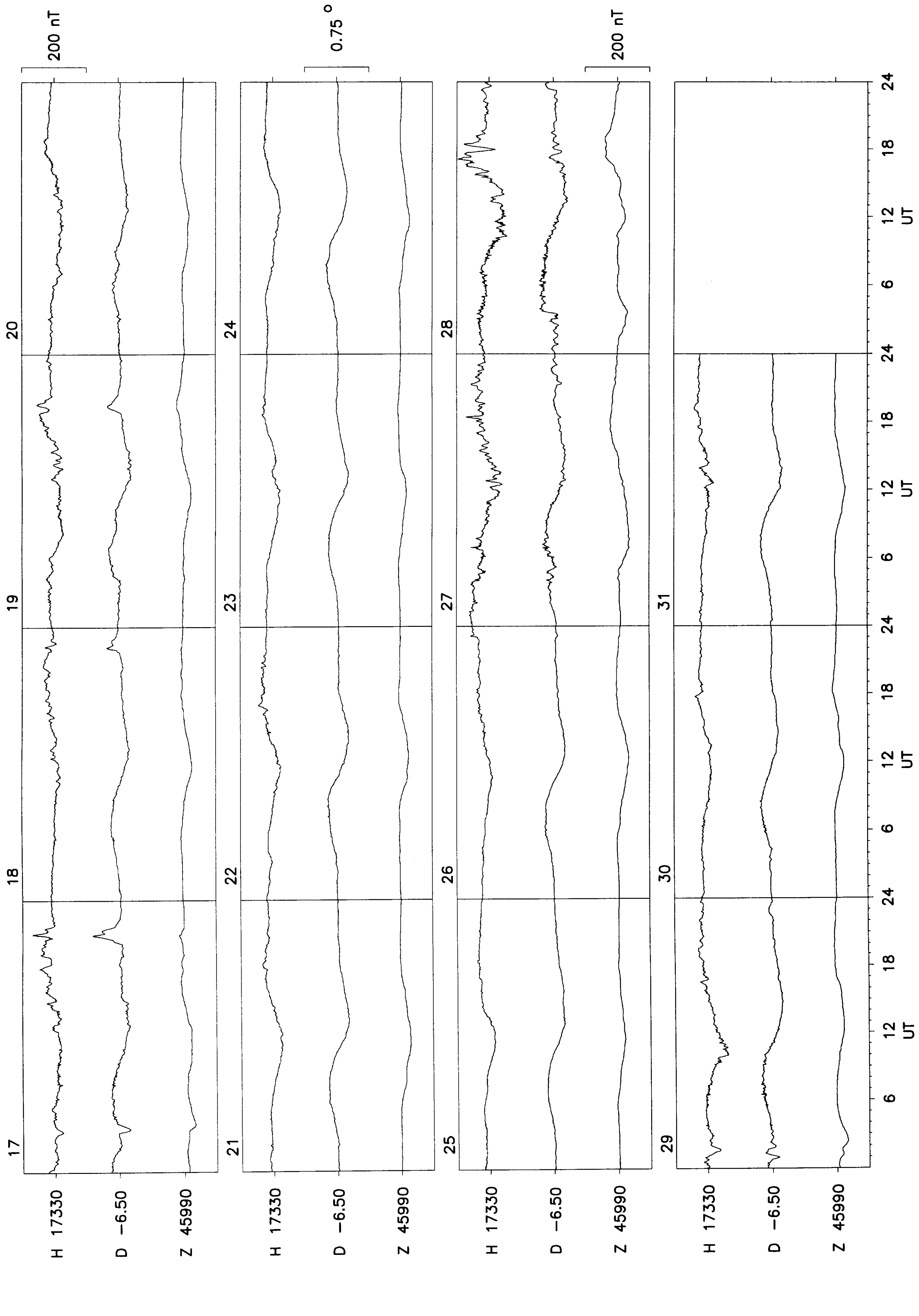
12
18
24
UT

ES 4 93



Eskdalemuir May 1993


200 nT
0.75 °
200 nT
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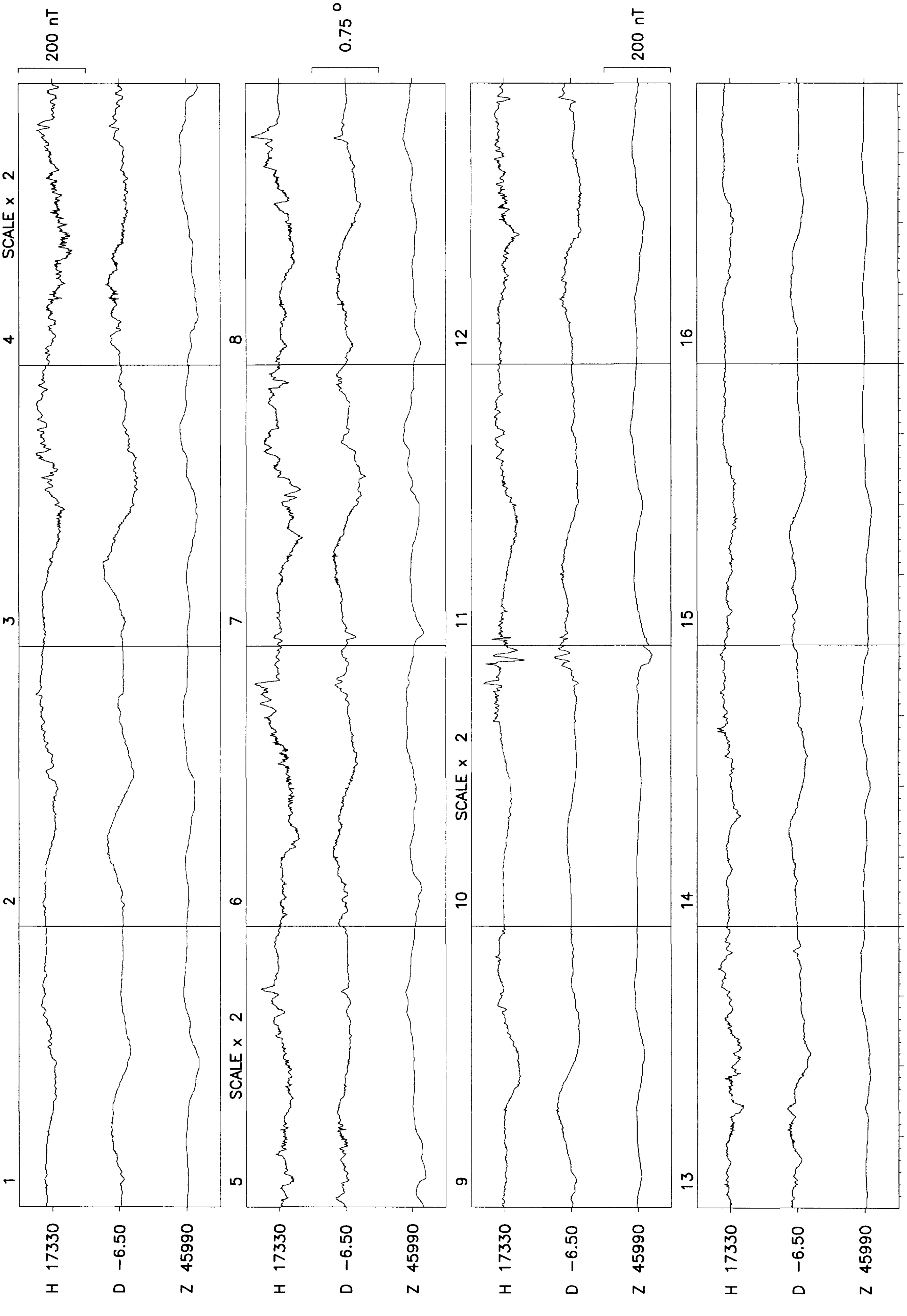
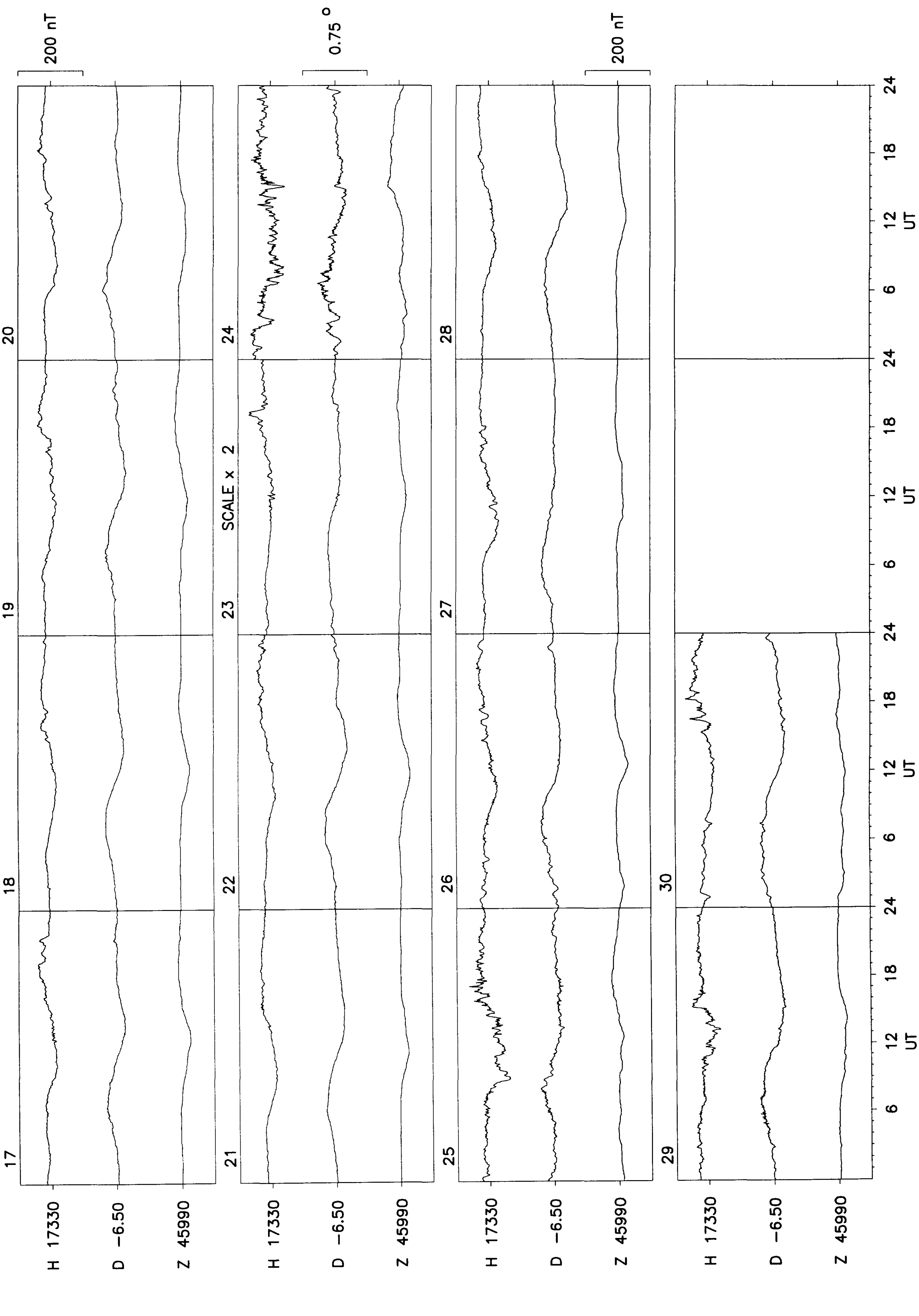
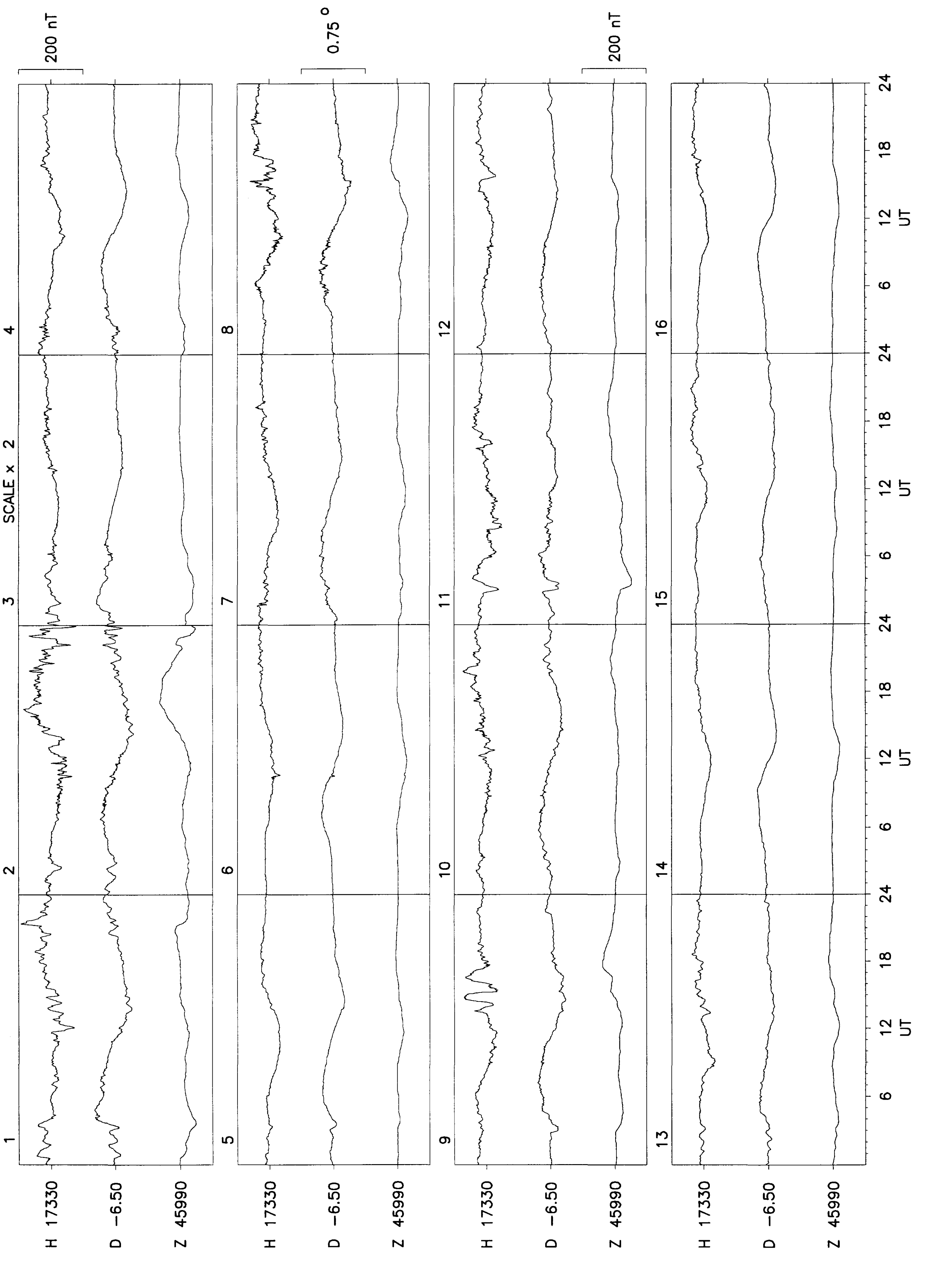
H 17330
D −6.50
Z 45990
6
12
18
24
UT

ES 5 93

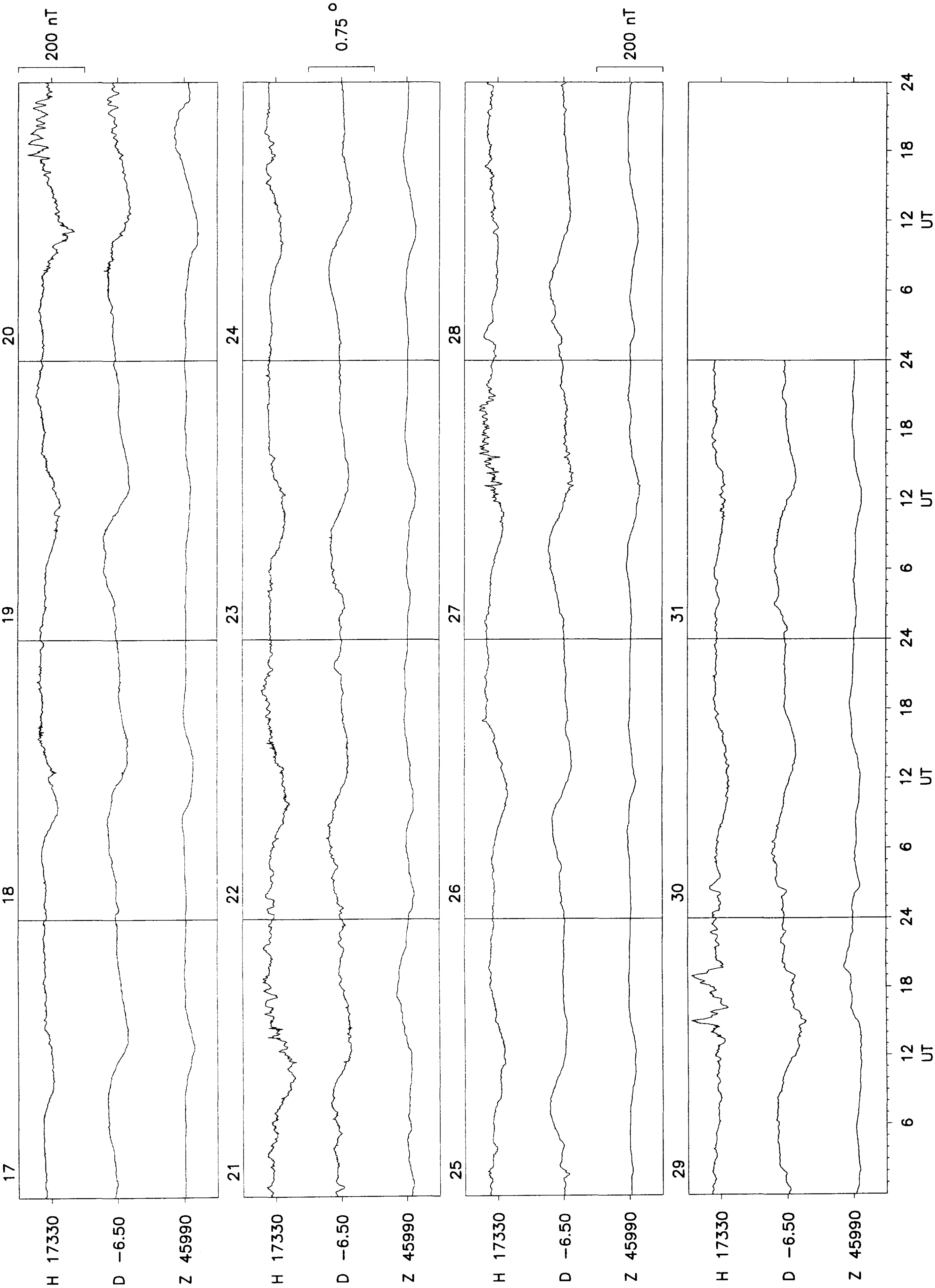


200 nT
0.75 °
200 nT
SCALE x 2
SCALE x 2
SCALE x 2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
H 17330
D −6.50
Z 45990
6
12
18
24
UT

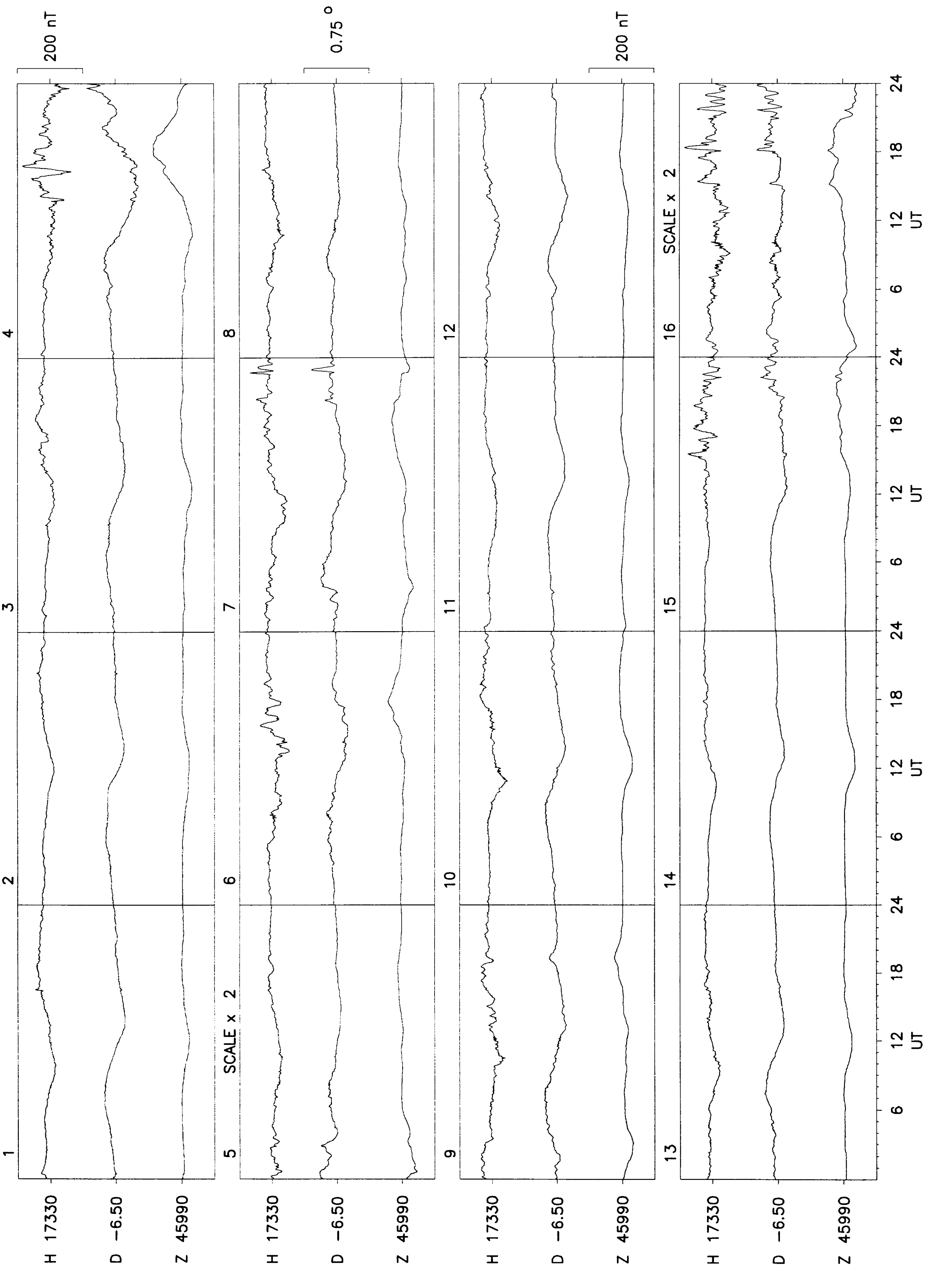

200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
SCALE x 2
H 17330
D −6.50
Z 45990
6
12
18
24
UT



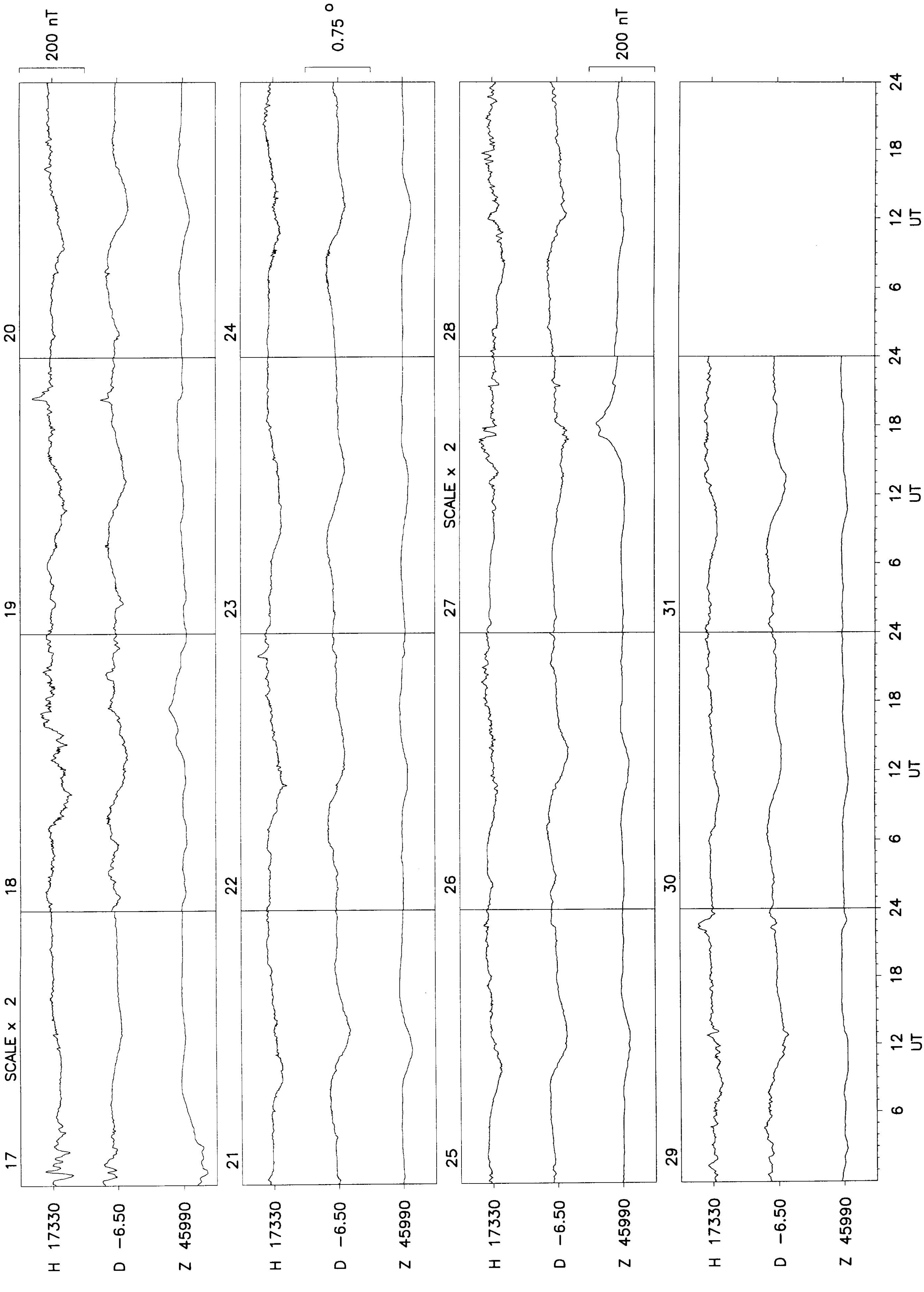
Eskdalemuir July 1993


200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
H 17330
D −6.50
Z 45990
6
12
18
24
UT

