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Magnetic Results 1996

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES

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1 INTRODUCTION

This bulletin is a report of the measurements made between 1 January and 31 December 1996 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 1996 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°02′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°19′N, 71°26′W, computed from the 7th generation International Geomagnetic Reference Field (Barton, 1997) at epoch 1996.5.

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 100 km from Edinburgh and 25 km 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 1996.

Figure 2 is a site diagram of Eskdalemuir observatory. No major changes were made at the observatory during 1996. Routine building maintenance was carried out on the observatory buildings.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	55°19′N	57°54′N
Longitude	356°48′E	84°05′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 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 1996.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	51°00′N	54°01′
Longitude	355°31′E	80°24′
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 "$\delta D/\delta I$" 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 a Sun Workstation for processing.

Data-