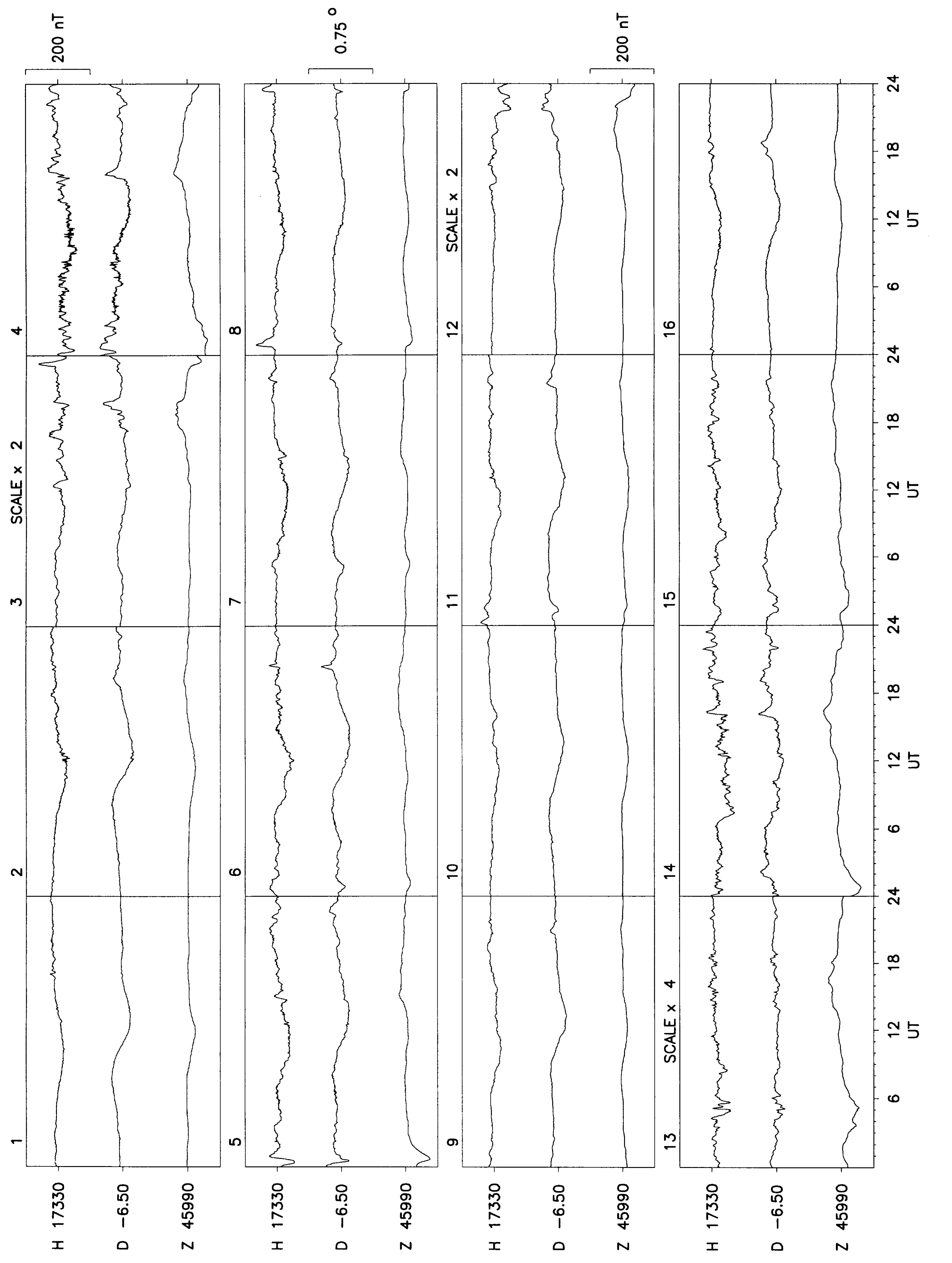
ES 7 93



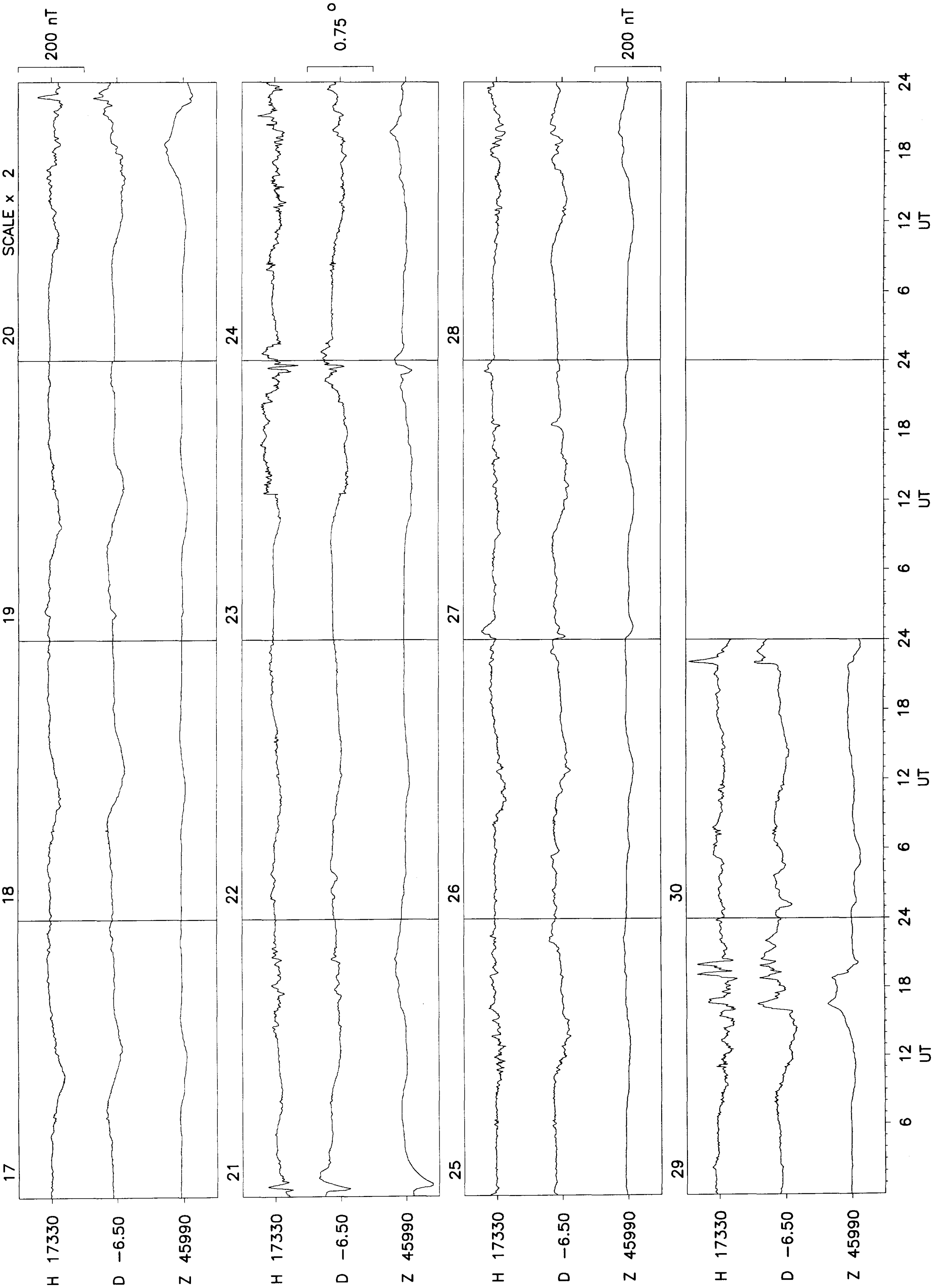
Eskdalemuir August 1993



200 nT
0.75 °
200 nT
SCALE x 2
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
6
12
18
24
UT

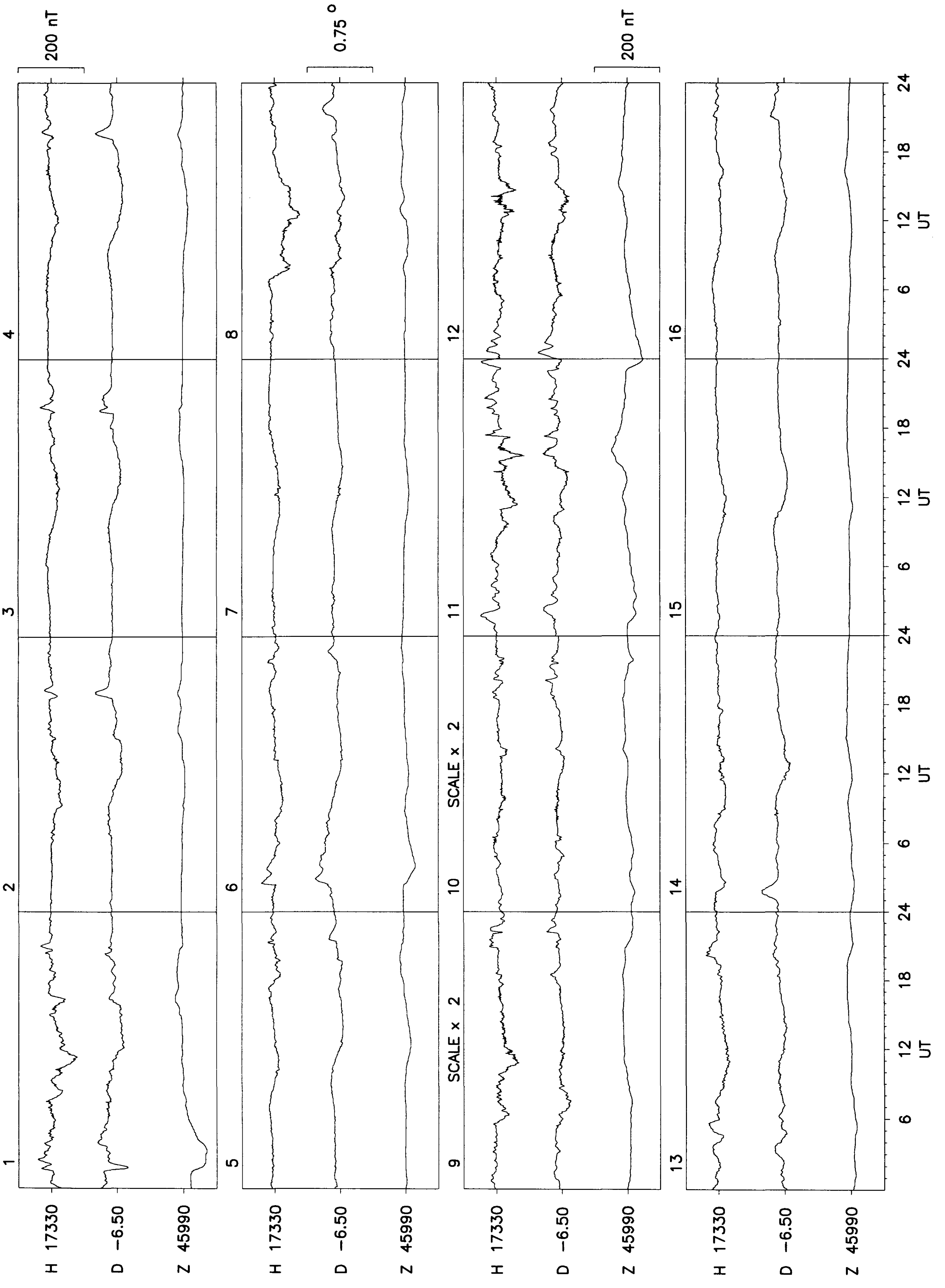


Eskdalemuir September 1993

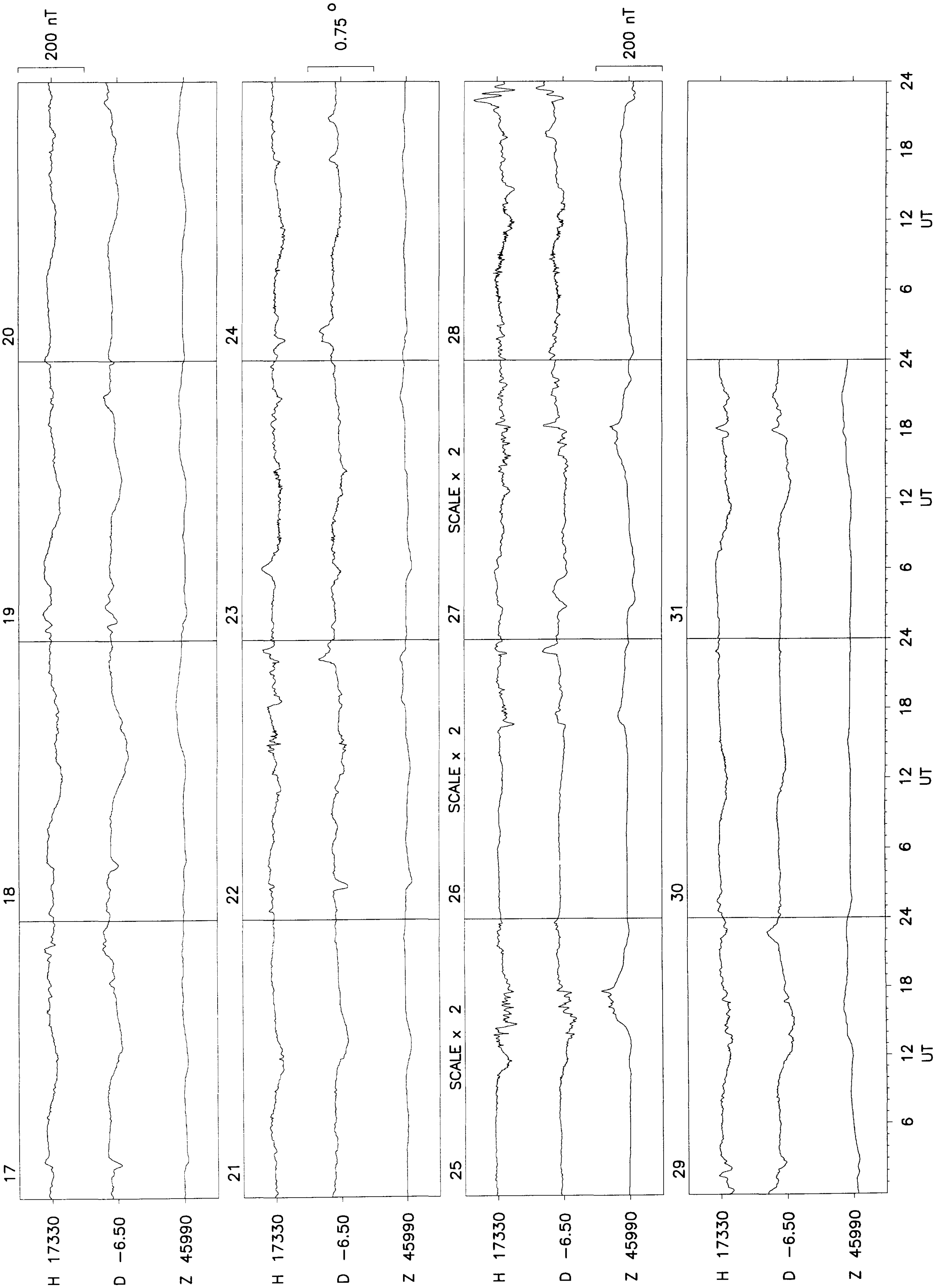


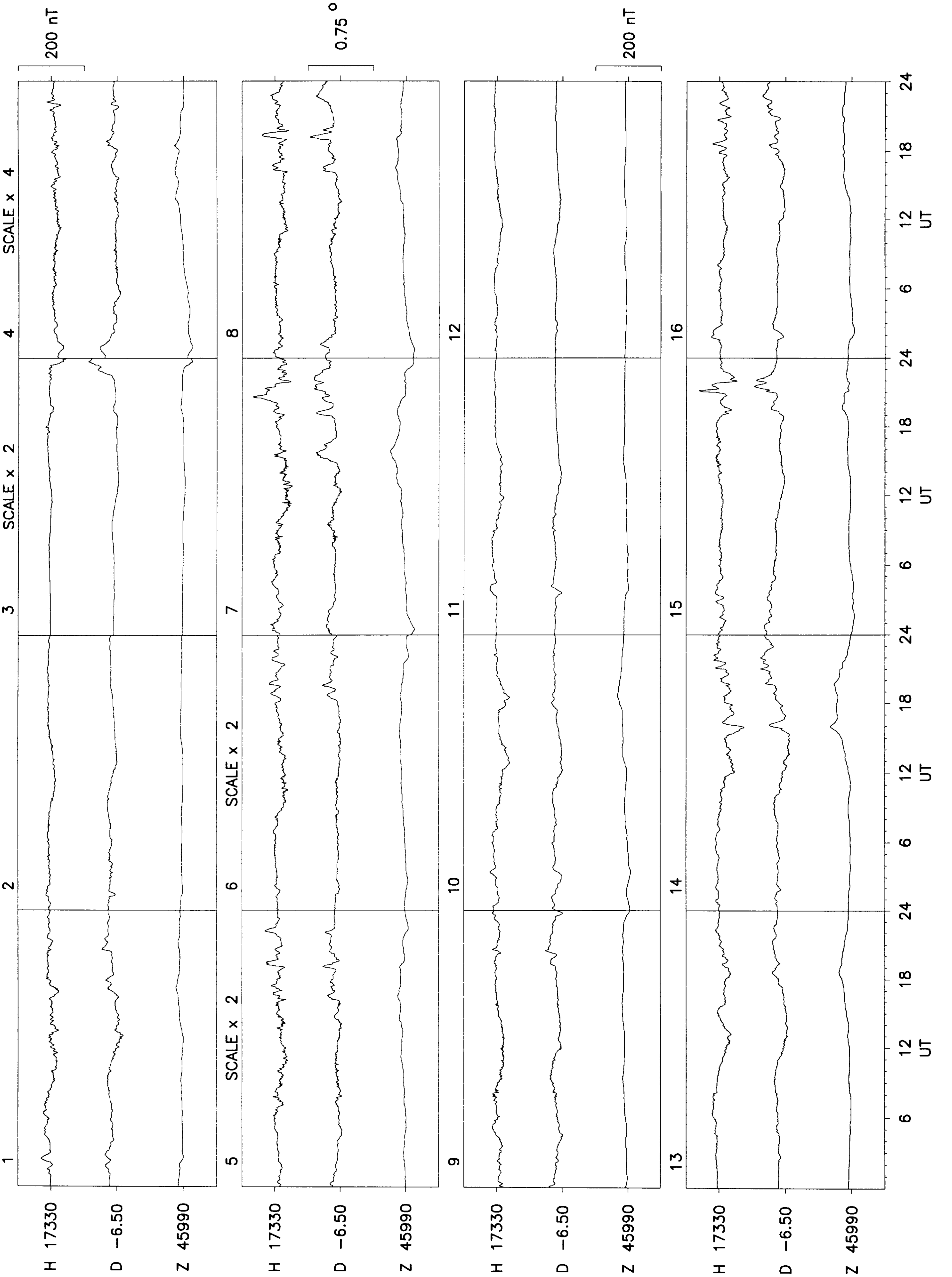
SCALE x 2
200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 17330
D −6.50
Z 45990
6
12
18
24
UT

ES 9 93

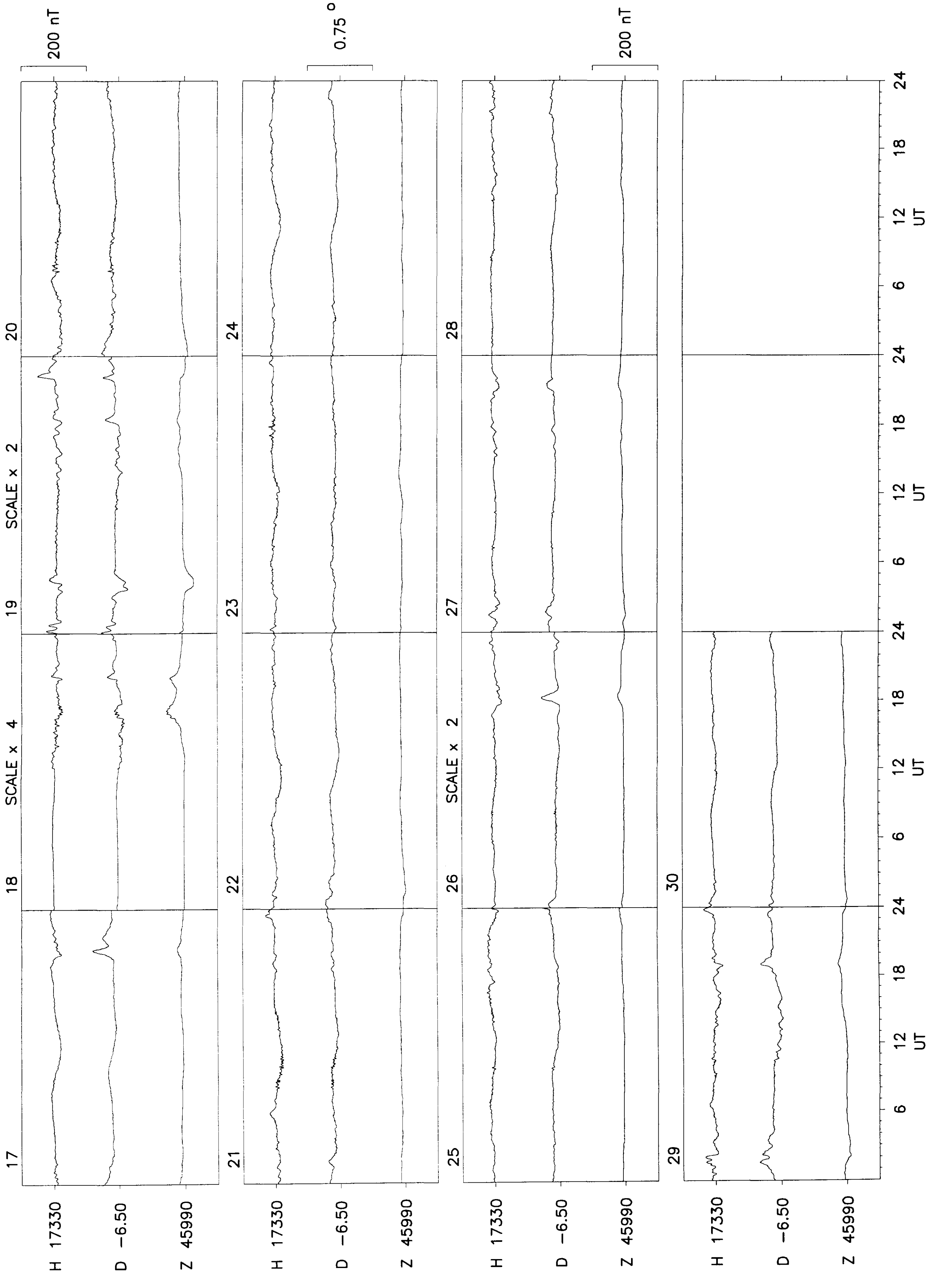


Eskdalemuir October 1993

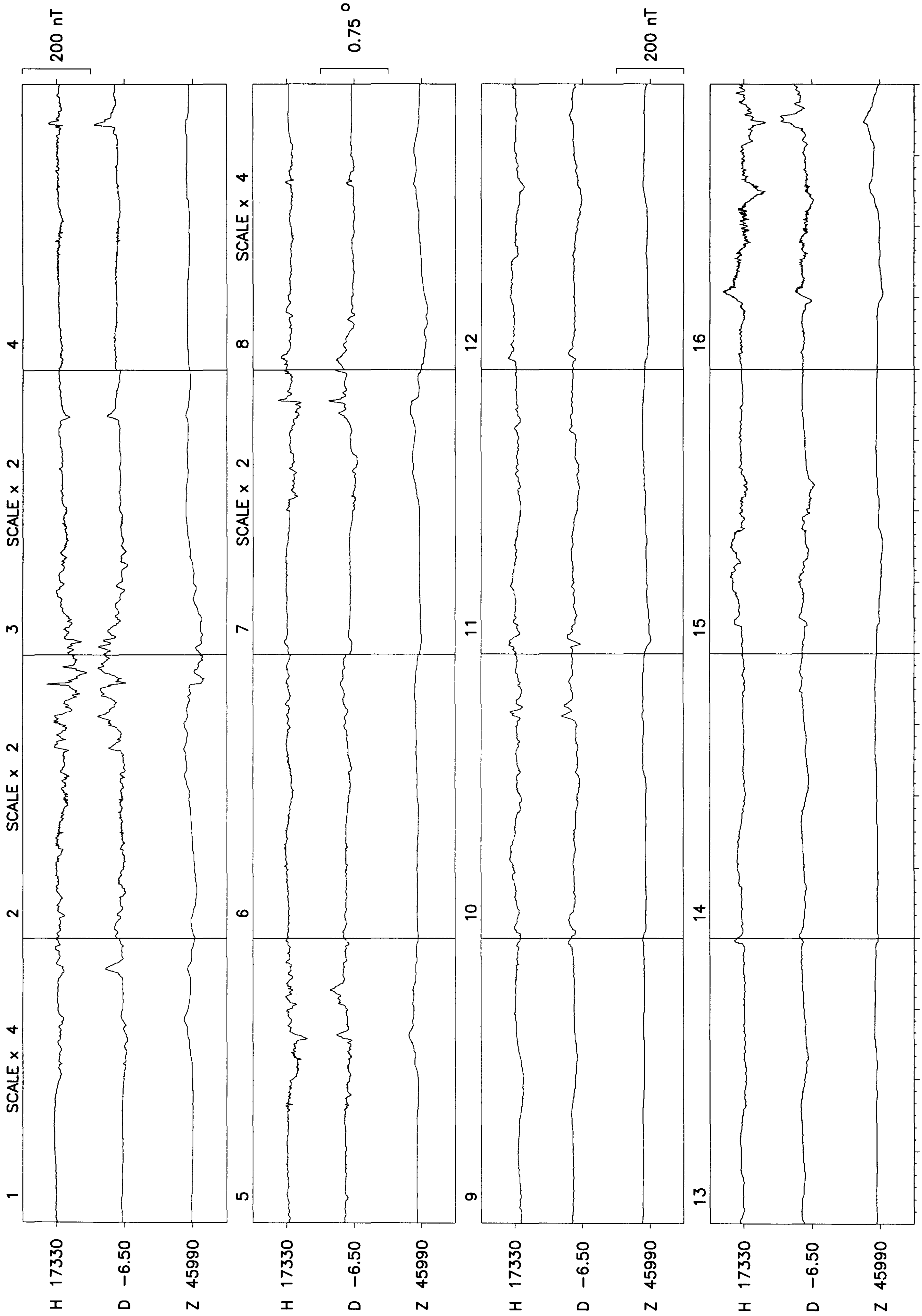

200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 2
SCALE x 2
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
H 17330
D −6.50
Z 45990
6
12
18
24
UT
ES 10 93



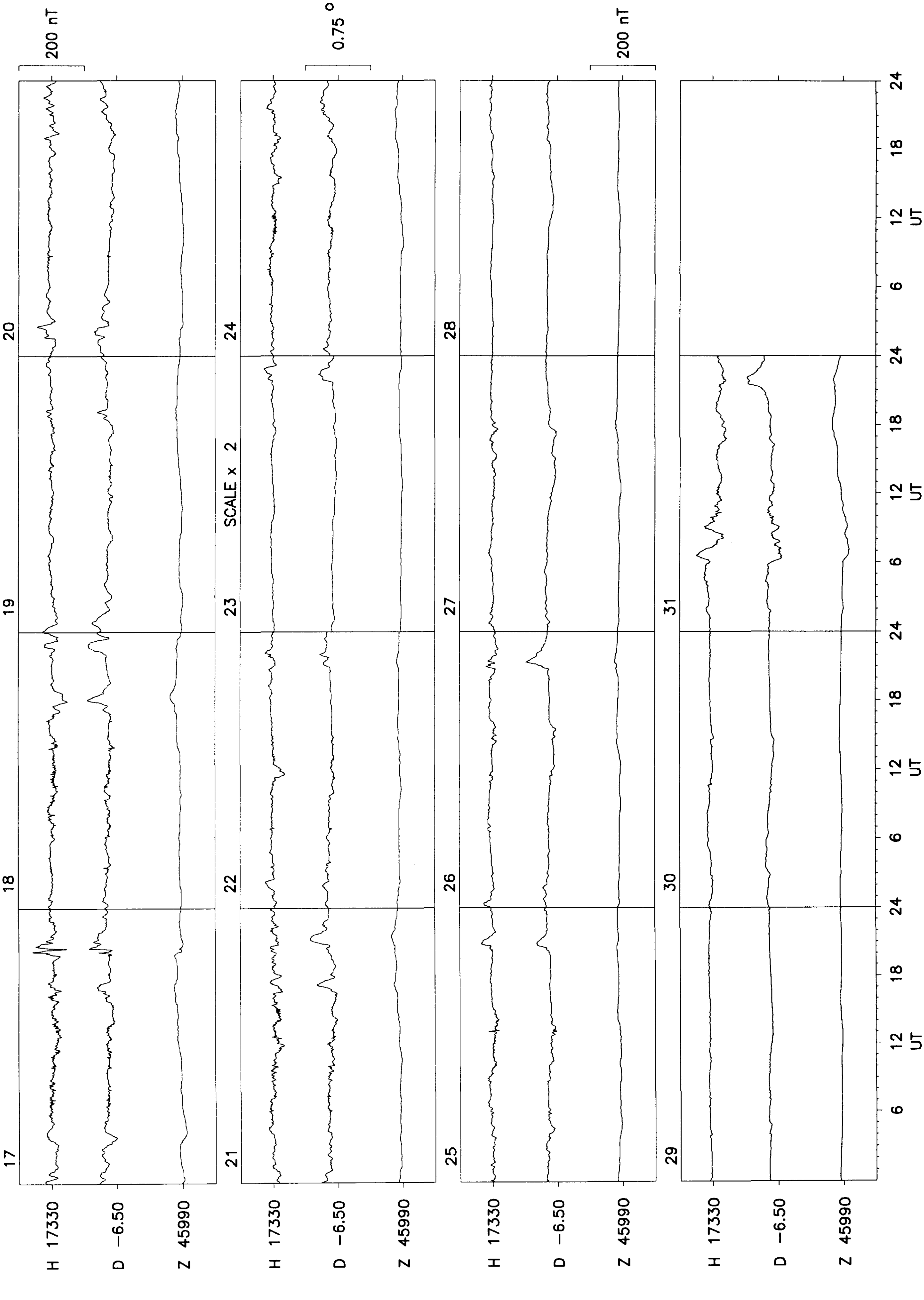
Eskdalemuir November 1993


200 nT
0.75 °
200 nT
SCALE x 4
SCALE x 2
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 17330
D −6.50
Z 45990
6
12
18
24
UT

ES 11 93



Eskdalemuir December 1993


200 nT
0.75 °
200 nT
SCALE x 2
H 17330
D -6.50
Z 45990
17
18
19
20
21
22
23
24
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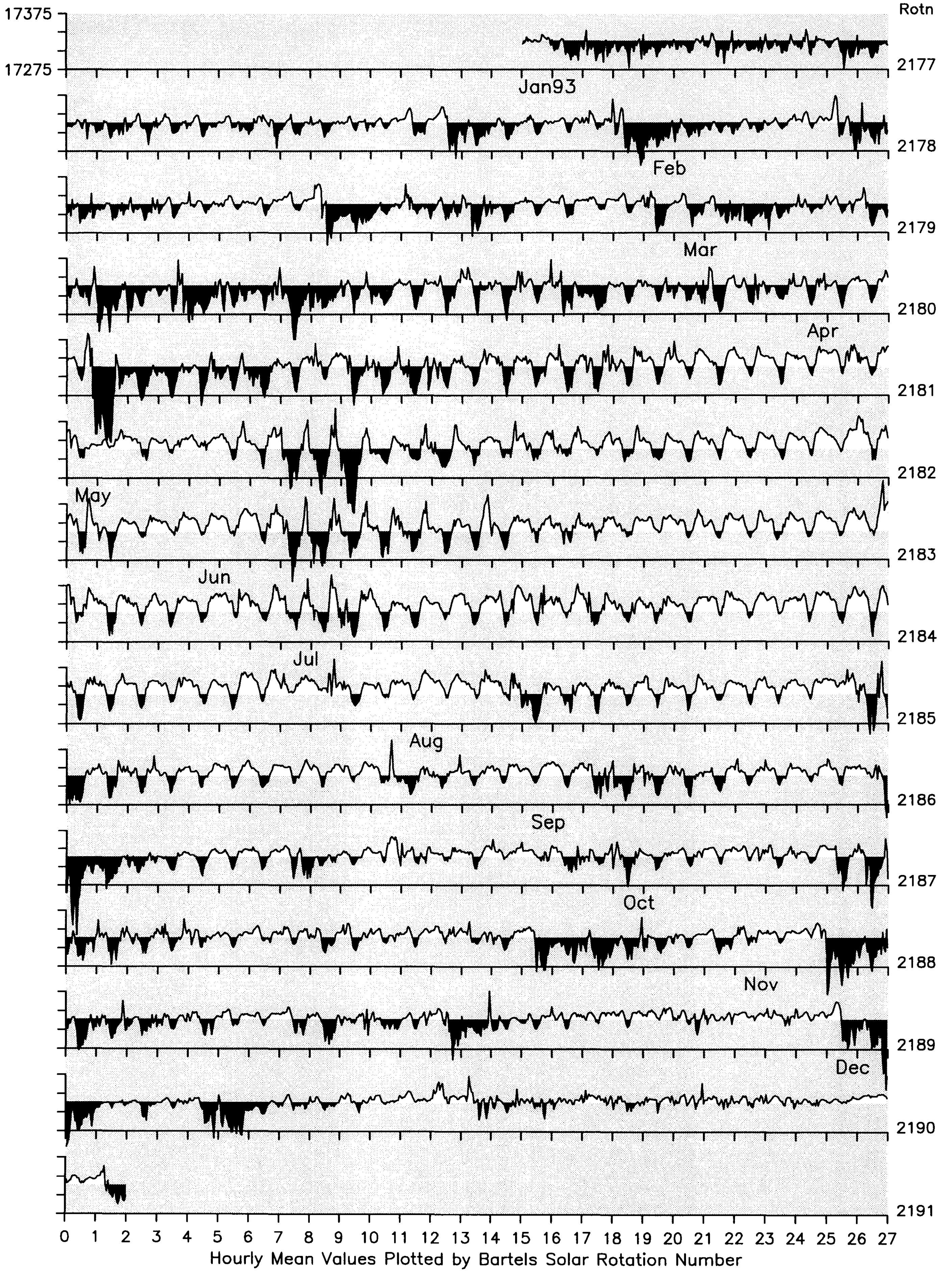
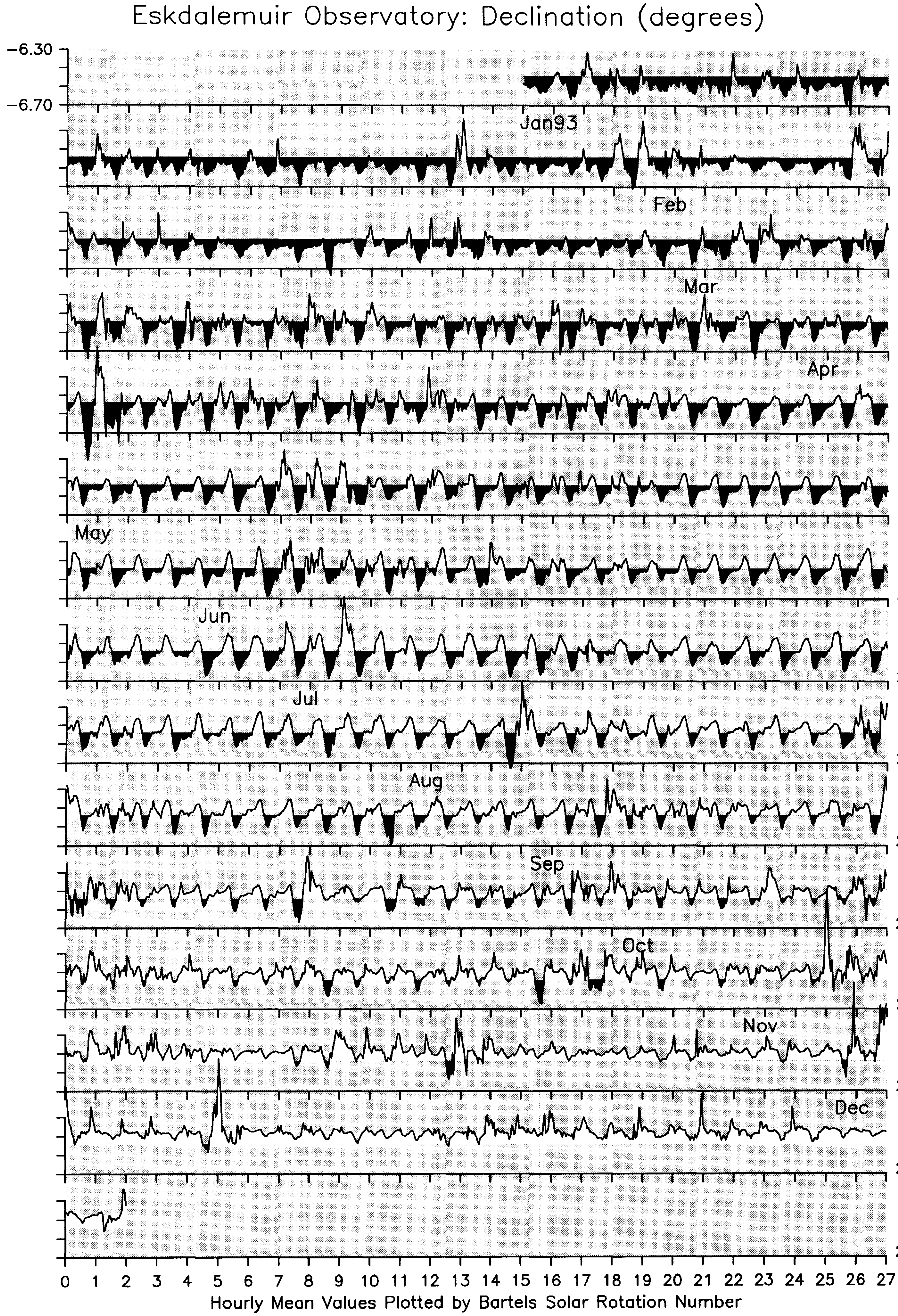
29
30
31
6
12
18
24
UT

ES 12 93

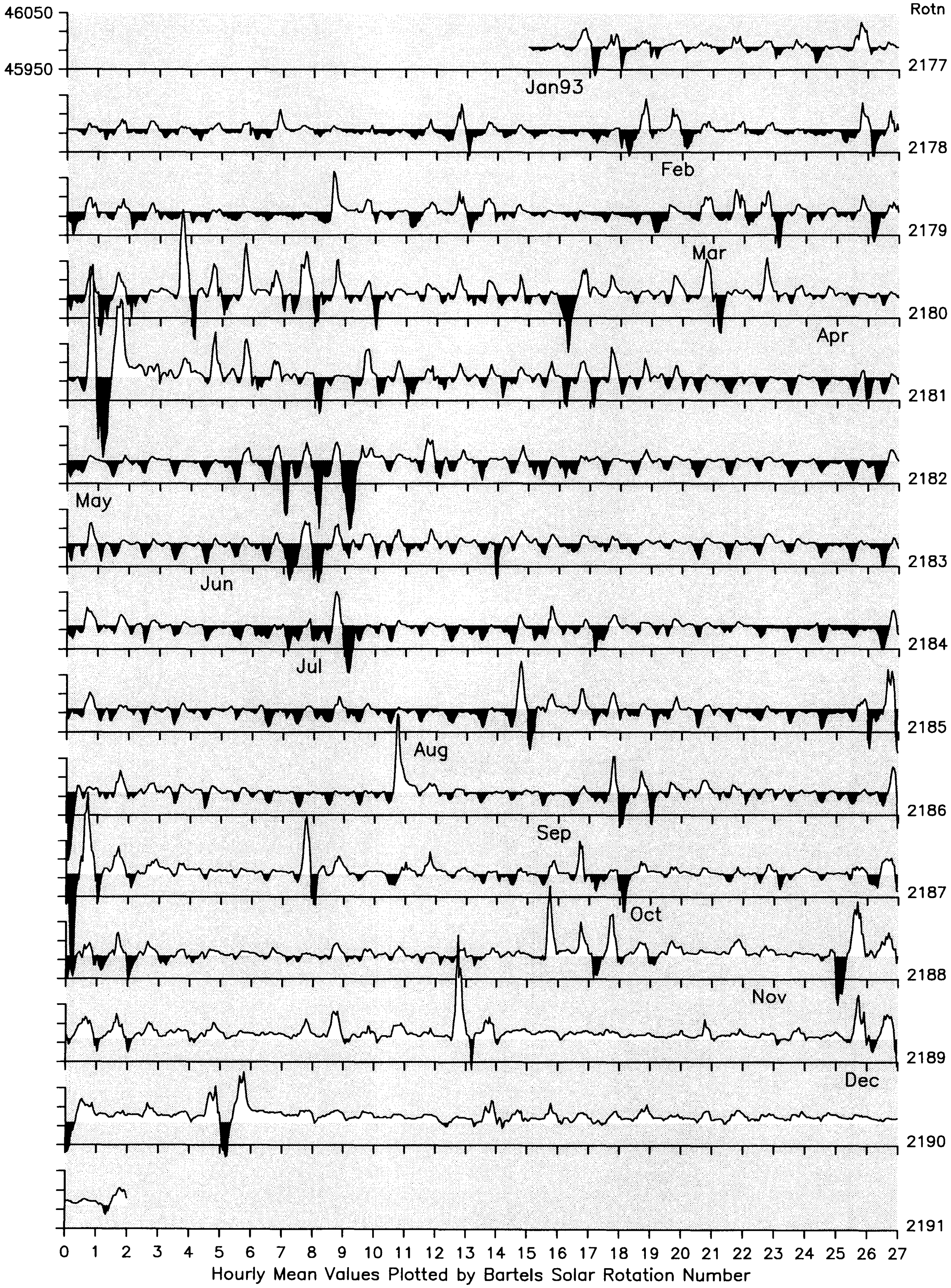
Eskdalemuir Observatory: Horizontal Intensity (nT)

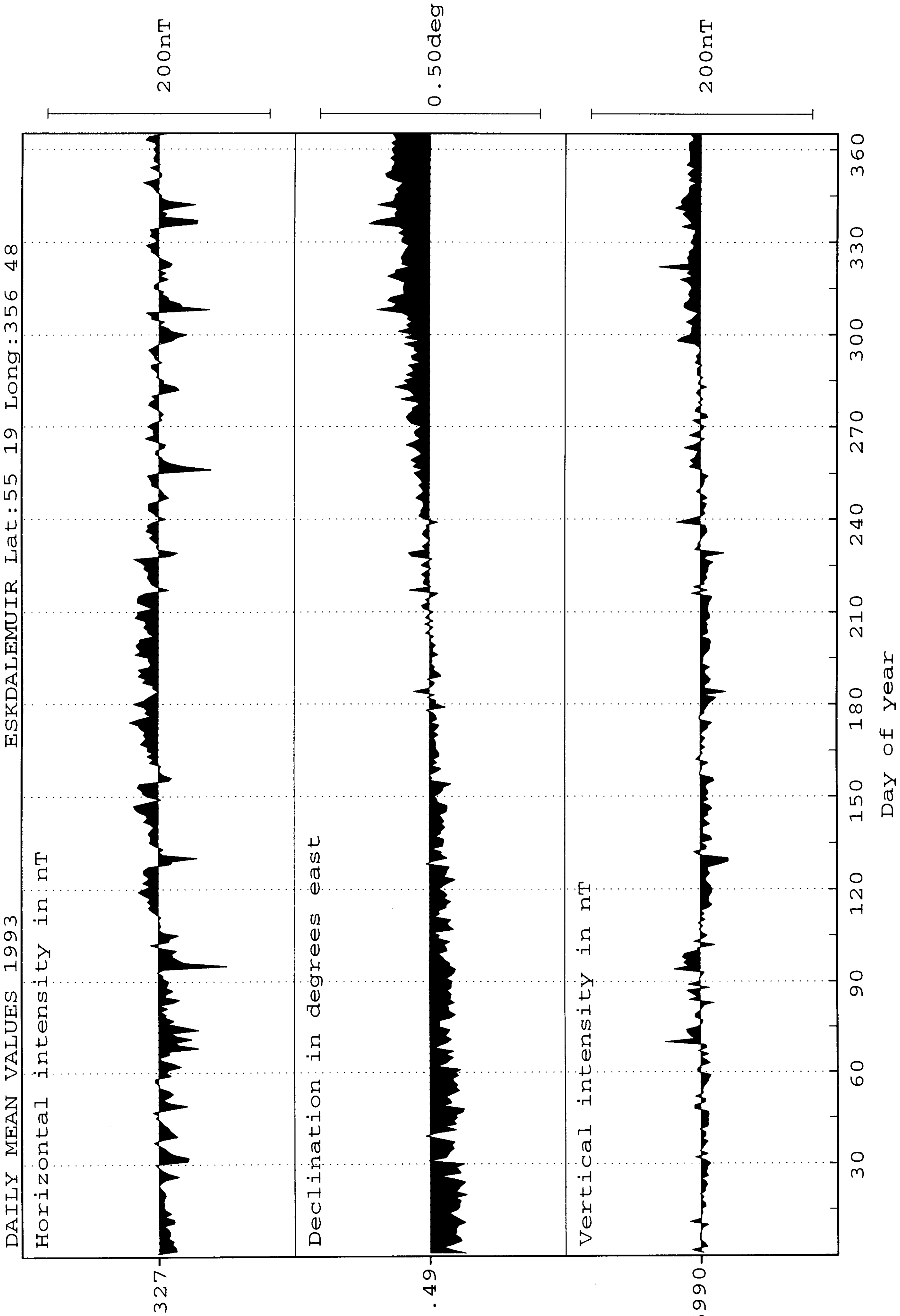




Eskdalemuir Observatory: Declination (degrees)
-6.30
-6.70
Rotn
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
Jan93
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

Eskdalemuir Observatory: Vertical Intensity (nT)





DAILY MEAN VALUES 1993
ESKDALEMUIR Lat:55 19 Long:356 48
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
200nT
0.50deg
200nT
17327
-6.49
45990
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Eskdalemuir 1993

Month	D	H	I	X	Y	Z	F
Jan	-6 32.8	17319	69 21.8	17206	-1975	45988	49141
Feb	-6 32.1	17320	69 21.7	17207	-1971	45987	49140
Mar	-6 31.8	17315	69 22.2	17203	-1969	45993	49144
Apr	-6 31.4	17323	69 21.6	17211	-1968	45990	49144
May	-6 30.9	17333	69 20.8	17221	-1967	45983	49141
Jun	-6 30.1	17337	69 20.6	17225	-1963	45987	49146
Jul	-6 29.4	17339	69 20.4	17228	-1960	45984	49144
Aug	-6 28.6	17334	69 20.8	17223	-1955	45987	49145
Sep	-6 27.5	17326	69 21.4	17216	-1949	45991	49146
Oct	-6 26.6	17325	69 21.6	17216	-1944	45994	49149
Nov	-6 25.2	17325	69 21.7	17216	-1937	46000	49154
Dec	-6 24.1	17325	69 21.8	17217	-1932	46001	49155
Annual	-6 29.2	17327	69 21.3	17216	-1957	45990	49146

D and I are given in degrees and decimal minutes
H, X, Y, Z and F are given in nanoteslas

Eskdalemuir Observatory K Indices 1993

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1222 2213	4333 3534	2123 4334	1210 1333	3312 2100	2100 2210	3423 4334	2000 1211	0000 1210	4334 3333	3212 3332	2113 3446
2	3233 3344	3422 3342	2333 3354	0111 1111	0111 2232	1111 3121	3224 4445	1100 0121	0011 3232	1012 2241	2100 1000	3334 3456
3	4433 3443	1111 1143	4333 3564	2100 1122	2011 3311	3322 3432	5441 3332	2011 3332	2322 4455	0010 1232	0000 1236	5443 3243
4	5333 4344	3101 1223	4432 2331	1001 5467	1110 2311	4444 4444	3212 2312	1122 4545	3333 3424	0001 1141	6534 4555	1002 2143
5	3223 3233	1011 0223	3221 1012	5654 5553	1111 3000	4443 4453	2300 1210	4432 2331	4221 3223	1001 1223	3344 3454	1002 2432
6	3222 3233	0111 1021	1022 2241	2212 3325	3122 3332	3332 3443	0012 1121	0232 3431	3211 3342	4321 1123	3233 3344	1111 2122
7	2323 2455	2343 3464	3431 2244	1211 1334	1221 3433	3234 4334	3221 2231	3422 3334	1321 2213	1100 2110	3223 3444	2010 4345
8	3211 2344	5433 3554	3232 3436	3233 4453	5344 4444	3221 3341	2333 4432	2222 1211	4212 2223	1242 3223	3222 2343	5433 3431
9	4222 3333	3334 3443	6554 3335	3221 2545	4443 4454	2011 1223	3322 4432	3213 2331	1001 1222	3445 3344	3323 2133	0000 0001
10	3343 3311	1132 3351	4321 3213	4331 3333	4444 4433	0112 1456	2222 4233	1013 2222	0110 1201	3443 4344	3321 3231	2111 2232
11	1103 4435	3322 3345	2034 5655	1212 3223	1111 2111	3111 2332	3433 2421	2100 1111	3101 2223	3233 3534	1311 1100	3211 1120
12	4221 1322	3221 1114	5232 2444	4521 2122	2323 2344	1223 3323	2212 3322	1222 2212	1011 3334	4333 4323	1100 1000	2112 1212
13	1001 3325	4201 2223	4432 3443	1444 4342	4200 1233	2333 3232	3232 3222	1111 2211	5655 4554	2321 1232	1111 3322	1000 0003
14	3313 3334	1201 1020	3234 3344	3322 1444	2313 3312	1212 2322	0000 1111	0000 1110	4233 3433	3122 2210	2112 3433	2100 0111
15	3212 2334	0001 2110	4244 3345	3332 2255	2221 3442	2221 1111	1211 2222	0001 2433	3232 3222	1011 1100	3211 1235	2233 2110
16	2320 2233	0121 2110	3444 3542	3432 2333	2332 3223	1110 1100	1000 1211	4455 4566	1101 2230	1100 1223	3221 2333	1333 4344
17	3232 2121	1334 5521	3313 3244	1111 2332	3421 3354	1110 2222	1000 1111	5422 3221	0111 1001	3310 1223	3000 0043	3322 3343
18	2211 2234	1012 3344	4323 3223	3323 4331	0111 2223	1000 1301	1101 3221	3333 3432	0111 1100	2310 2211	1101 4564	2222 2444
19	4323 2355	3021 1121	1012 3431	2112 2322	2231 3332	0111 1221	1212 2222	3222 2343	2111 2101	3211 1133	5522 3345	4221 2232
20	3132 3311	3334 3235	2333 4333	3433 3332	1221 2210	0221 2220	1134 2443	3121 1220	0113 3445	2000 1122	3222 1111	3221 2233
21	2311 1111	1233 3554	3334 5333	4343 3444	1001 1121	0000 1200	3322 4332	1111 1111	5110 2332	1111 1101	3222 1112	3223 3444
22	1111 1133	3343 3433	4233 3444	3222 3444	0111 1221	1111 1122	3222 2223	1112 1123	2210 1111	3322 2334	2111 1121	3223 2013
23	2000 1011	2211 2310	2122 3224	2212 1344	0000 2010	2213 3453	3211 2201	1100 1110	0001 3234	2331 2232	2211 2211	2111 1324
24	0211 2241	2212 2111	4555 4434	3122 3321	0110 0010	3443 4433	1001 1321	0012 2112	3122 3344	3212 1332	1200 1112	2122 2333
25	0002 5455	1211 2210	2233 2332	2221 2223	0100 1110	3243 3432	3201 1110	1001 1212	2113 3323	2124 5533	1111 1213	1322 3133
26	5333 3332	1111 2212	0112 2233	0010 2220	0100 1112	2221 2222	1100 1211	2112 2222	2212 2112	2021 2435	4221 2453	3011 2224
27	1221 2332	0001 1013	3111 3324	1000 2202	2333 3343	2112 2321	1002 3432	2012 4534	3111 2232	4433 4453	3111 1222	2111 1220
28	1311 1010	3332 3321	3211 1344	1110 2221	3424 3543	1111 1110	3212 2222	2113 3323	0101 2333	2233 3235	0010 1112	0000 0111
29	1101 1113		4431 1113	0002 3334	3223 1222	2223 3312	2112 4543	3222 3113	2123 3553	4211 2213	3212 2233	0100 0000
30	3321 2224		3133 4423	4221 2232	1210 2210	3221 1433	3211 1211	1110 1111	3322 1125	2000 1101	2001 1111	1101 1000
31	4444 4455		4111 2223		1001 3221		3212 2121	2210 2111		0011 1333		2243 2324

Annual Values of Geomagnetic Elements

Eskdalemuir

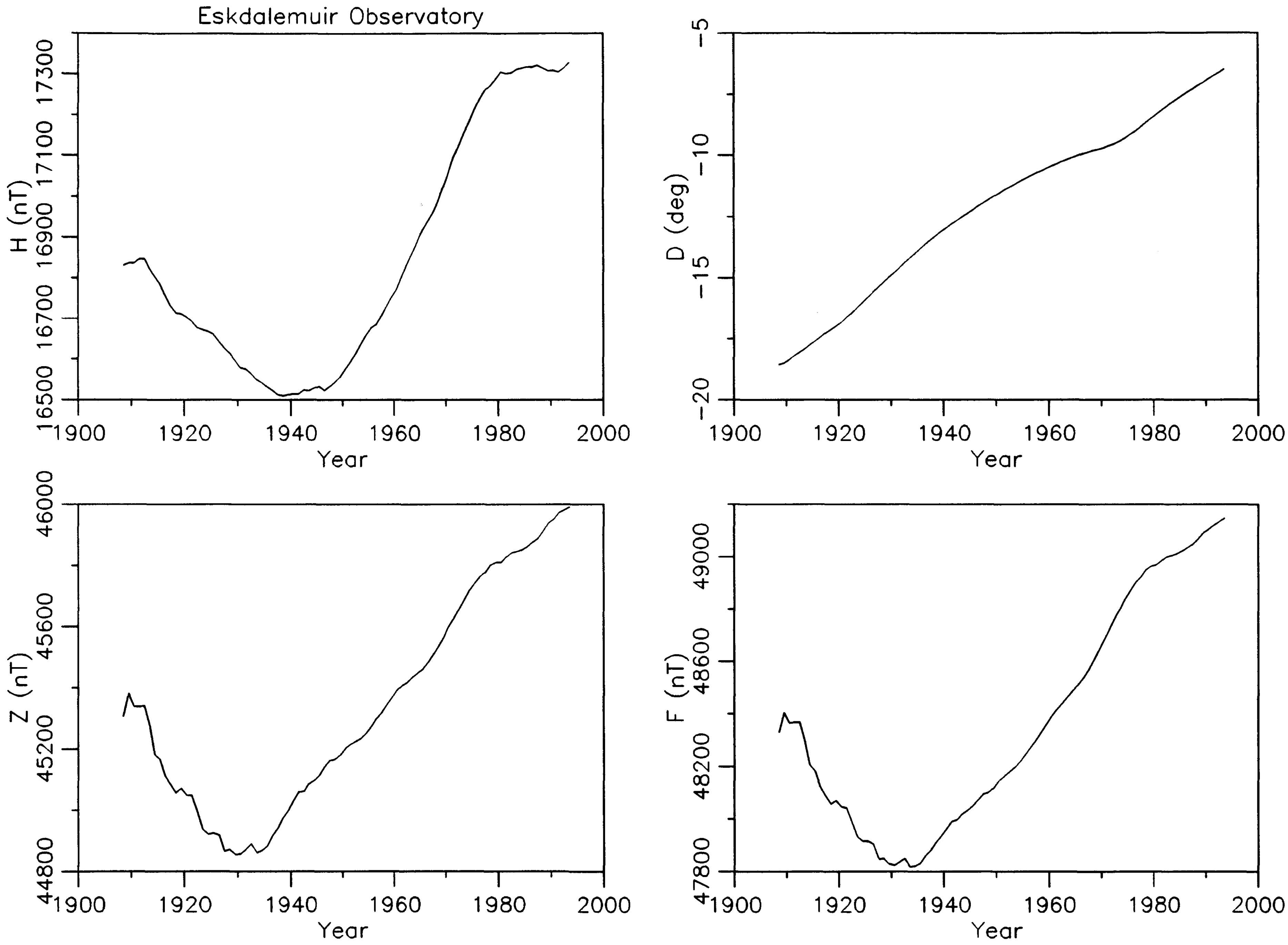
Year	D		H	I		X	Y	Z	F
1908.5	-18	33.3	16821	69	37.3	15947	-5353	45283	48306
1909.5	-18	30.1	16826	69	38.9	15956	-5339	45360	48380
1910.5	-18	23.3	16826	69	37.8	15967	-5308	45317	48340
1911.5	-18	12.4	16836	69	37.1	15993	-5260	45317	48343
1912.5	-18	3.9	16836	69	37.2	16006	-5221	45318	48344
1913.5	-17	54.9	16811	69	37.3	15996	-5171	45254	48276
1914.5	-17	45.3	16793	69	36.1	15993	-5121	45159	48180
1915.5	-17	35.9	16775	69	36.9	15990	-5072	45142	48158
1916.5	-17	26.1	16744	69	37.6	15975	-5017	45088	48097
1917.5	-17	17.1	16720	69	38.6	15965	-4968	45061	48063
1918.5	-17	8.1	16703	69	39.0	15962	-4921	45034	48032
1919.5	-16	58.7	16700	69	39.6	15972	-4877	45049	48045
1920.5	-16	49.6	16693	69	39.5	15978	-4832	45026	48021
1921.5	-16	37.2	16681	69	40.3	15984	-4771	45025	48016
1922.5	-16	25.8	16666	69	40.0	15985	-4714	44974	47963
1923.5	-16	13.8	16661	69	38.8	15997	-4657	44915	47906
1924.5	-16	1.2	16657	69	38.7	16010	-4597	44898	47889
1925.5	-15	48.4	16650	69	39.3	16020	-4535	44902	47890
1926.5	-15	35.3	16632	69	40.3	16020	-4469	44896	47878
1927.5	-15	22.7	16615	69	40.2	16020	-4406	44843	47822
1928.5	-15	10.5	16602	69	41.2	16024	-4346	44849	47823
1929.5	-14	58.8	16586	69	41.9	16022	-4287	44832	47802
1930.5	-14	47.1	16568	69	43.2	16019	-4228	44834	47797
1931.5	-14	34.8	16565	69	43.7	16032	-4170	44850	47812
1932.5	-14	23.7	16553	69	45.0	16033	-4115	44867	47823
1933.5	-14	12.1	16539	69	45.2	16033	-4058	44839	47792
1934.5	-14	0.6	16531	69	45.9	16039	-4002	44845	47795
1935.5	-13	48.8	16520	69	47.0	16042	-3944	44861	47806
1936.5	-13	37.4	16512	69	48.4	16047	-3889	44894	47834
1937.5	-13	26.9	16501	69	49.8	16049	-3837	44920	47855
1938.5	-13	17.1	16499	69	50.7	16057	-3791	44953	47885
1939.5	-13	7.3	16502	69	51.1	16071	-3746	44977	47909
1940.5	-12	57.9	16503	69	51.8	16082	-3703	45008	47938
1941.5	-12	48.2	16503	69	52.5	16093	-3657	45037	47965
1942.5	-12	39.8	16513	69	51.9	16111	-3620	45039	47971
1943.5	-12	31.2	16511	69	52.7	16118	-3579	45064	47994
1944.5	-12	23.0	16518	69	52.5	16134	-3542	45076	48007
1945.5	-12	14.5	16522	69	52.6	16146	-3503	45093	48025
1946.5	-12	5.9	16512	69	54.0	16145	-3461	45120	48046
1947.5	-11	57.1	16520	69	53.9	16162	-3421	45140	48068
1948.5	-11	48.9	16532	69	53.2	16182	-3385	45144	48076
1949.5	-11	40.9	16544	69	52.8	16201	-3350	45158	48093
1950.5	-11	33.2	16564	69	52.0	16228	-3317	45180	48121
1951.5	-11	25.5	16581	69	51.1	16252	-3284	45193	48139
1952.5	-11	18.0	16601	69	50.0	16279	-3253	45203	48155
1953.5	-11	11.0	16625	69	48.7	16309	-3224	45213	48173
1954.5	-11	3.4	16647	69	47.6	16338	-3193	45228	48194
1955.5	-10	56.3	16665	69	46.9	16362	-3162	45250	48221
1956.5	-10	49.7	16674	69	47.0	16377	-3132	45277	48250
1957.5	-10	43.6	16695	69	46.0	16403	-3107	45296	48275
1958.5	-10	38.0	16719	69	45.0	16432	-3085	45320	48306
1959.5	-10	32.1	16742	69	44.1	16460	-3061	45344	48336
1960.5	-10	26.3	16761	69	43.5	16484	-3037	45370	48367
1961.5	-10	20.9	16792	69	41.8	16519	-3016	45385	48392
1962.5	-10	15.7	16825	69	39.8	16556	-2997	45396	48414
1963.5	-10	10.2	16850	69	38.6	16585	-2975	45413	48438
1964.5	-10	5.3	16880	69	36.9	16619	-2957	45427	48462
1965.5	-10	0.8	16907	69	35.5	16649	-2940	45440	48483
1966.5	-9	56.4	16928	69	34.6	16674	-2922	45460	48509
1967.5	-9	52.1	16949	69	33.8	16698	-2905	45486	48541
1968.5	-9	48.6	16979	69	32.5	16731	-2893	45514	48578
1969.5	-9	45.4	17013	69	31.0	16767	-2883	45542	48616

	Year	D	H	I	X	Y	Z	F
	1970.5	-9 41.6	17046	69 29.6	16803	-2870	45576	48659
	1971.5	-9 36.8	17084	69 27.8	16844	-2853	45604	48699
	1972.5	-9 31.5	17112	69 26.7	16876	-2832	45635	48738
	1973.5	-9 25.2	17141	69 25.5	16910	-2805	45664	48775
	1974.5	-9 17.4	17169	69 24.5	16944	-2772	45696	48815
	1975.5	-9 9.8	17200	69 23.0	16981	-2739	45719	48847
	1976.5	-9 1.1	17227	69 21.8	17014	-2700	45741	48877
	1977.5	-8 51.2	17249	69 20.6	17044	-2655	45755	48899
	1978.5	-8 40.5	17260	69 20.5	17063	-2603	45780	48926
	1979.5	-8 30.5	17277	69 19.6	17087	-2556	45788	48939
	1980.5	-8 21.3	17294	69 18.5	17110	-2513	45788	48945
	1981.5	-8 11.2	17291	69 19.2	17114	-2462	45806	48961
	1982.5	-8 1.3	17292	69 19.4	17123	-2413	45820	48975
	1983.5	-7 51.7	17301	69 18.9	17138	-2366	45824	48981
	1984.5	-7 42.5	17304	69 18.9	17147	-2321	45830	48988
	1985.5	-7 33.8	17307	69 18.9	17156	-2278	45840	48998
	1986.5	-7 25.1	17306	69 19.4	17161	-2234	45854	49011
	1987.5	-7 17.2	17311	69 19.3	17171	-2196	45866	49024
	1988.5	-7 8.6	17304	69 20.4	17170	-2152	45889	49043
	1989.5	*-7 1.4*	*17297*	*69 21.5*	*17167*	*-2115*	*45916*	*49066*
	1989.5	**-7 0.2**	**17297**	**69 21.5**	**17168**	**-2109**	**45916**	**49066**
Note 1		0 0.0	11	0 -0.2	11	-1	22	25
	1990.5	*-6 55.2*	*17314*	*69 21.2*	*17188*	*-2086*	*45950*	*49104*
	1990.5	**-6 52.7**	**17309**	**69 21.6**	**17184**	**-2073**	**45952**	**49104**
	1991.5	*-6 47.6*	*17311*	*69 21.9*	*17189*	*-2048*	*45970*	*49121*
	1991.5	**-6 45.1**	**17305**	**69 22.3**	**17185**	**-2034**	**45972**	**49121**
	1992.5	*-6 40.0*	*17321*	*69 21.5*	*17204*	*-2011*	*45979*	*49133*
Note 2	**1992.5**	**-6 37.5**	**17315**	**69 21.9**	**17199**	**-1998**	**45981**	**49133**
	1993.5	-6 29.2	17327	69 21.3	17216	-1957	45990	49146

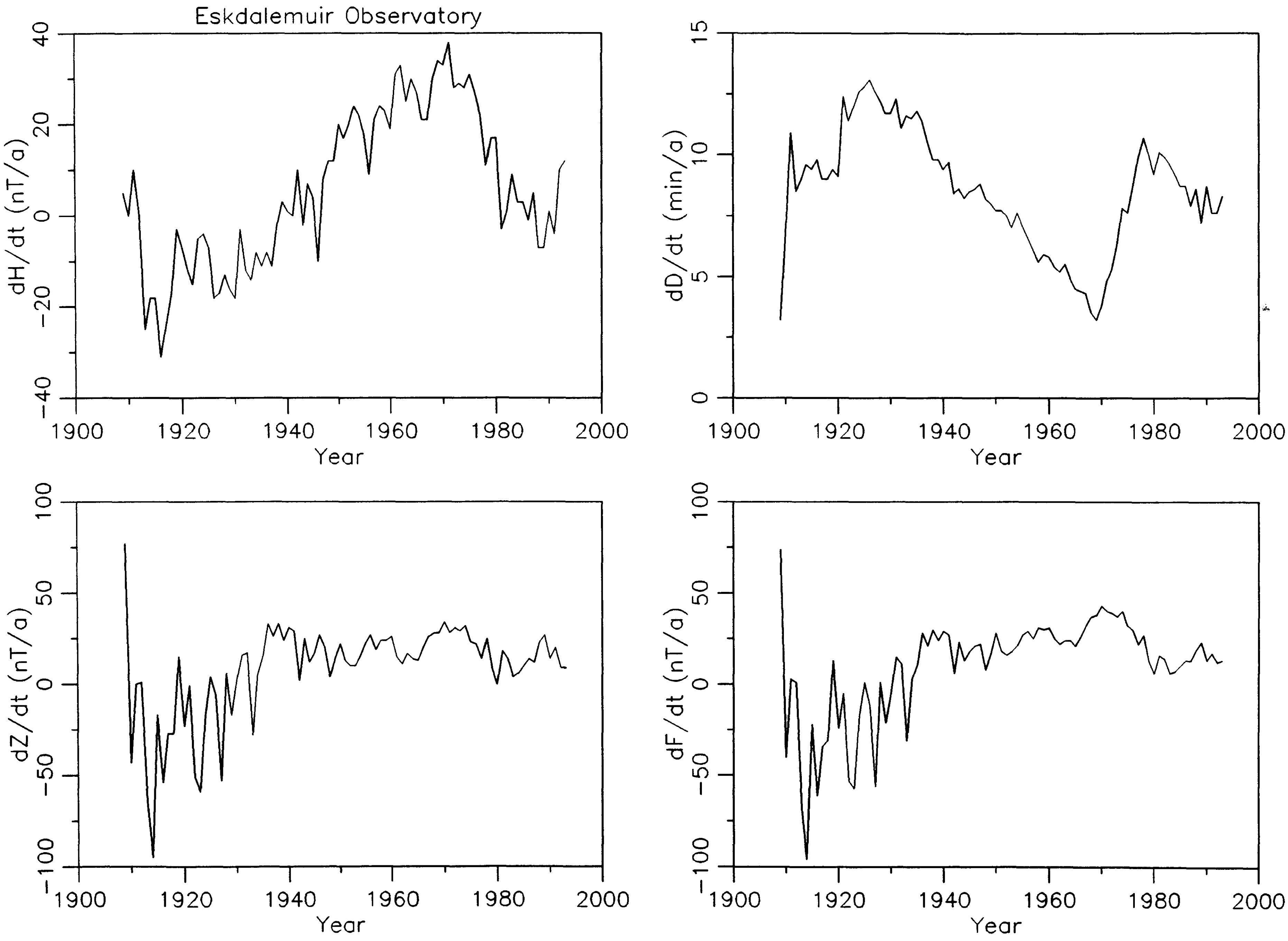
1 Site differences 1 Jan 1990 (new value - old value)

2 The values for 1989-1992 given in italics are previously published values which are calculated from the archived one-minute values. The values given in bold are corrected annual mean values following the removal of magnetic parts from the fluxgate theodolite.

D and I are given in degrees and decimal minutes
All other elements are in nanoteslas

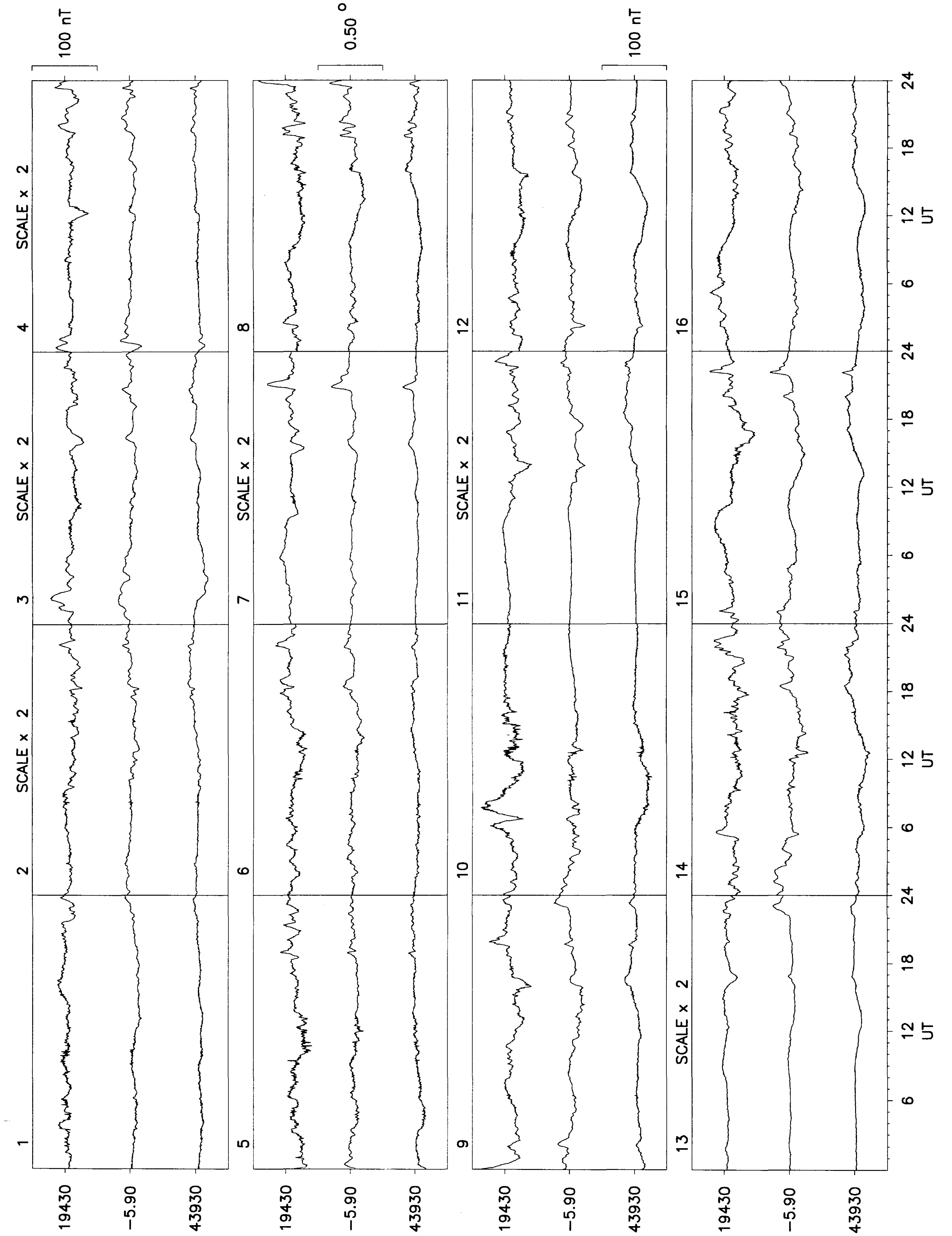


Annual mean values of H, D, Z & F at Eskdalemuir

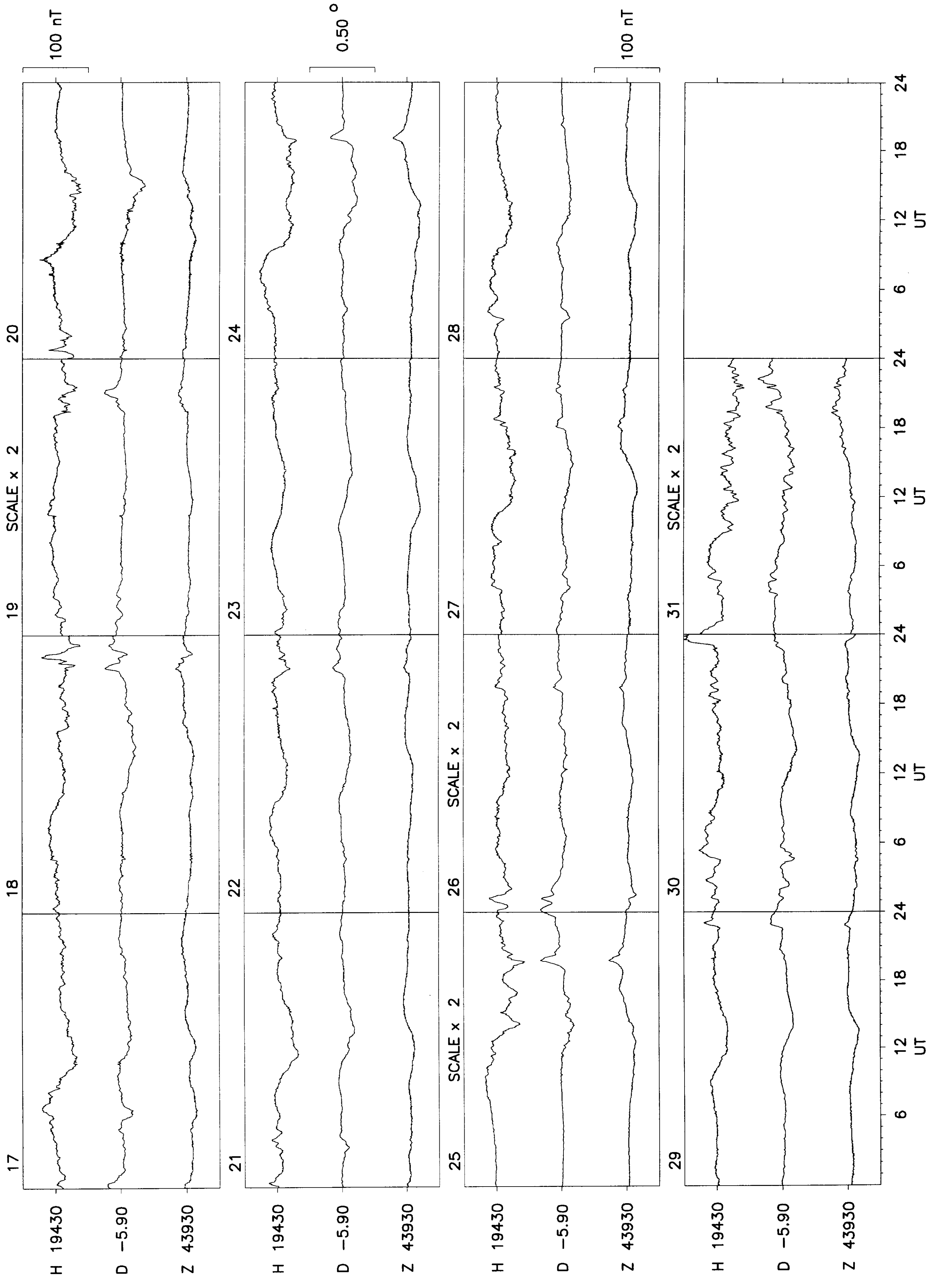


Rate of change of annual mean values for H, D, Z & F at Eskdalemuir

Hartland 1993



Hartland January 1993


100 nT
0.50 °
100 nT
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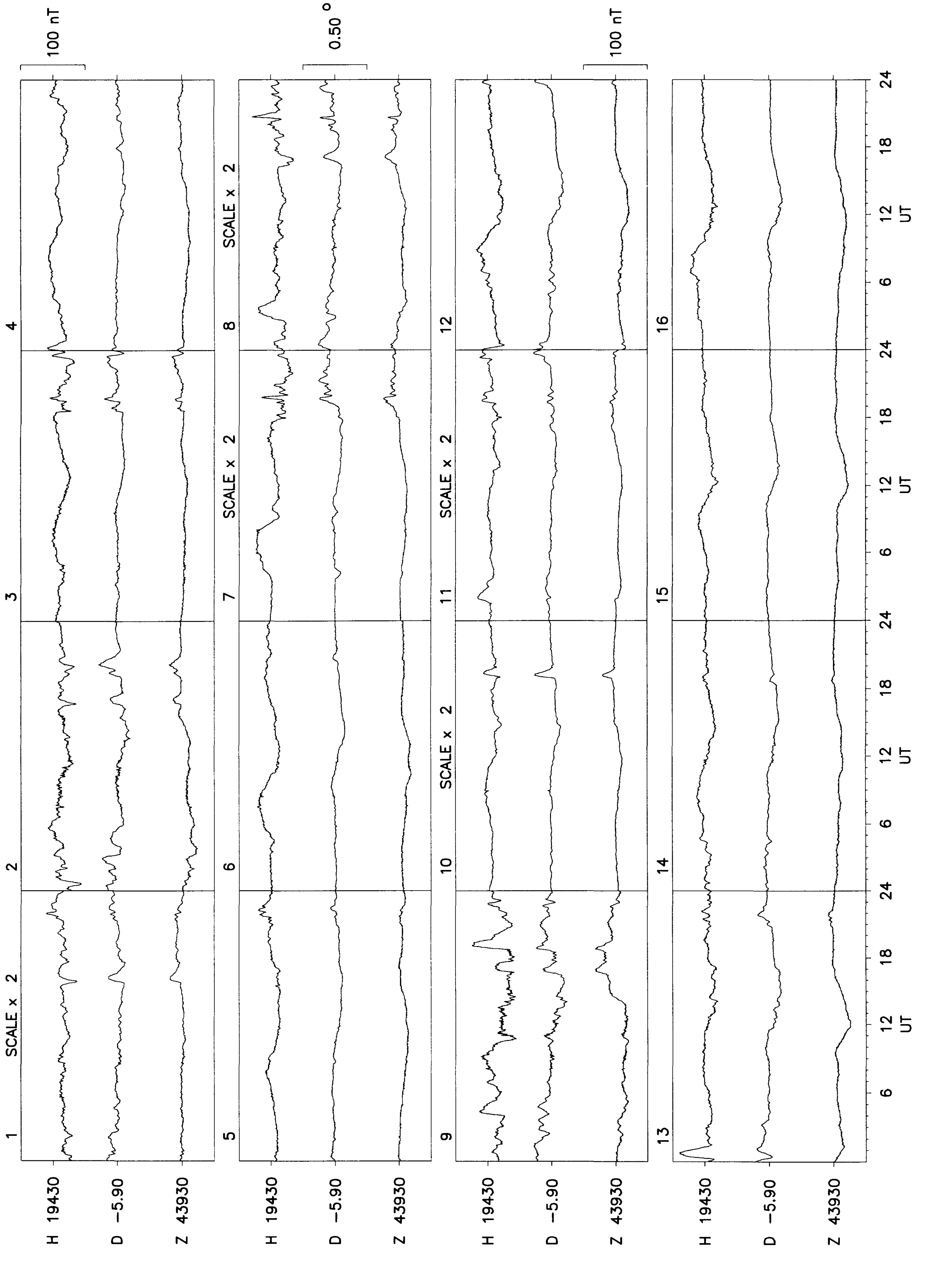
28
29
30
31
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
H 19430
D −5.90
Z 43930
UT
6
12
18
24


100 nT
0.50 °
100 nT
SCALE x 2
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4
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6
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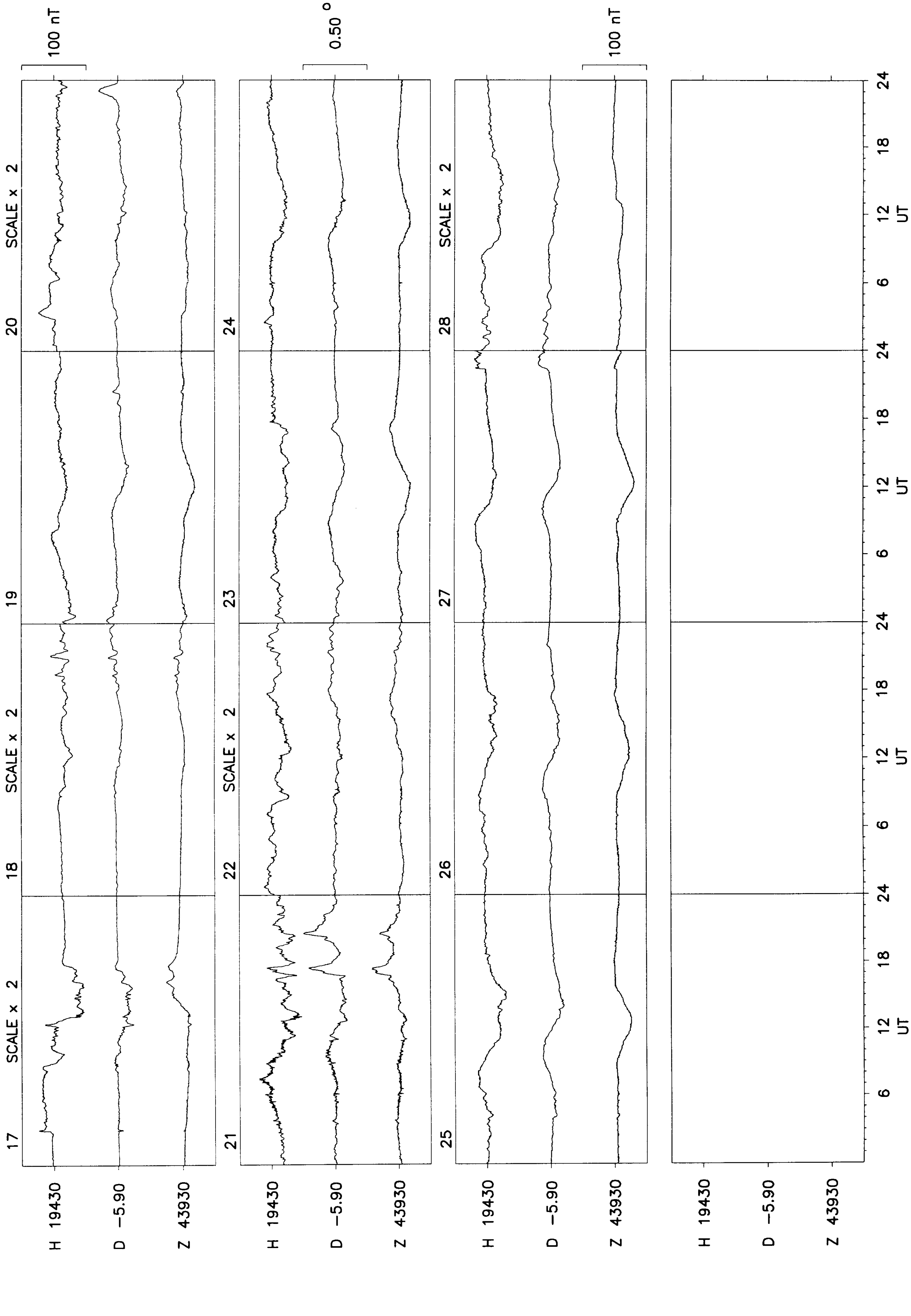
15
16
H 19430
D −5.90
Z 43930
6
12
18
24
UT



100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
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28
H 19430
D −5.90
Z 43930
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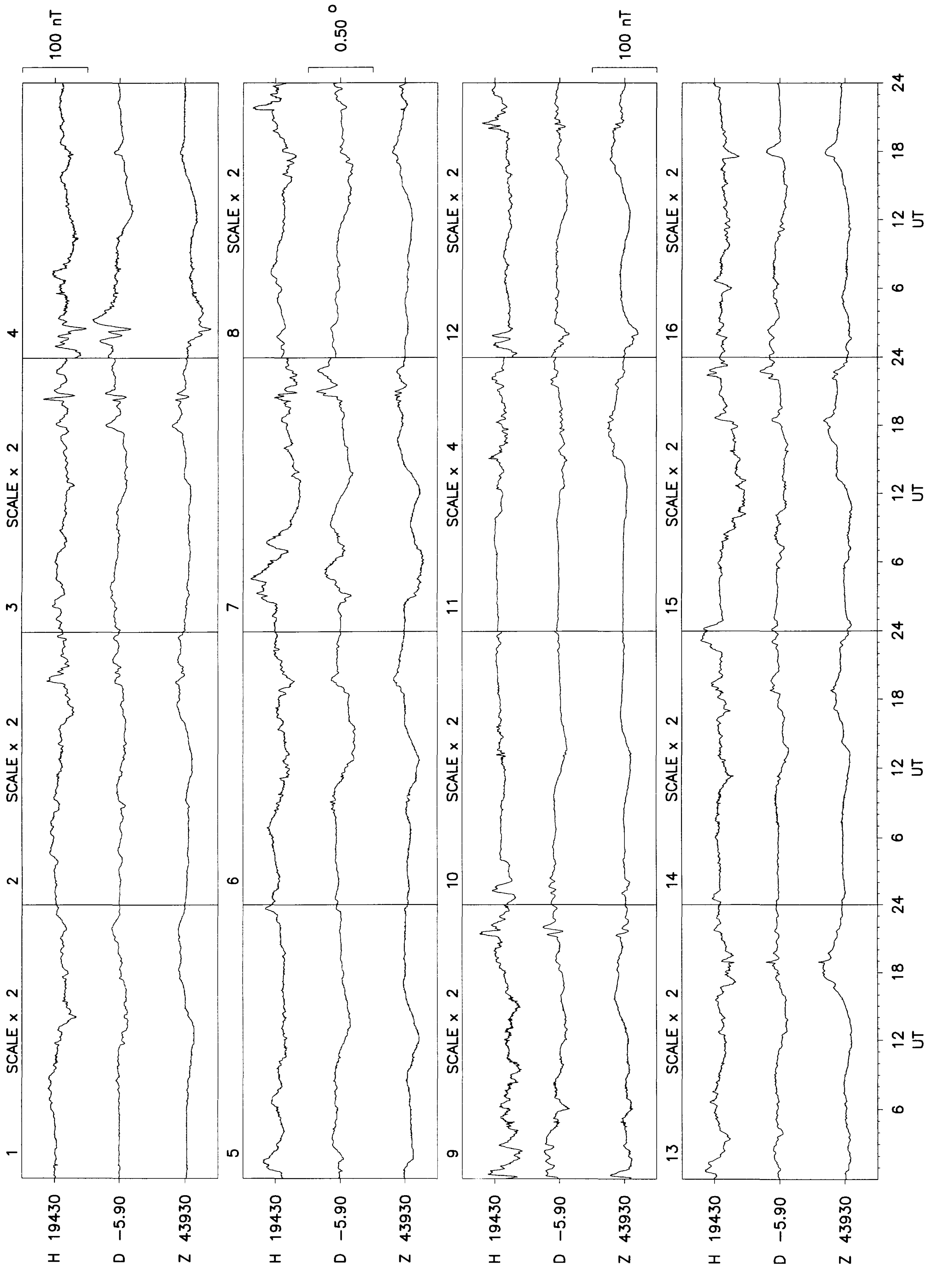
UT


100 nT
0.50 °
100 nT
H 19430
D −5.90
Z 43930
SCALE x 2
SCALE x 4
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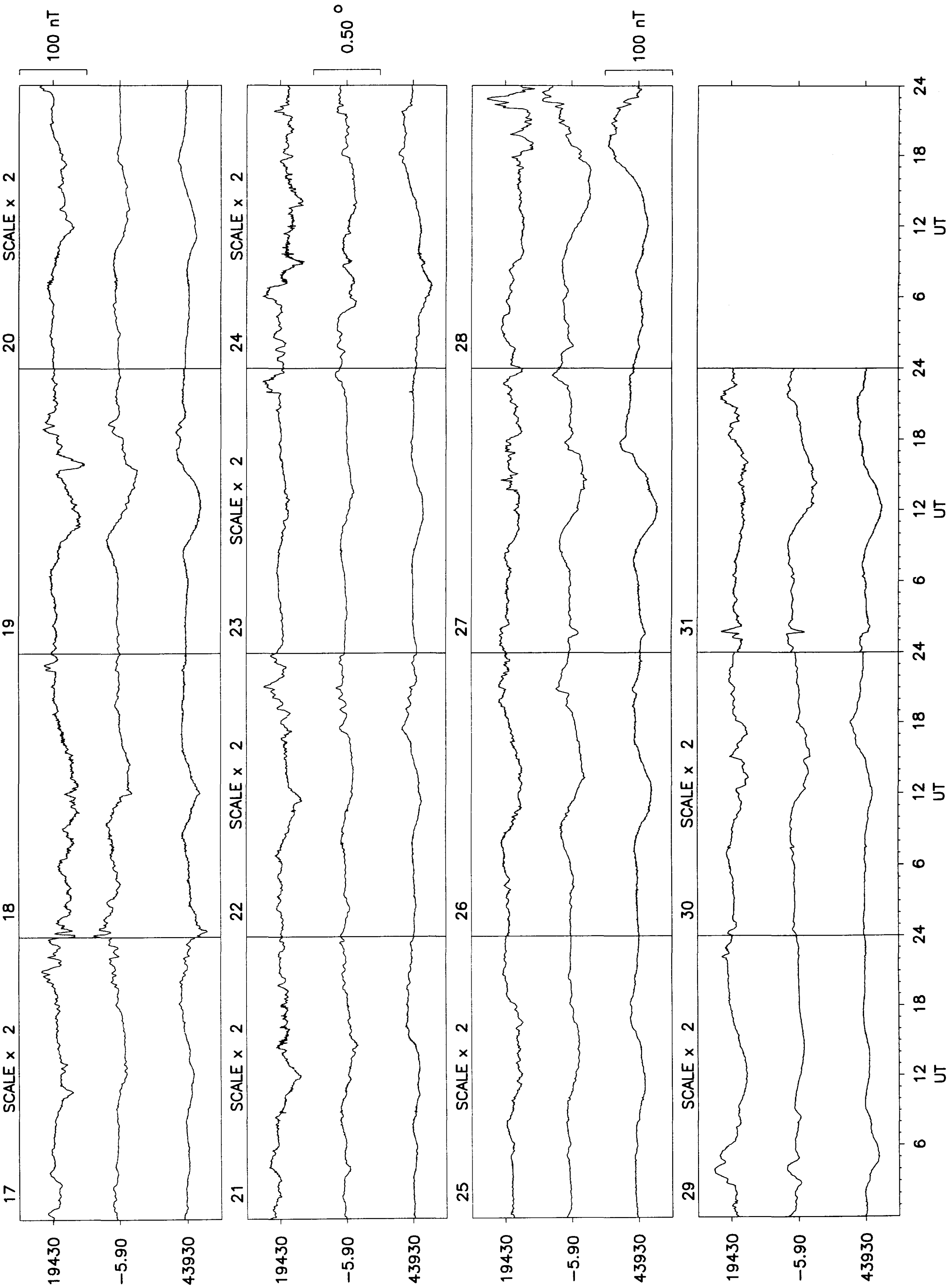
UT



100 nT
0.50 °
100 nT
SCALE x 2
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H 19430
D −5.90
Z 43930
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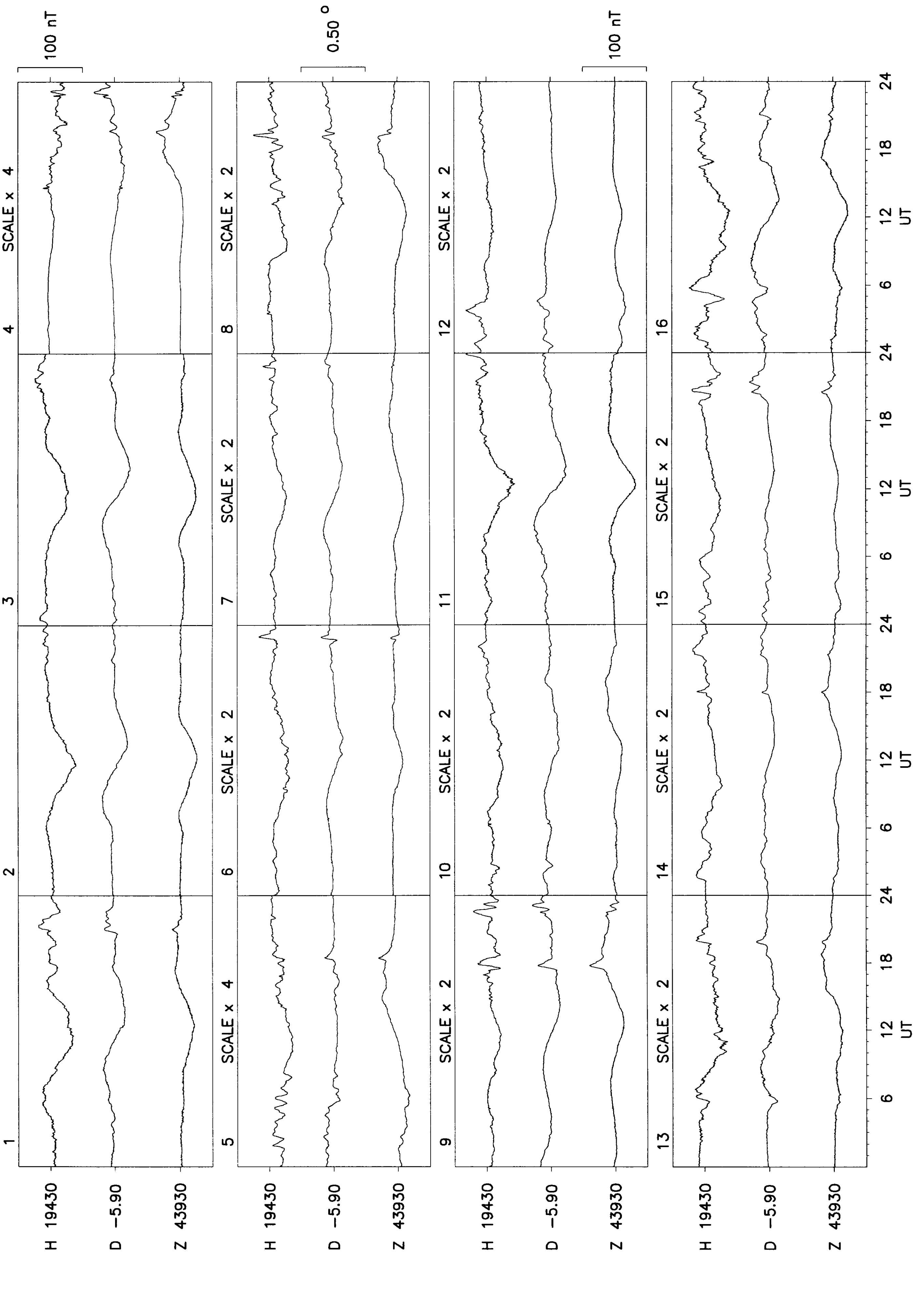
UT

HA 3 93


100 nT
0.50 °
100 nT
H 19430
D −5.90
Z 43930
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16
SCALE x 4
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 4
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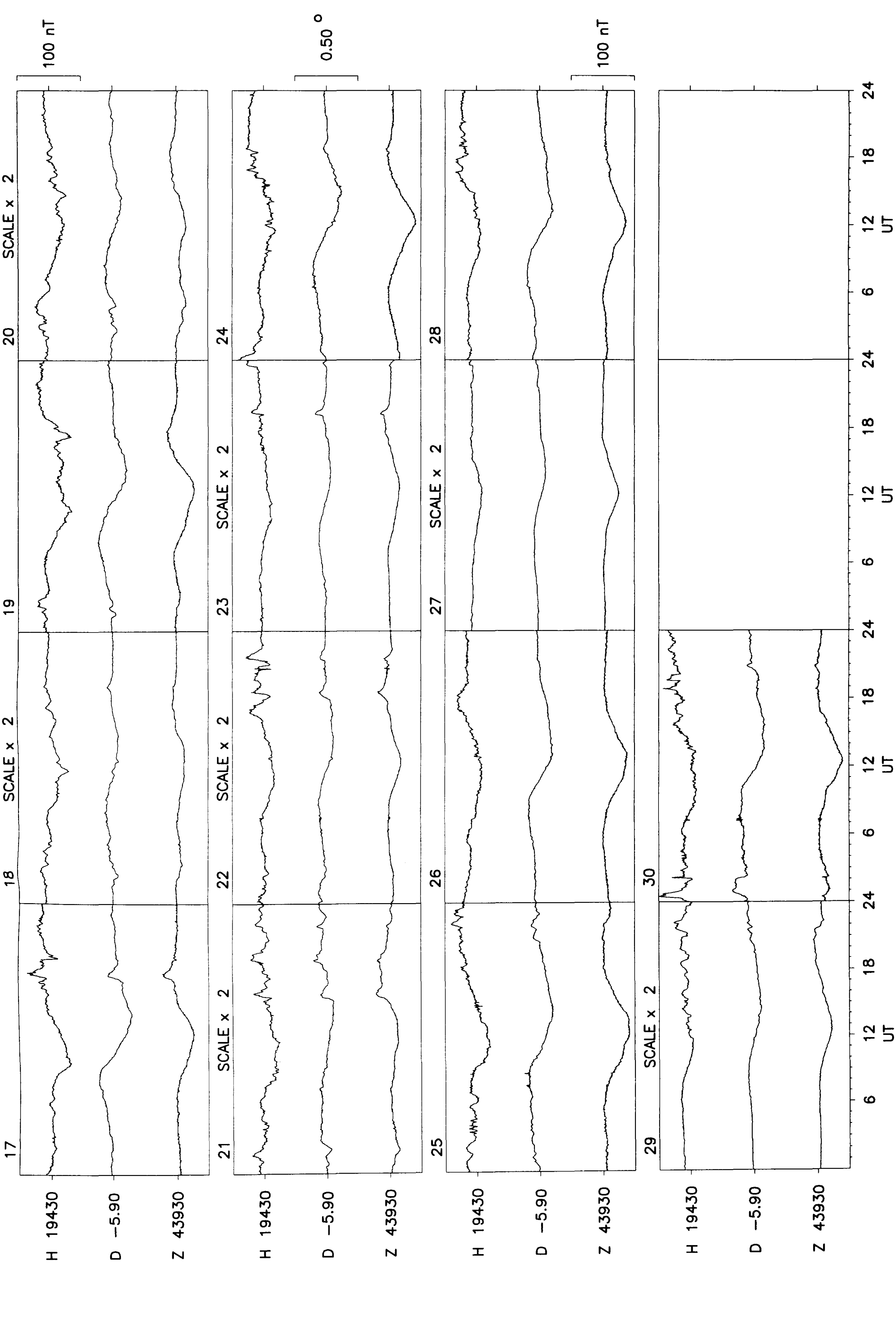
UT


100 nT
0.50 °
100 nT
H 19430
D −5.90
Z 43930
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SCALE x 2
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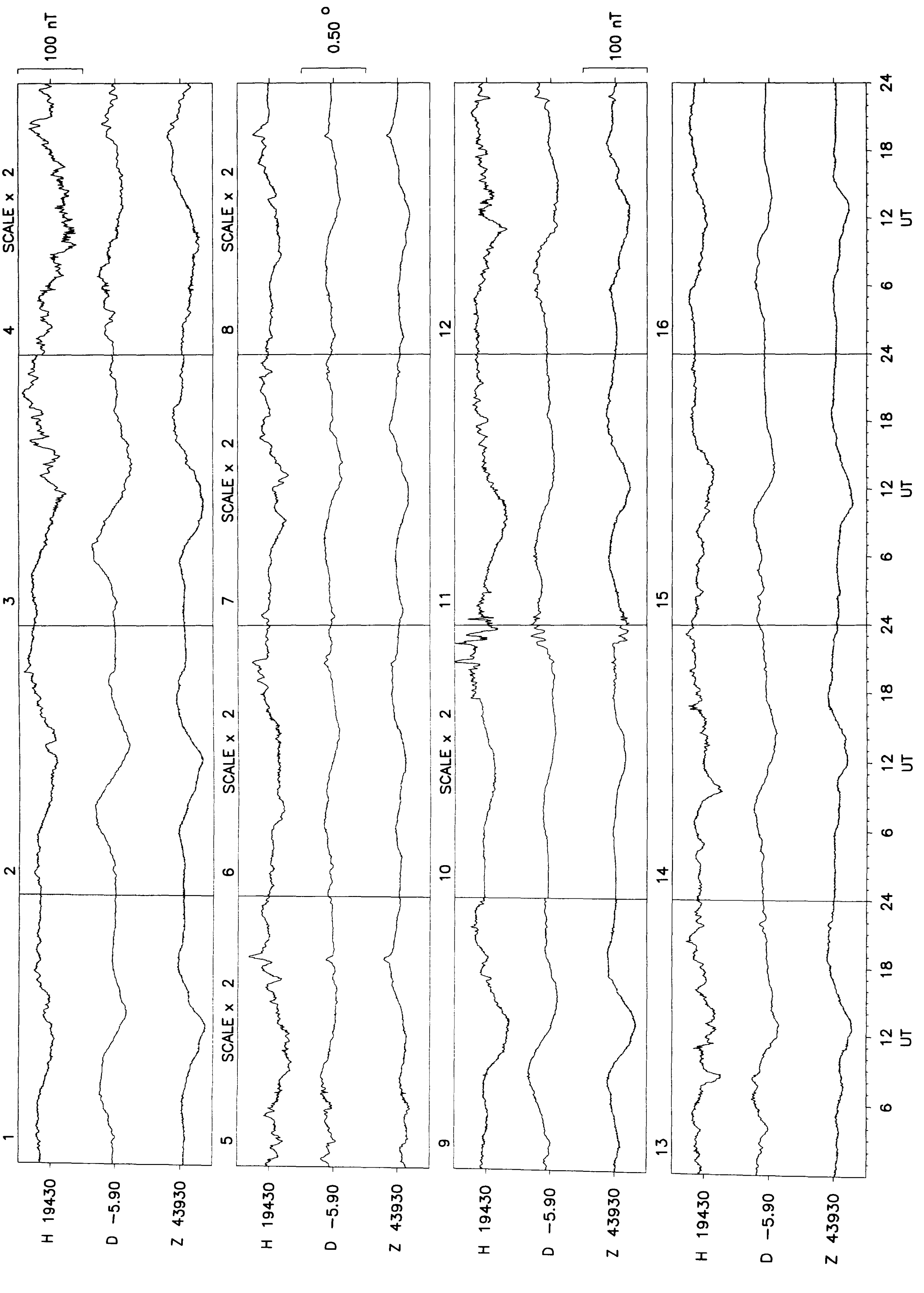
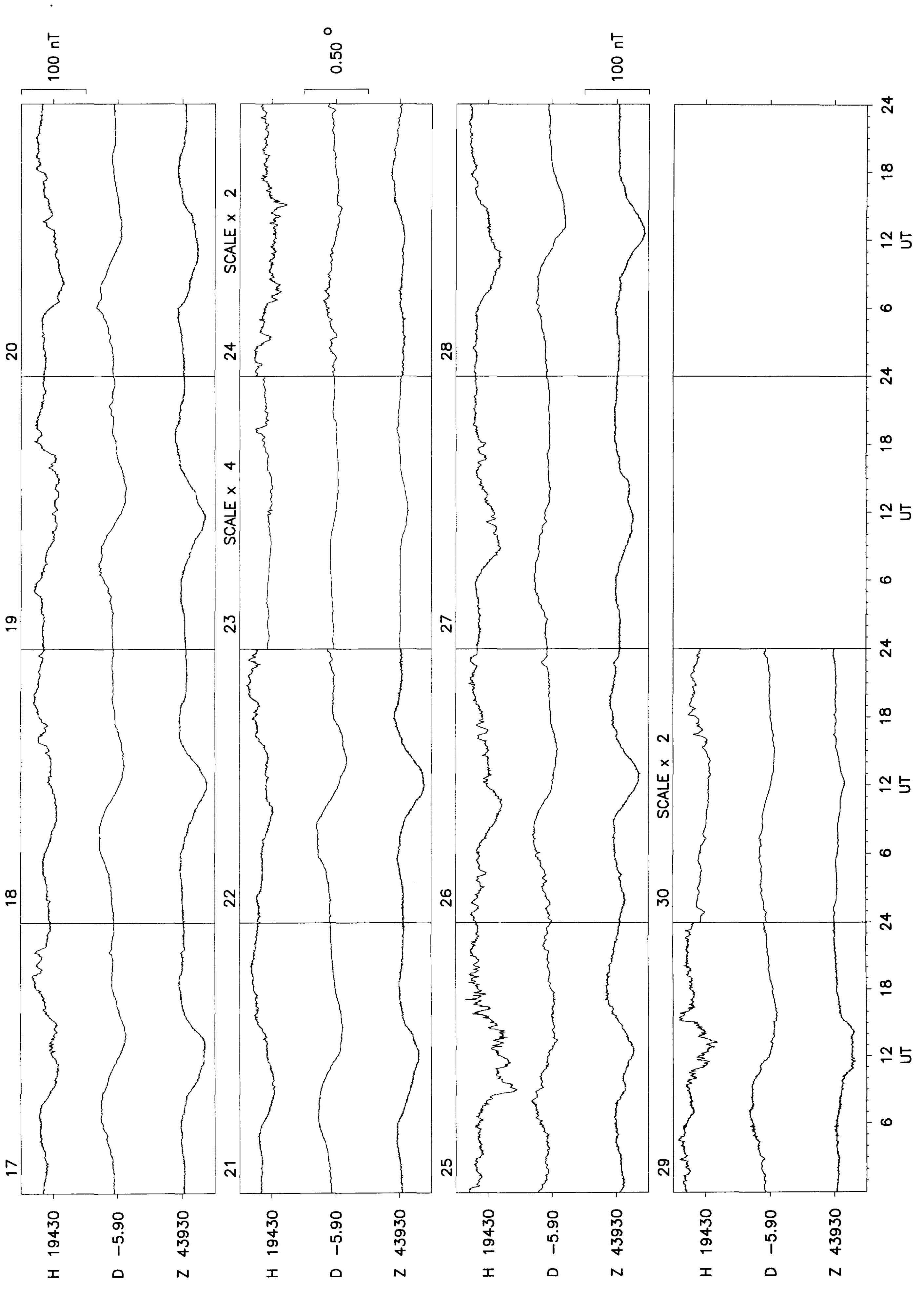
HA 4 93



Hartland June 1993


100 nT
0.50 °
100 nT
17
18
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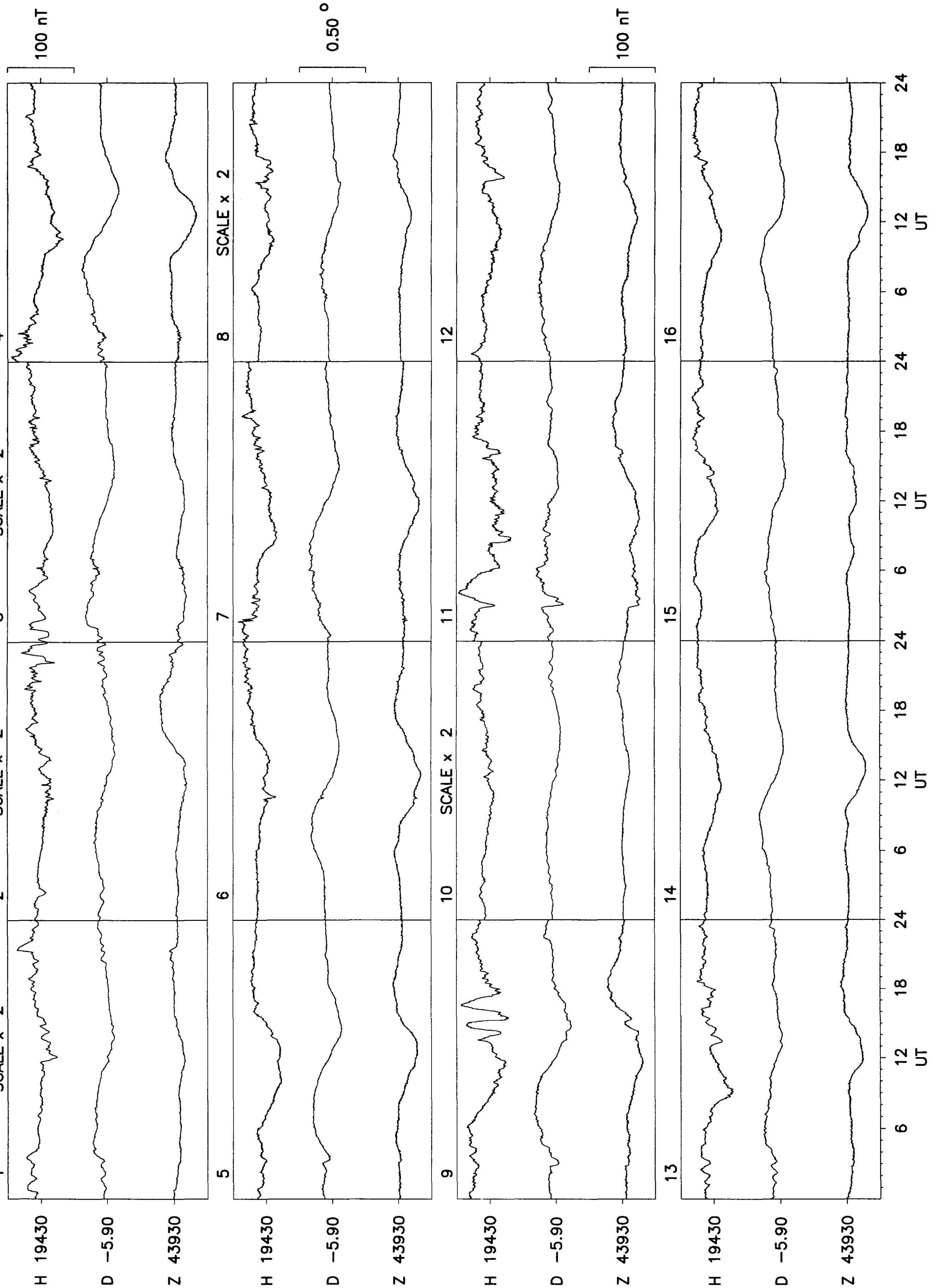
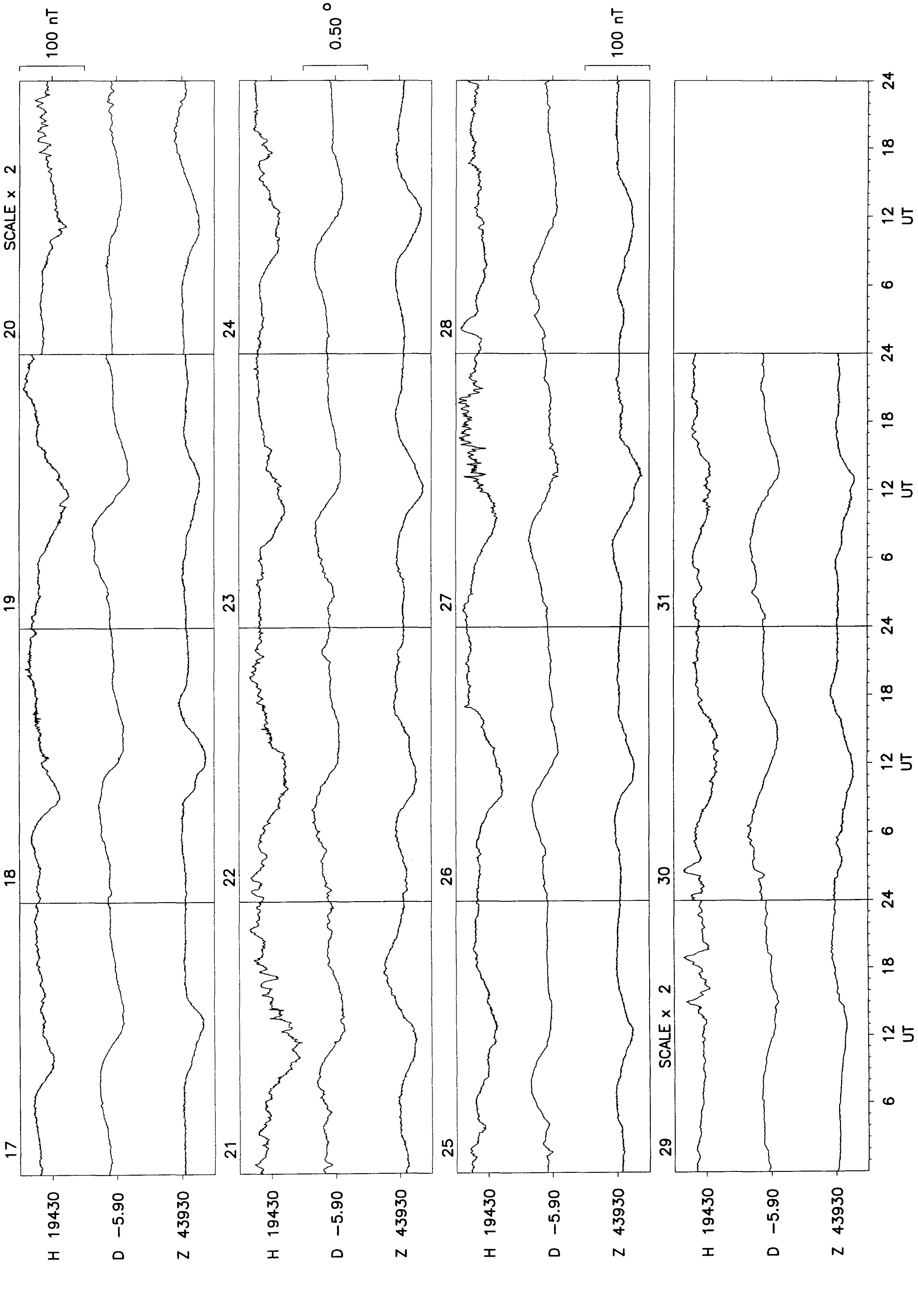
SCALE x 2
SCALE x 4
SCALE x 2
H 19430
D −5.90
Z 43930
6
12
18
24
UT



Hartland July 1993



100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 2
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H 19430
D −5.90
Z 43930
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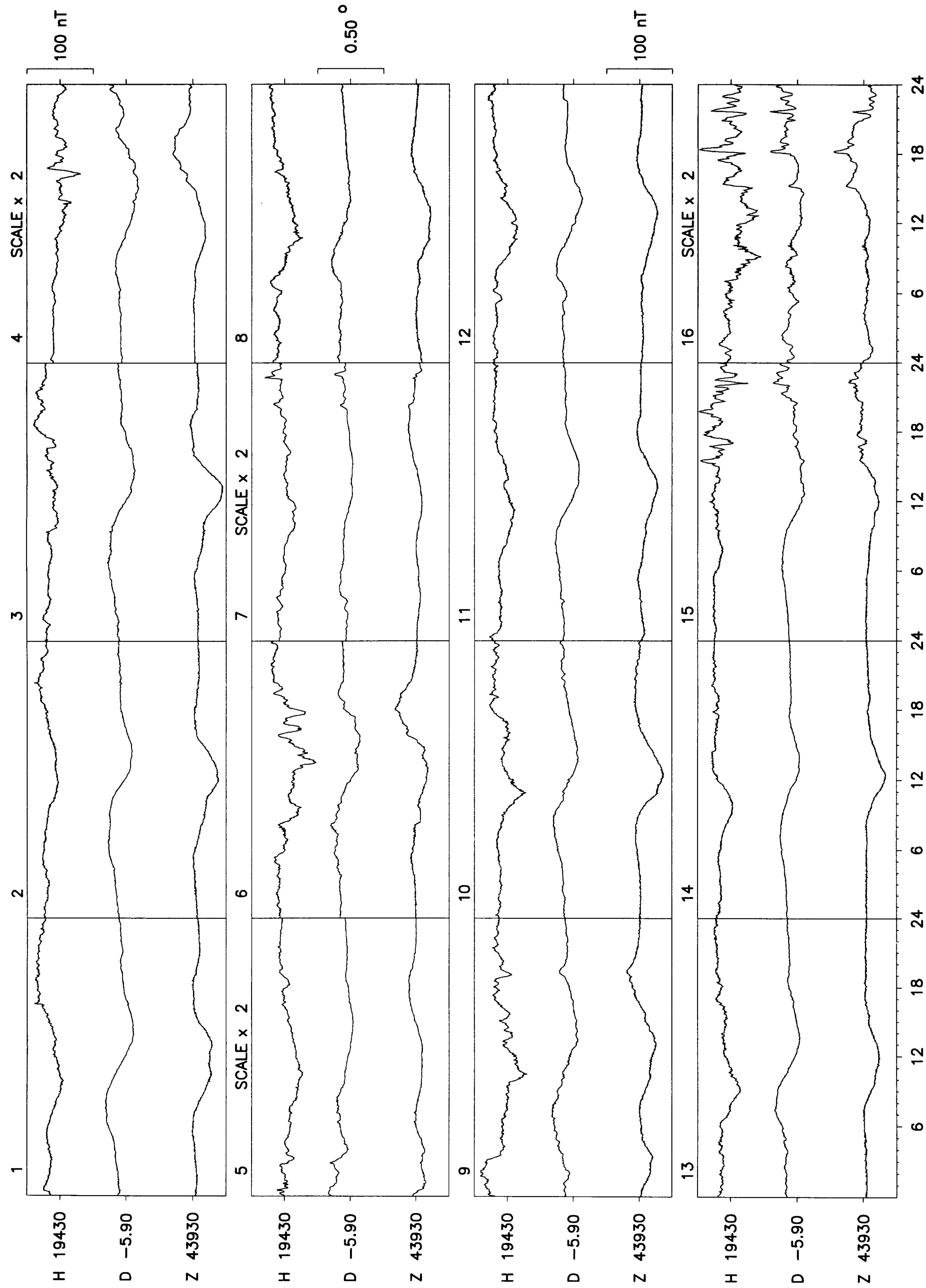
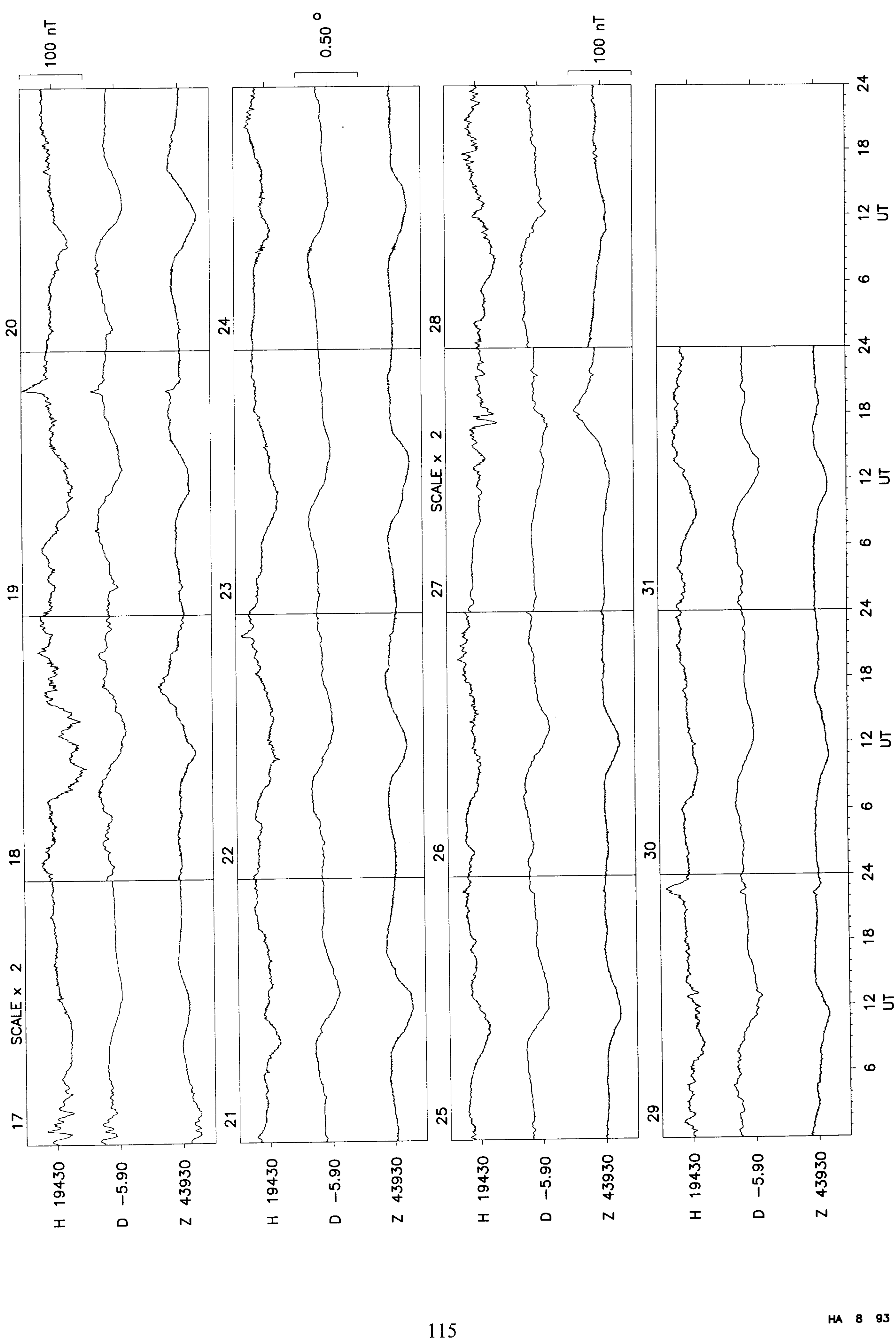
24
UT

HA 7 93



Hartland August 1993


100 nT
0.50 °
100 nT
17
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SCALE x 2
SCALE x 2
H 19430
D −5.90
Z 43930
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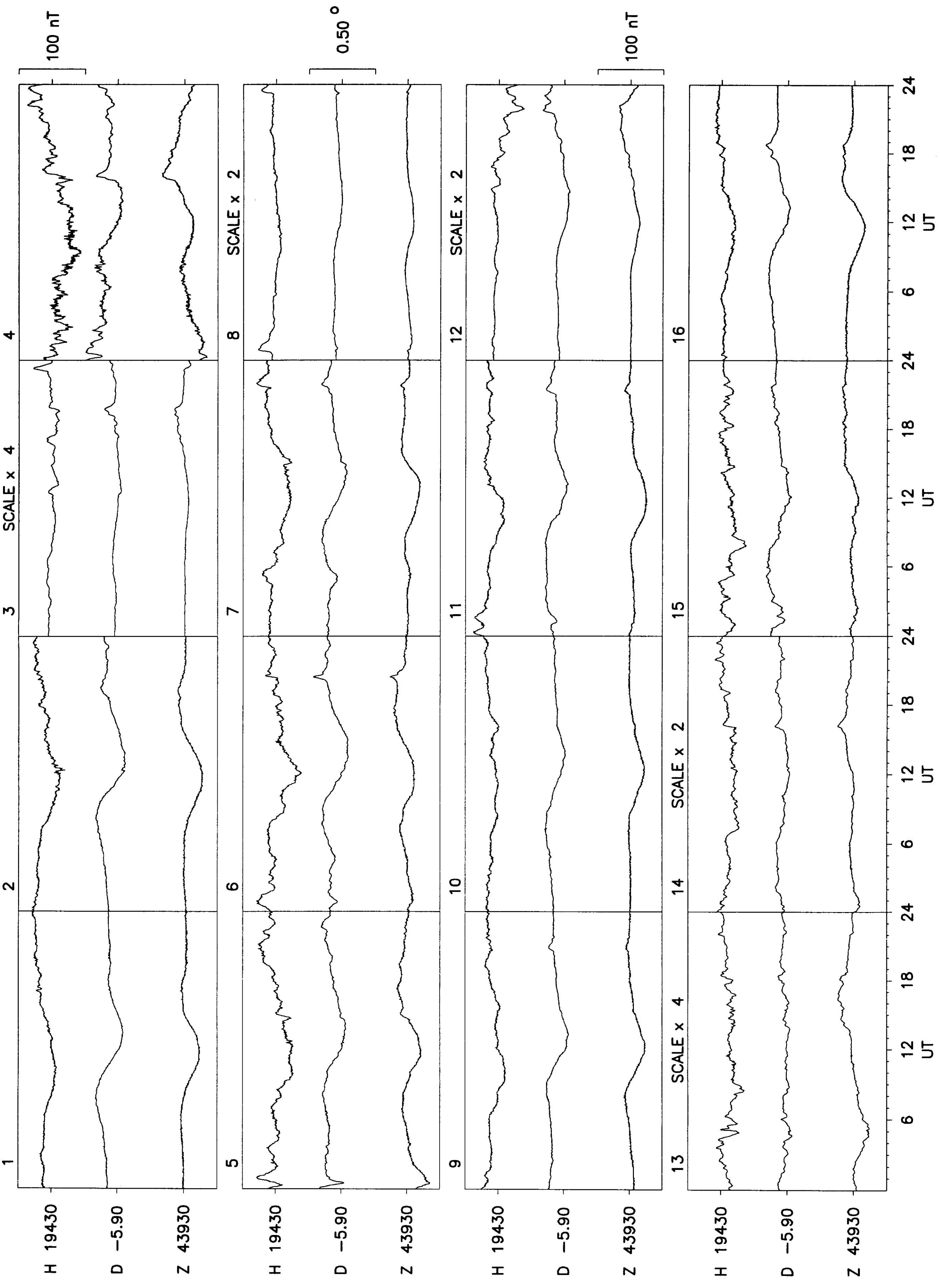
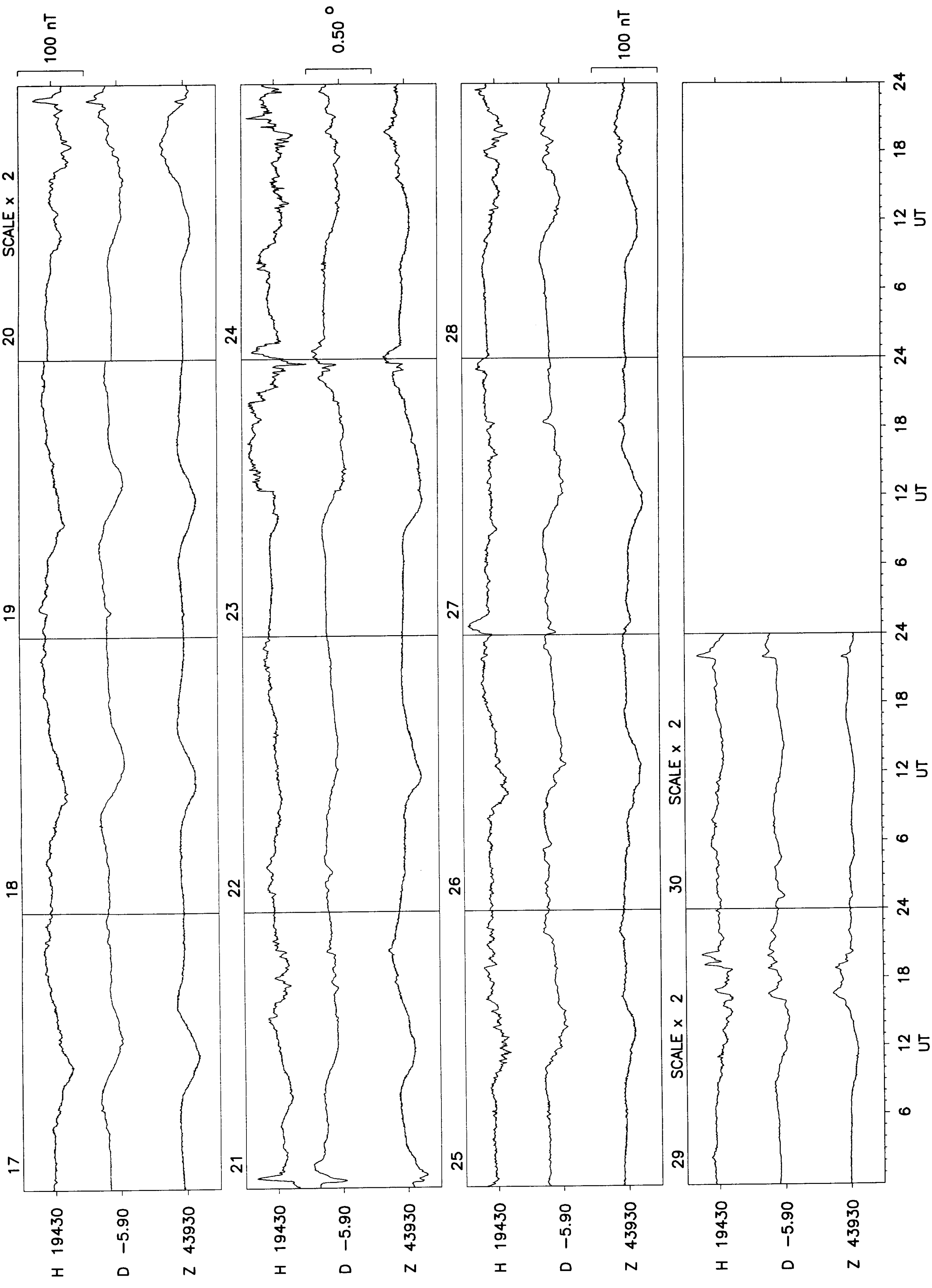
UT



Hartland September 1993


100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 2
SCALE x 2
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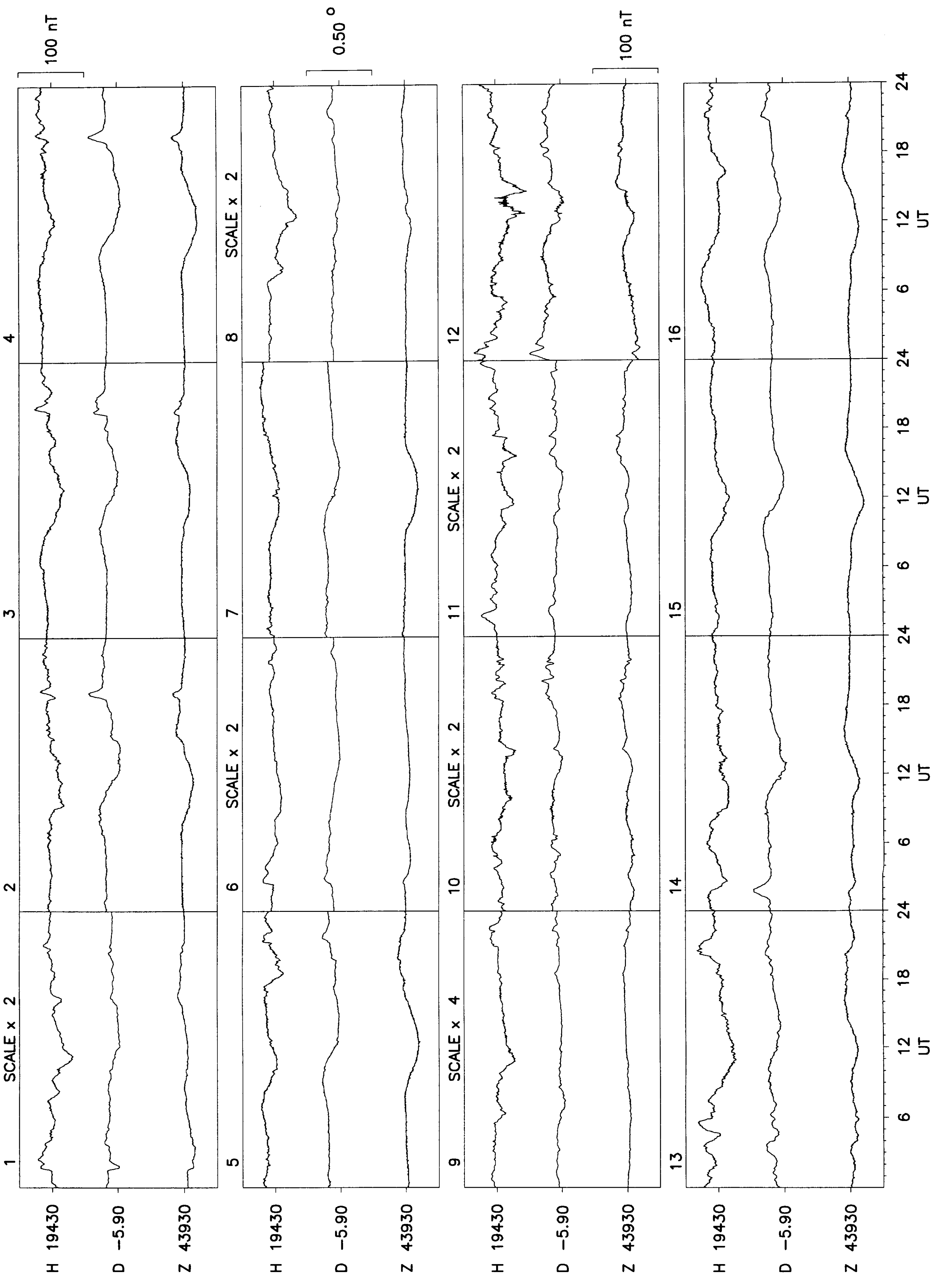
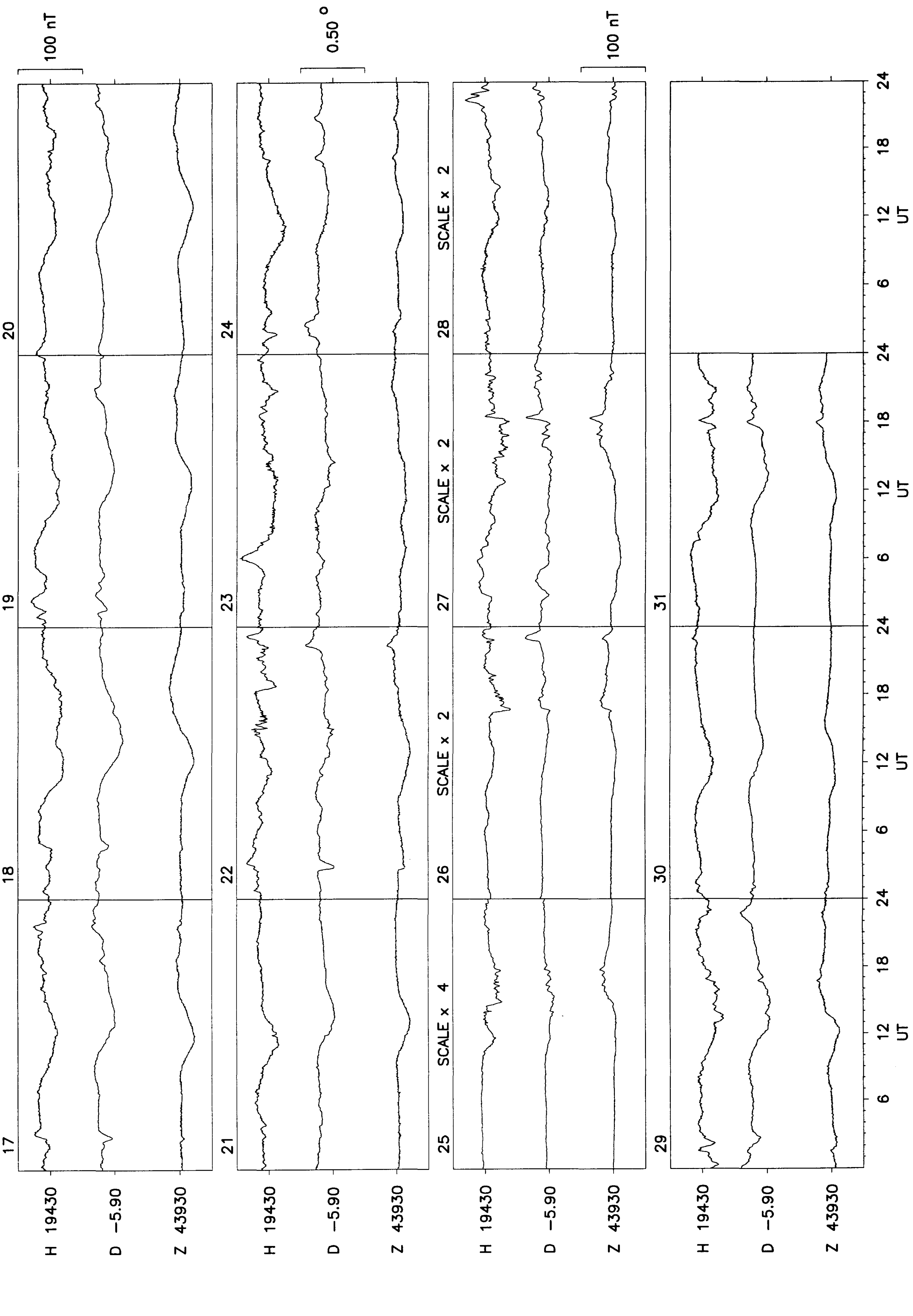
H 19430
D −5.90
Z 43930
UT



Hartland October 1993

HA 10 93


100 nT
0.50 °
100 nT
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22
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SCALE x 4
SCALE x 2
SCALE x 2
SCALE x 2
H 19430
D −5.90
Z 43930
H 19430
D −5.90
Z 43930
H 19430
D −5.90
Z 43930
H 19430
D −5.90
Z 43930
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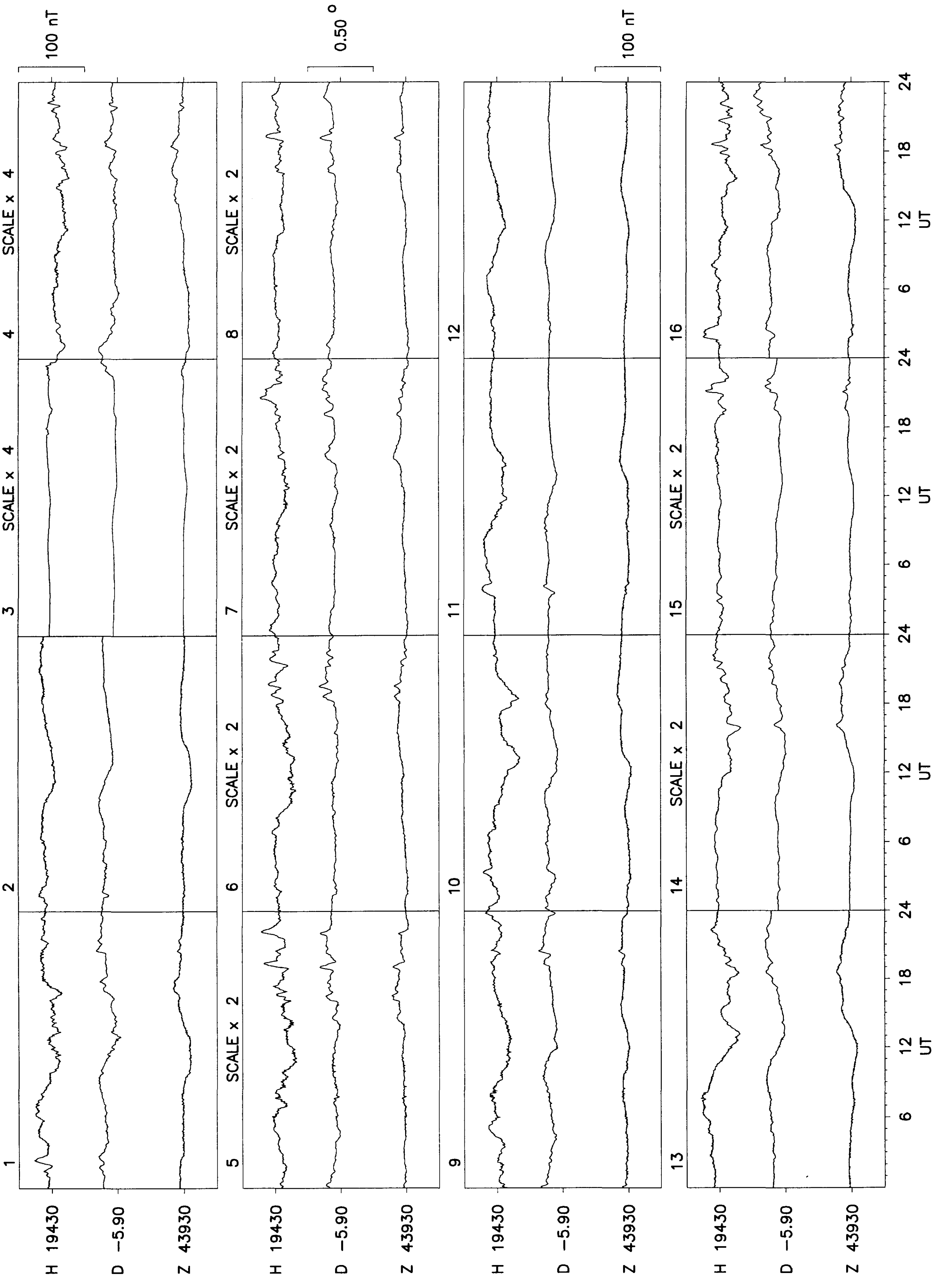
UT


100 nT
0.50 °
100 nT
SCALE x 4
SCALE x 2
H 19430
D −5.90
Z 43930
UT
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11
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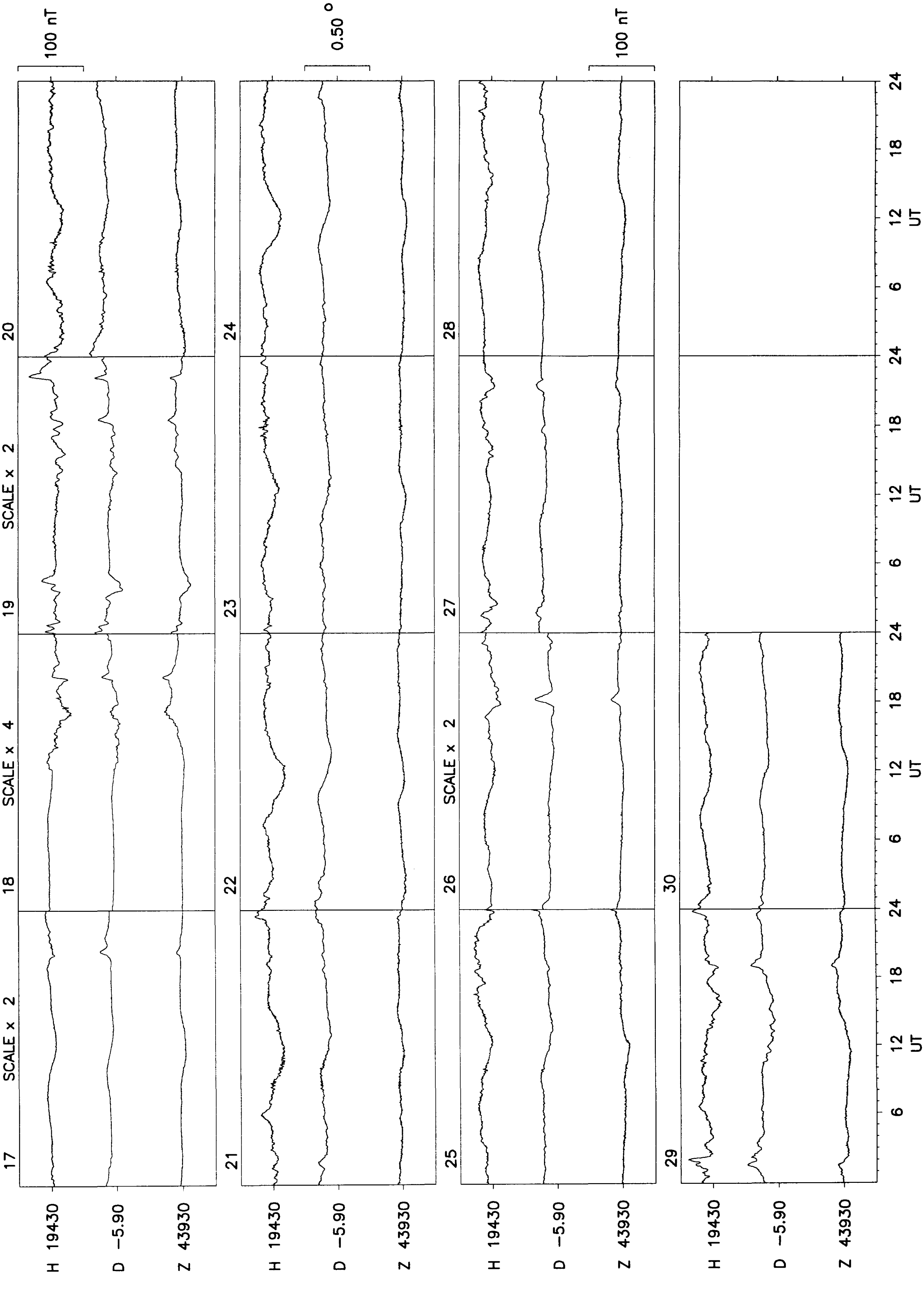

100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 4
SCALE x 2
SCALE x 2
17
18
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20
21
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24
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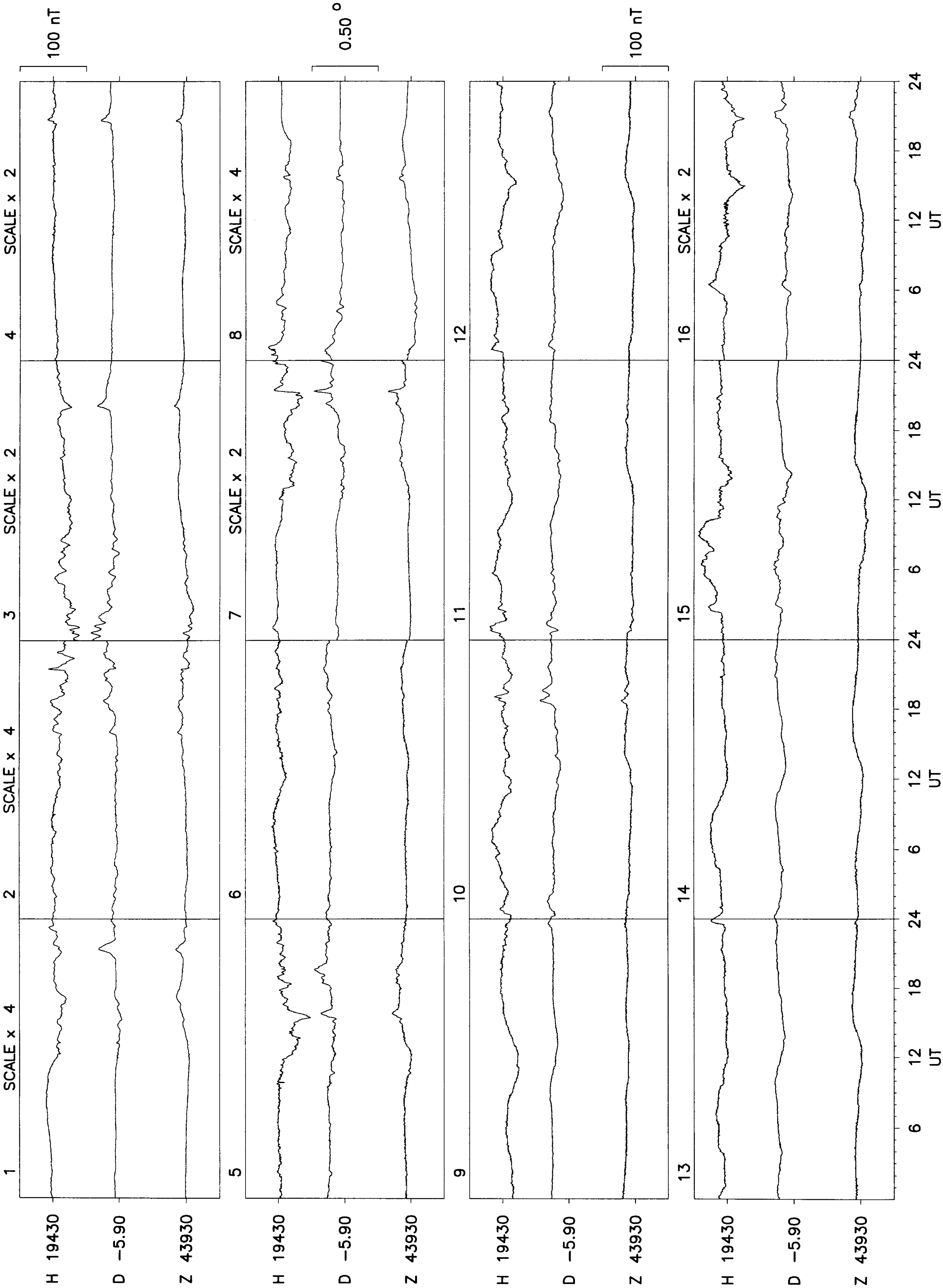
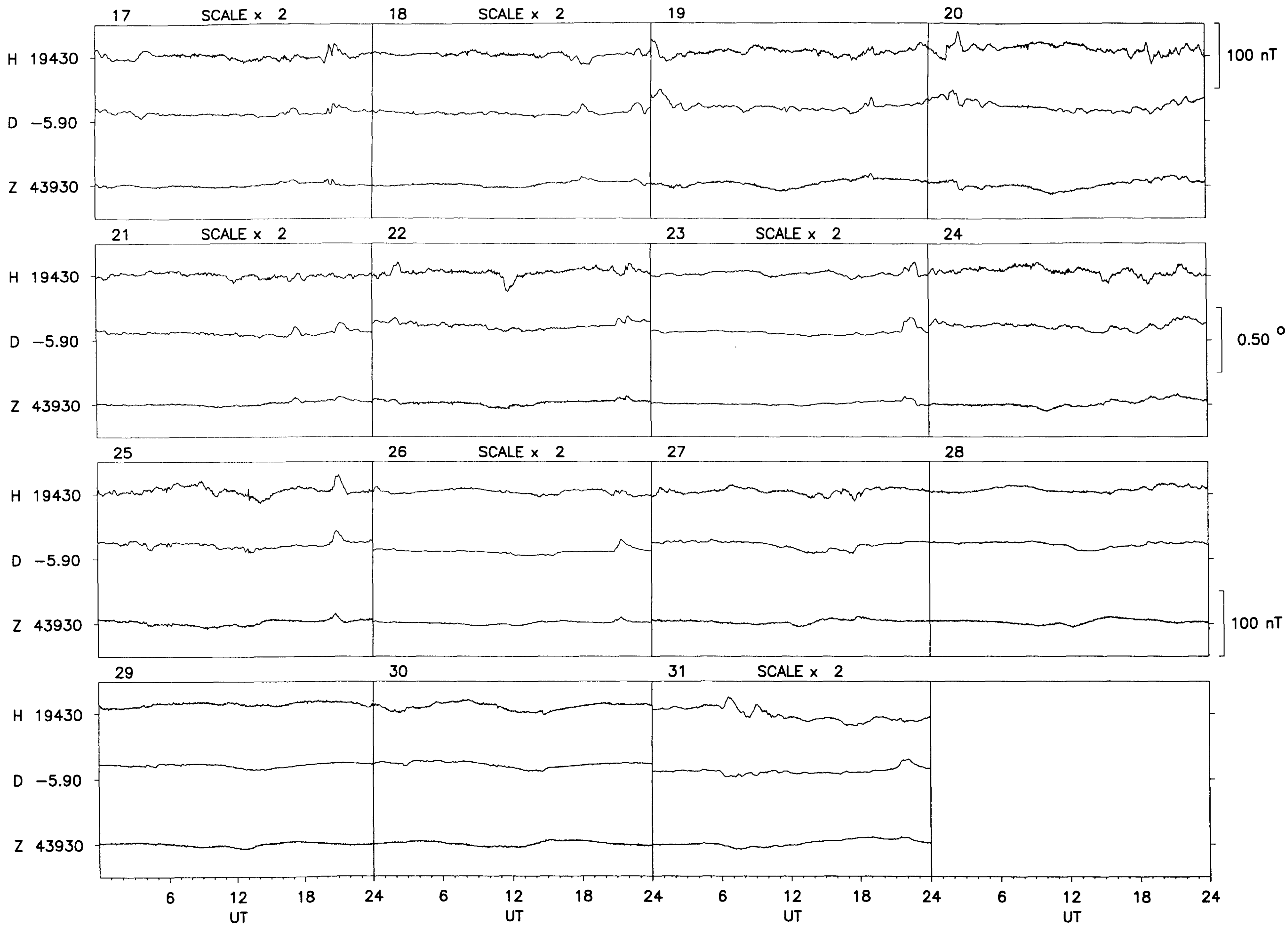
26
27
28
29
30
H 19430
D −5.90
Z 43930
6
12
18
24
UT

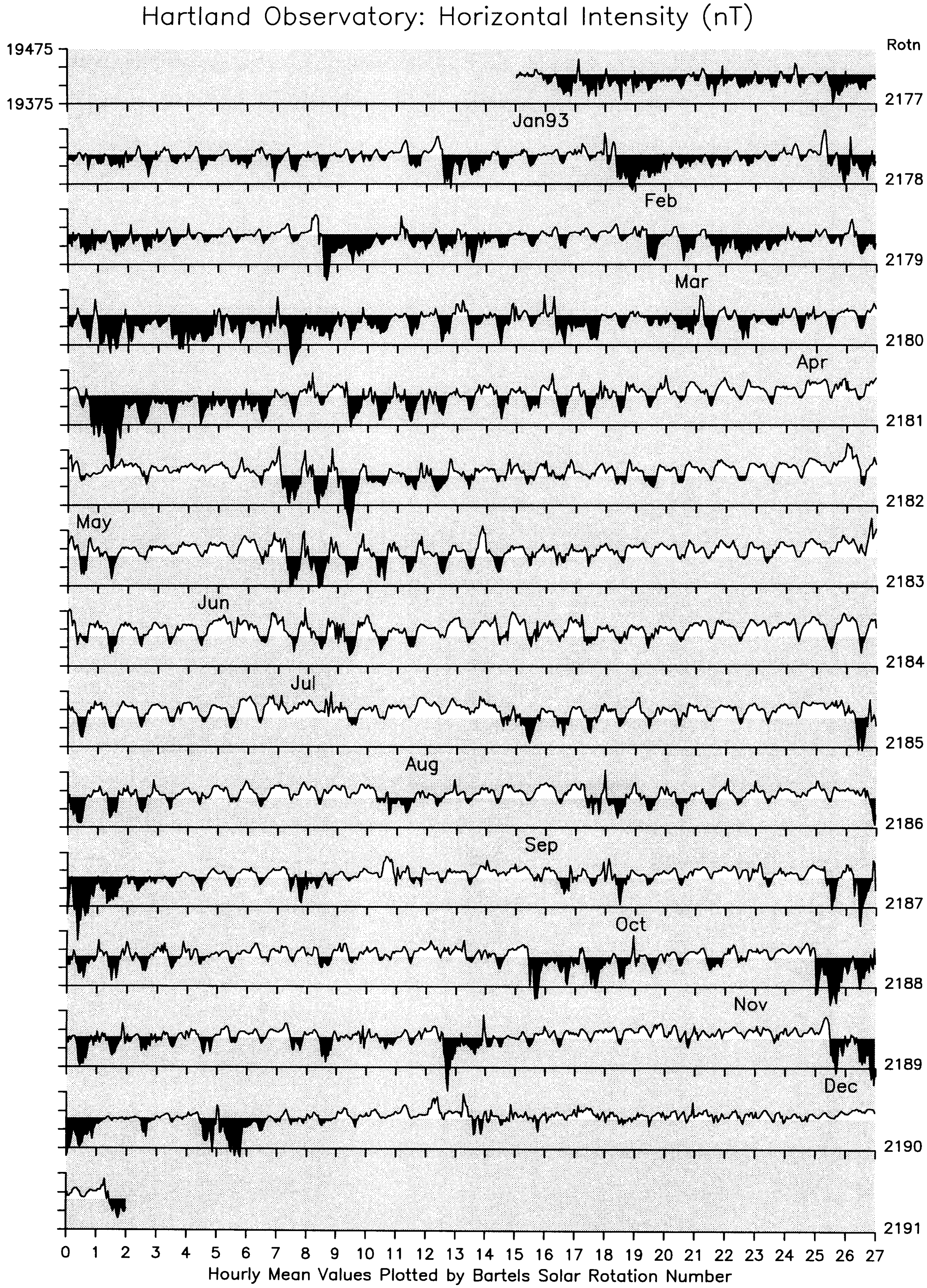


Hartland December 1993

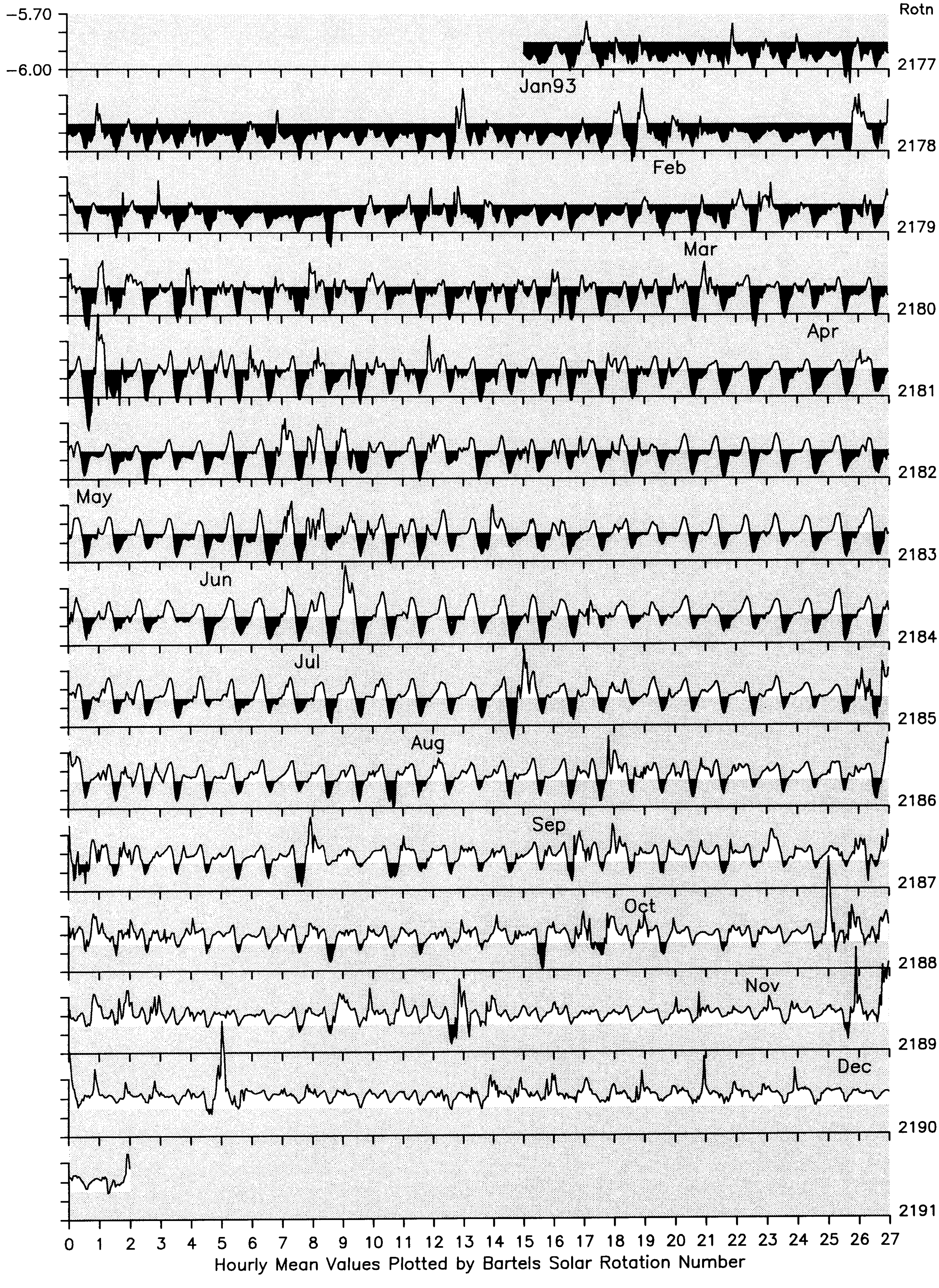
HA 12 93

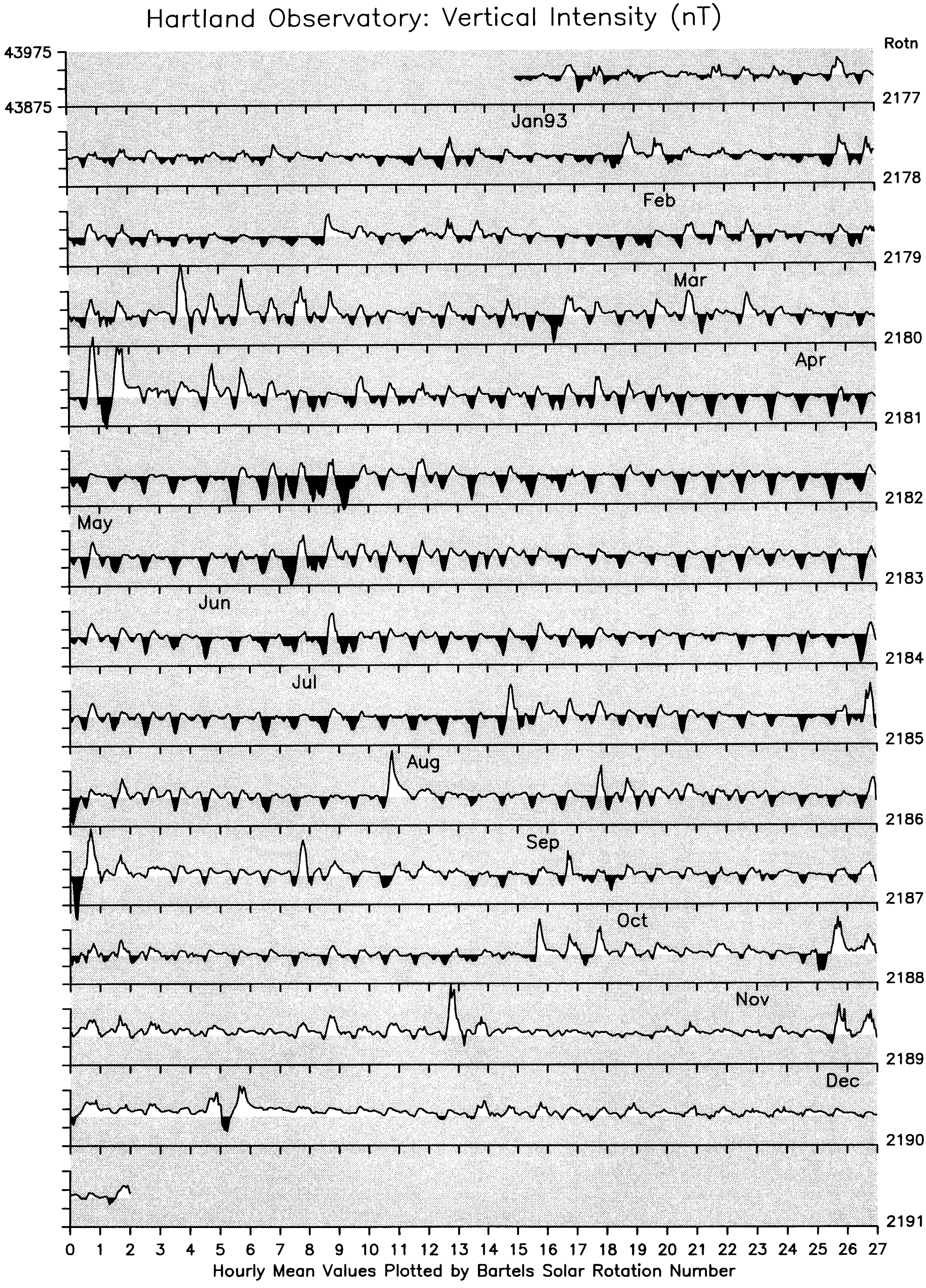

17
SCALE x 2
18
SCALE x 2
19
20
21
SCALE x 2
22
23
SCALE x 2
24
25
26
SCALE x 2
27
28
29
30
31
SCALE x 2
H 19430
D −5.90
Z 43930
100 nT
0.50 °
100 nT
6
12
18
24
UT

HA 12 93

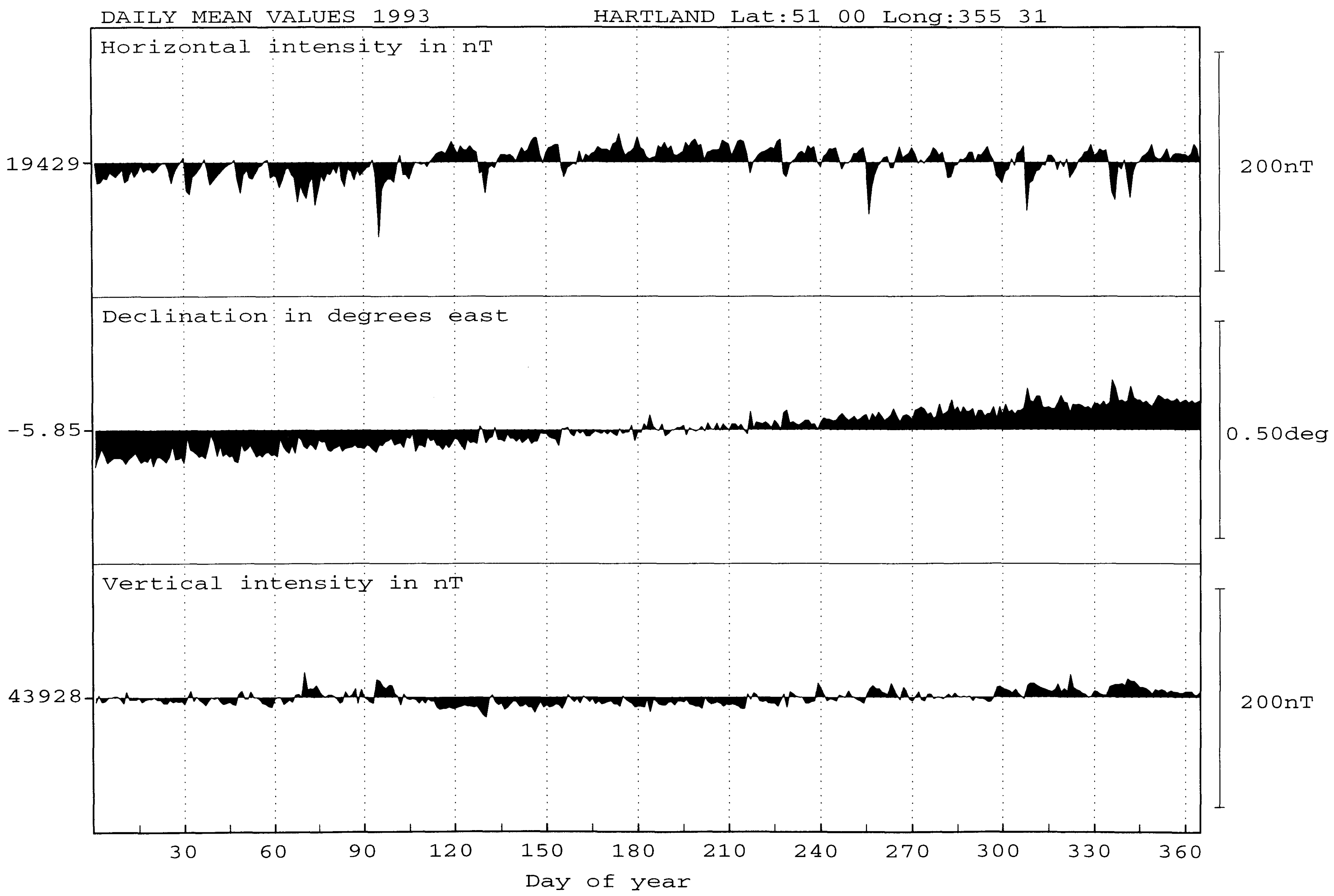

Hartland Observatory: Horizontal Intensity (nT)
19475
19375
Rotn
2177
Jan93
2178
Feb
2179
Mar
2180
Apr
2181
2182
May
2183
Jun
2184
Jul
2185
Aug
2186
Sep
2187
Oct
2188
Nov
2189
Dec
2190
2191
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

Hartland Observatory: Declination (degrees)





Hartland Observatory: Vertical Intensity (nT)
43975
43875
Rotn
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
Jan93
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number


DAILY MEAN VALUES 1993
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
19429
200nT
Declination in degrees east
-5.85
0.50deg
Vertical intensity in nT
43928
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Hartland 1993

Month	D		H	I		X	Y	Z	F
Jan	-5	55.1	19420	66	9.0	19316	-2002	43926	48027
Feb	-5	54.3	19420	66	9.0	19317	-1998	43926	48027
Mar	-5	53.6	19414	66	9.5	19311	-1993	43930	48029
Apr	-5	53.1	19424	66	8.7	19322	-1992	43927	48030
May	-5	52.4	19435	66	7.8	19333	-1989	43920	48028
Jun	-5	51.7	19438	66	7.7	19336	-1985	43924	48033
Jul	-5	50.9	19441	66	7.5	19340	-1981	43922	48032
Aug	-5	50.3	19436	66	7.9	19335	-1977	43926	48034
Sep	-5	49.3	19430	66	8.5	19330	-1971	43931	48036
Oct	-5	48.7	19430	66	8.4	19330	-1967	43930	48035
Nov	-5	47.7	19429	66	8.6	19330	-1962	43934	48038
Dec	-5	47.0	19430	66	8.6	19331	-1958	43936	48041
Annual	-5	51.2	19429	66	8.4	19328	-1981	43928	48033

D and I are given in degrees and decimal minutes
H, X, Y, Z and F are given in nanoteslas

Hartland Observatory K Indices 1993

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2322 2223	4333 3534	2124 4344	1211 2333	3312 1010	2111 2210	3424 4244	2111 1211	1110 1120	5334 2333	3223 3333	2114 3546
2	3334 3344	4432 3442	2333 3453	1121 1121	0111 1232	1111 3221	3324 4345	1100 1121	1011 2232	1112 2342	2211 1011	4333 3556
3	5433 3454	1211 1144	4333 3554	2101 1122	2122 3311	3322 3432	5441 3333	2112 2322	3332 4465	0111 1232	1011 2236	5442 3253
4	5334 4445	3111 2223	5432 2331	2111 5467	1110 2311	4554 4454	3212 1322	2232 4555	4343 3424	0111 1242	6545 4565	2112 1243
5	3323 3233	2111 1223	3221 1112	5654 5453	1121 3101	5443 4453	2411 1211	4432 1331	4221 3223	1001 1233	4344 4455	1012 2442
6	3222 3333	1211 1122	1122 2242	2212 3225	3221 2332	3332 2443	0113 1122	1233 3432	3223 3242	4431 1123	3243 4454	2111 2122
7	2323 3465	3443 3454	3531 2254	2231 1334	1221 3444	3234 4434	3221 2231	3422 2344	1321 2213	2110 2111	3223 3444	3121 4355
8	3221 2344	5433 3555	3332 3445	3244 4454	5343 4445	3332 3342	3333 3432	2232 1211	4212 1223	2242 3223	4223 3354	6533 4443
9	4232 3334	4334 3444	5554 4435	3221 2545	4543 4454	3111 1223	3422 4533	3323 3332	1111 1222	3445 3345	3323 2133	1000 0012
10	3343 4311	2132 3352	5311 3213	4331 3333	4445 4434	0111 1456	2222 3243	1113 2322	1111 1211	3443 4244	3322 3332	2111 2242
11	2113 5445	4322 3345	2134 5645	2212 3223	1211 2111	4221 2232	3433 2421	2201 1111	3112 2223	4334 4534	1311 2110	3211 1221
12	4222 2332	4333 2214	5332 2454	4531 2122	2323 2344	1223 3223	2212 2322	1222 2212	2121 2445	4333 4333	1111 1111	2112 2212
13	2112 3425	4212 2223	4432 3443	2455 4352	4210 1243	2343 3233	3332 3322	1111 1211	5654 5554	3321 2233	1111 3333	1101 1013
14	3423 4334	2212 1121	3234 3444	3322 1434	2313 3322	1213 2322	1110 1211	1001 1221	4343 3433	4222 3211	2222 2443	2101 1111
15	3322 2334	1111 2111	4244 3445	3332 2255	2222 3443	2321 1111	1211 2222	1112 2444	3332 3232	1111 1101	3211 2235	2233 2111
16	2321 2223	1121 2110	3344 3553	3442 2433	3432 2223	1121 1111	1111 1211	4455 4566	1111 2231	1111 1223	3221 2333	2333 4454
17	4233 2222	2334 6531	4324 3244	1122 2432	3421 3355	1111 2222	1010 1111	5422 3231	1111 1111	3311 1223	3111 1143	3422 3443
18	2212 2224	1113 3344	4333 3223	3434 3331	1111 3223	1110 1311	1111 2221	3333 3433	1111 1111	2311 1212	2111 5564	2232 3444
19	4323 2355	3121 2121	1112 2431	2112 2332	1332 3341	1221 1222	1212 2222	3322 2343	2111 2111	3311 1233	5522 4455	4222 2232
20	3133 4411	3334 3235	3334 3434	3432 3432	1231 2221	1221 2211	1124 2444	3122 1221	1113 3445	2111 1122	3222 2111	4322 2233
21	3311 2212	2233 3554	3334 5333	4343 3544	1111 1121	1100 1110	3322 3322	2111 1111	5210 2332	1211 1111	3222 1113	3223 3444
22	1111 1133	3353 3434	4244 3444	4222 2445	1111 1221	1111 1132	3322 2223	1112 2123	2311 1112	4422 2234	2111 1121	3223 3113
23	3101 1111	3312 2321	3122 2124	2212 1244	0111 1111	3213 3453	3211 2211	1111 1111	0001 4235	2342 2232	2221 2222	3212 2325
24	1223 2242	2212 2112	4564 4434	4122 2321	1111 1111	3443 4533	1111 2321	0112 2112	4132 3344	4222 1332	1211 1112	2222 2333
25	0012 5465	1221 2210	3233 3332	2232 2123	1100 1110	3243 3433	3211 1111	2001 1212	2213 3333	2225 5543	1111 1223	2323 3133
26	5343 3342	1111 2312	1212 2143	1111 2221	0111 1222	2221 2222	1211 1311	2111 2222	2322 2212	2121 2445	4222 3453	3111 2234
27	2322 2333	1011 1013	3223 3434	1110 1212	2333 3333	2212 1221	2112 3433	3112 4543	3221 2232	4533 4454	3111 1223	2111 1321
28	1322 1121	3333 3322	4221 1345	1111 2221	3424 3443	1111 2111	3312 2212	2213 3333	1111 2333	3233 3235	1011 2212	1011 1121
29	1111 1123		4431 1113	1112 3344	3123 1222	2223 3322	2111 4553	3322 3123	2123 3554	4211 2313	4222 2343	1111 1111
30	3321 2224		3233 4533	4221 2232	1211 2220	3221 1433	3221 1111	1111 1112	4322 1135	2111 1101	3011 1111	2211 1100
31	5444 4455		4221 2223		1111 3221		3312 2121	2211 2121		1111 2433		2244 2334

DAILY aa INDICES

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	31	45	36	16	12	7	42	6	5	38	21	54
2	48	32	38	8	11	11	44	6	12	17	9	64
3	54	17	46	7	17	27	31	11	48	10	27	47
4	58	14	30	73	9	78	16	40	41	13	94	16
5	26	13	12	87	11	61	12	29	23	11	56	20
6	25	10	19	25	20	34	11	30	24	20	49	10
7	45	47	36	22	34	40	13	33	14	7	33	41
8	27	62	46	44	69	23	31	14	14	35	32	77
9	29	44	80	40	76	12	29	26	9	60	19	6
10	39	31	23	34	66	35	22	14	8	45	21	17
11	43	34	71	15	8	19	37	6	12	47	11	13
12	20	26	41	24	32	21	14	13	30	33	7	11
13	26	20	46	60	19	26	24	7	109	18	18	7
14	36	11	38	27	22	18	6	5	43	15	29	8
15	25	9	72	47	26	10	10	23	23	7	26	23
16	22	11	53	30	24	7	7	89	10	11	20	46
17	22	60	37	25	40	9	5	28	7	14	14	32
18	23	28	29	32	13	7	9	31	7	13	55	32
19	46	13	19	20	26	11	9	23	8	16	54	18
20	33	40	38	35	15	8	27	14	39	9	16	27
21	15	48	45	45	6	4	24	9	22	9	14	35
22	12	51	40	34	8	9	22	12	12	32	9	21
23	10	17	20	21	6	28	11	6	20	22	12	23
24	21	12	71	19	6	47	10	8	33	20	10	24
25	50	12	27	18	4	32	8	6	22	66	14	21
26	37	11	17	11	7	11	9	10	18	31	35	18
27	19	10	28	8	27	10	18	35	17	61	14	14
28	13	31	37	8	35	7	13	24	17	37	9	7
29	9		22	21	17	21	30	18	40	19	25	7
30	23		39	23	9	18	11	7	29	7	9	9
31	79		19		10		12	9		19		36
Monthly Mean Value	31.1	27.1	37.9	29.2	22.1	21.7	18.2	19.1	23.8	24.6	25.4	25.2

Annual mean value for 1993 = 25.4

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
7	1	11	09	SI*	B	-15	2.0	3
19	1	10	23	SI*	B	23	1.7	-5
19	1	19	22	SI*	C	27		10
3	2	18	31	SSC	C	-19	1.9	6
17	2	03	01	SSC*	A	37	-5.1	+6/-7
17	2	13	09	SSC	B	-32	4.3	-3
27	2	22	19	SSC	B	16	-0.3	3
8	3	21	37	SSC*	A	33	-1.3	9
11	3	06	40	SSC*	B	-8	0.4	-2
15	3	05	26	SSC*	B	-9	-2.8	-6
21	3	08	58	SI*	C	19	-1.9	7
23	3	21	55	SSC*	A	39	-0.8	12
26	3	16	22	SI	C	-9	0.9	
4	4	14	34	SSC*	B	37	1.5	-2
29	4	11	45	SSC*	C	7	-1.5	
10	6	17	27	SSC*	B	29	-1.5	5
15	8	15	14	SSC*	C	10	-0.8	4
23	9	10	27	SSC*	C	-3	0.5	
23	9	12	30	SSC*	A	26	-3.3	-3
3	11	17	55	SSC*	B	12	1.4	4
18	11	12	12	SSC*	A	20	-3.4	-2
7	12	12	03	SSC	B	12	-0.3	3

Notes

A * indicates that the principal impulse was preceded by a smaller reversed impulse.

The quality of the event is classified as follows :

A = very distinct

B = fair, ordinary, but unmistakable

C = doubtful

The amplitudes given are for the first chief movement of the event.

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
26	4	12	49	12	52	12	56	11	0.9	

Notes

The amplitudes given are for the first chief movement of the event.

Annual Values of Geomagnetic Elements

Abinger

	Year	D		H	I		X	Y	Z	F
	1925.5	-13	22.7	18597	66	35.2	18092	-4303	42946	46800
	1926.5	-13	10.4	18581	66	36.3	18092	-4234	42947	46794
	1927.5	-12	58.4	18575	66	36.2	18101	-4170	42932	46778
	1928.5	-12	47.0	18564	66	37.2	18104	-4108	42941	46782
	1929.5	-12	35.8	18555	66	37.2	18108	-4047	42918	46758
	1930.5	-12	24.6	18542	66	38.2	18109	-3985	42924	46757
	1931.5	-12	13.7	18543	66	38.1	18122	-3928	42923	46757
	1932.5	-12	2.6	18536	66	39.1	18128	-3868	42940	46770
	1933.5	-11	51.7	18532	66	39.4	18136	-3809	42942	46770
	1934.5	-11	41.1	18533	66	39.7	18149	-3754	42955	46782
	1935.5	-11	30.3	18527	66	40.9	18155	-3695	42981	46805
	1936.5	-11	20.0	18524	66	41.8	18163	-3640	43007	46827
	1937.5	-11	10.4	18522	66	42.7	18171	-3589	43031	46848
	1938.5	-11	1.4	18522	66	43.2	18180	-3542	43050	46865
	1939.5	-10	51.9	18528	66	43.5	18196	-3492	43074	46890
	1940.5	-10	43.0	18533	66	43.9	18210	-3446	43099	46915
	1941.5	-10	33.8	18539	66	44.3	18225	-3399	43128	46944
	1942.5	-10	24.8	18554	66	43.9	18248	-3354	43146	46966
	1943.5	-10	16.2	18556	66	44.5	18259	-3308	43172	46991
	1944.5	-10	7.8	18566	66	44.3	18277	-3265	43189	47010
	1945.5	-9	59.5	18573	66	44.3	18291	-3223	43207	47030
	1946.5	-9	51.1	18569	66	45.4	18295	-3177	43235	47054
	1947.5	-9	43.1	18577	66	45.2	18310	-3136	43246	47067
	1948.5	-9	35.4	18593	66	44.4	18333	-3098	43255	47082
	1949.5	-9	27.5	18607	66	44.0	18354	-3058	43273	47104
	1950.5	-9	19.7	18628	66	43.0	18382	-3019	43288	47126
	1951.5	-9	12.2	18648	66	42.1	18408	-2983	43305	47149
	1952.5	-9	4.7	18670	66	41.0	18436	-2946	43316	47168
	1953.5	-8	57.5	18695	66	39.5	18467	-2911	43321	47183
	1954.5	-8	50.9	18720	66	38.1	18497	-2879	43332	47203
	1955.5	-8	43.6	18738	66	37.4	18521	-2843	43348	47225
	1956.5	-8	36.8	18750	66	37.4	18539	-2808	43376	47255
	1957.1	-8	32.9	18755	66	37.6	18547	-2788	43394	47274

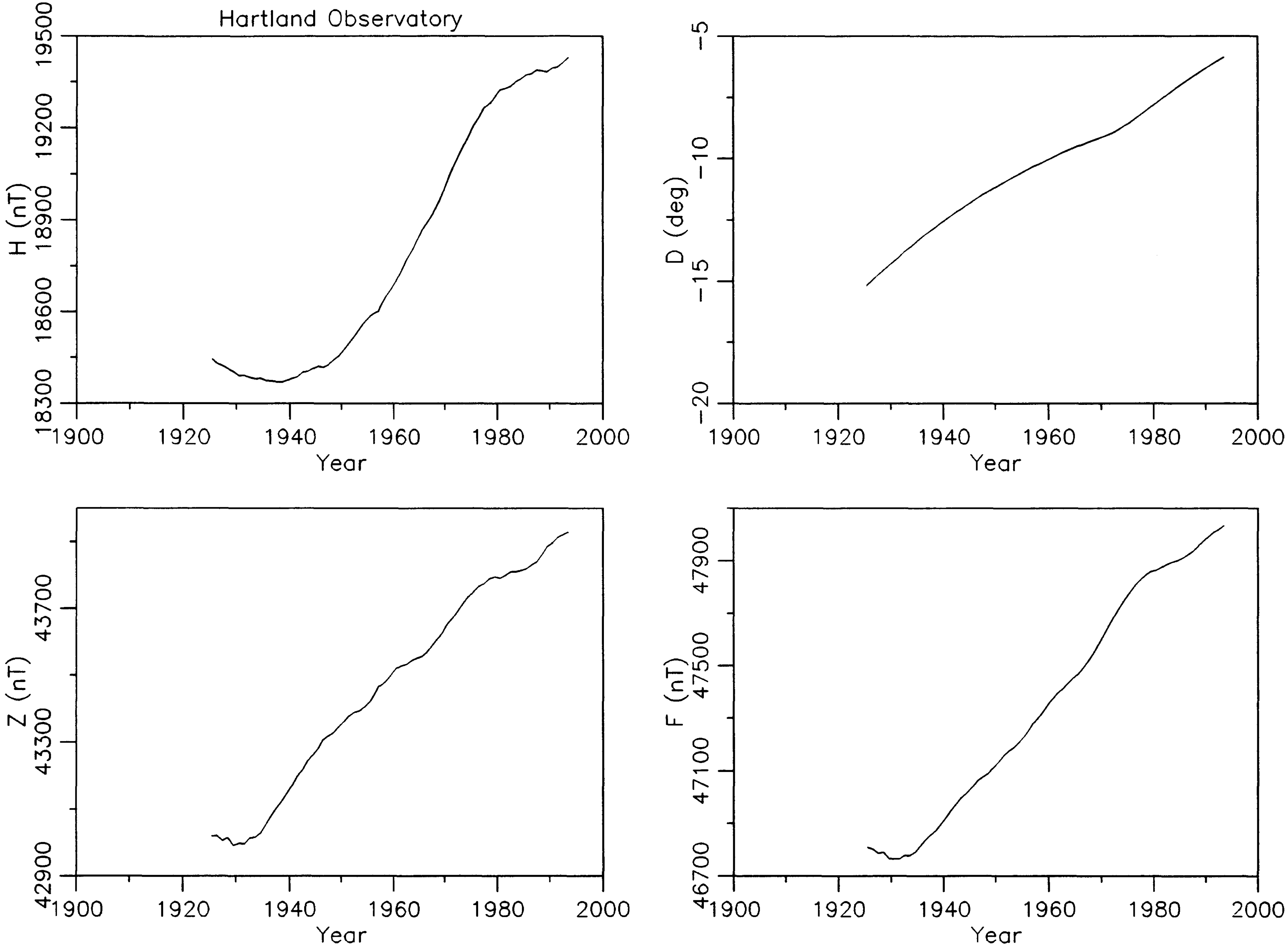
Hartland

	Year	D		H	I		X	Y	Z	F
Note 1		-1	-46.6	-146	0	11.4	-247	-542	56	-6
	1957.5	-10	17.2	18627	66	47.7	18328	-3326	43451	47275
	1958.5	-10	11.0	18655	66	46.3	18361	-3298	43465	47299
	1959.5	-10	5.0	18681	66	45.1	18392	-3271	43484	47327
	1960.5	-9	58.8	18707	66	43.9	18424	-3242	43504	47356
	1961.5	-9	53.0	18744	66	41.7	18466	-3217	43512	47378
	1962.5	-9	46.9	18779	66	39.5	18506	-3190	43517	47396
	1963.5	-9	40.6	18807	66	37.9	18539	-3161	43528	47417
	1964.5	-9	35.2	18840	66	36.0	18577	-3138	43535	47437
	1965.5	-9	30.1	18872	66	34.0	18613	-3115	43540	47454
	1966.5	-9	25.1	18897	66	32.7	18642	-3092	43554	47477
	1967.5	-9	20.3	18923	66	31.5	18672	-3071	43573	47505
	1968.5	-9	15.5	18956	66	29.9	18709	-3050	43592	47535
	1969.5	-9	11.1	18994	66	27.9	18750	-3032	43611	47568
	1970.5	-9	6.5	19033	66	26.1	18793	-3013	43636	47606
	1971.5	-9	1.1	19075	66	23.8	18839	-2990	43655	47640
	1972.5	-8	55.3	19110	66	22.1	18879	-2964	43676	47674
	1973.5	-8	48.2	19144	66	20.5	18918	-2930	43697	47707
	1974.5	-8	40.4	19175	66	19.1	18956	-2892	43719	47739
	1975.5	-8	32.3	19212	66	17.0	18999	-2852	43733	47767
	1976.5	-8	23.1	19240	66	15.7	19034	-2806	43749	47793
	1977.5	-8	13.7	19271	66	13.9	19073	-2758	43758	47813
	1978.5	-8	03.6	19286	66	13.3	19095	-2704	43773	47833
	1979.5	-7	53.5	19309	66	12.0	19127	-2651	43778	47847
Note 2		0	0.0	0	0	-0.2	0	0	-6	-5
	1980.5	-7	43.8	19330	66	10.3	19154	-2600	43768	47846

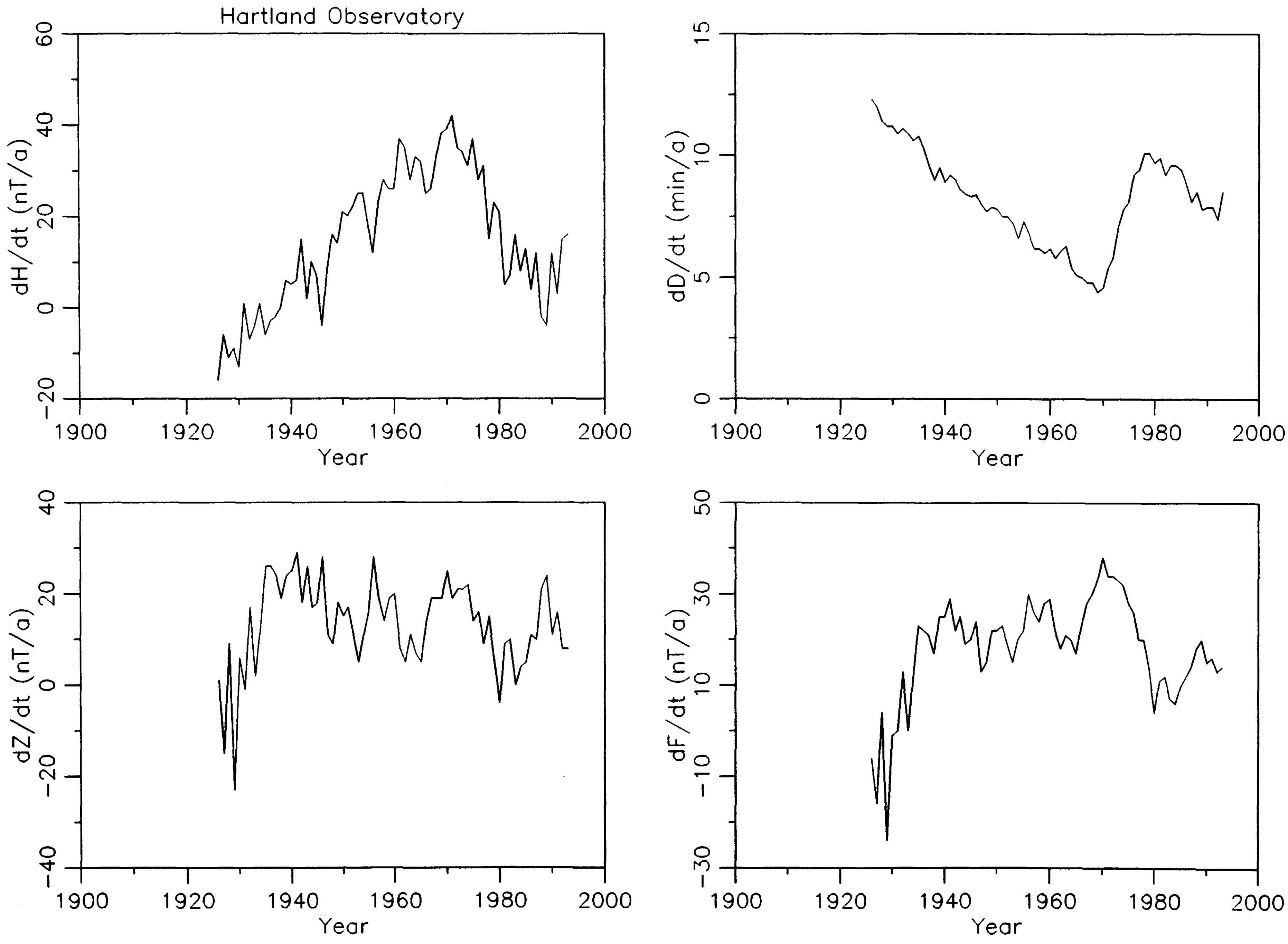
	Year	D		H	I		X	Y	Z	F
	1981.5	-7	33.9	19335	66	10.2	19167	-2546	43777	47857
	1982.5	-7	24.7	19342	66	10.1	19180	-2495	43787	47869
	1983.5	-7	15.1	19358	66	9.0	19203	-2443	43787	47876
	1984.5	-7	5.5	19366	66	8.6	19218	-2391	43791	47882
	1985.5	-6	56.1	19379	66	7.9	19237	-2340	43796	47892
	1986.5	-6	47.3	19383	66	8.0	19247	-2291	43807	47904
	1987.5	-6	39.2	19395	66	7.4	19264	-2247	43817	47918
	1988.5	-6	30.7	19393	66	8.2	19267	-2199	43838	47936
	1989.5	-6	22.9	19389	66	9.1	19269	-2155	43862	47956
Note 3		0	0.0	-6	0	1.1	-6	1	23	19
	1990.5	-6	15.0	19395	66	9.7	19280	-2111	43896	47990
	1991.5	-6	7.1	19398	66	10.0	19288	-2067	43912	48006
	1992.5	-5	59.7	19413	66	9.3	19307	-2028	43920	48019
	1993.5	-5	51.2	19429	66	8.4	19328	-1981	43928	48033

1 Site differences 1 Jan 1957 (Hartland value - Abinger value)
2 Site differences 1 Jan 1980 (new value - old value)
3 Site differences 1 Jan 1990 (new value - old value)

D and I are given in degrees and decimal minutes
All other elements are in nanoteslas



Annual mean values of H, D, Z & F at Hartland



Rate of change of annual mean values for H, D, Z & F at Hartland

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Front
Eskdalemuir Observatory

Back
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1984–93

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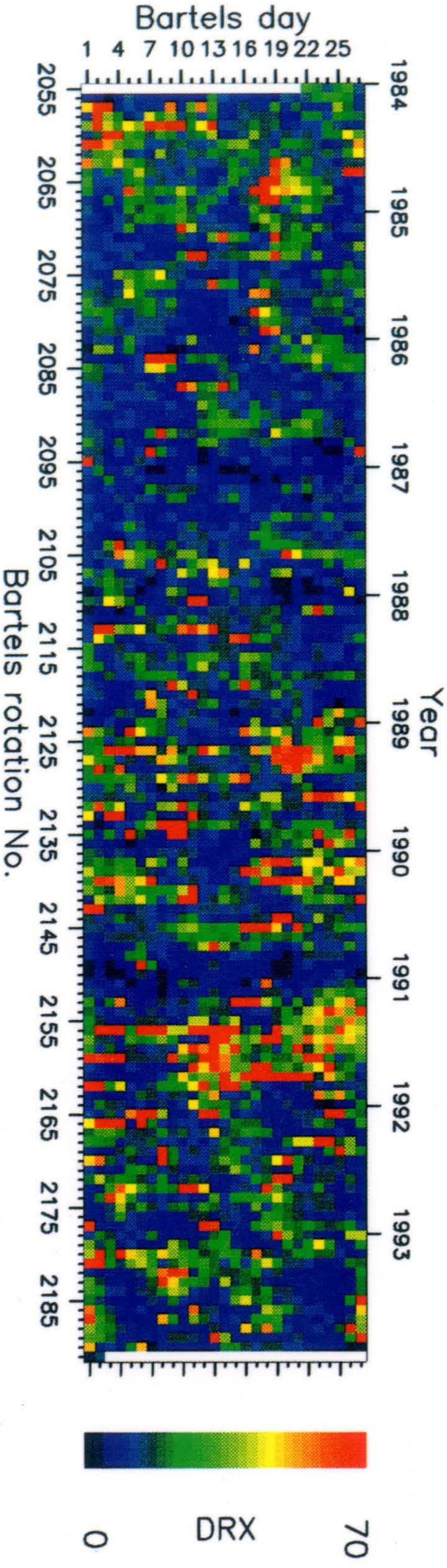

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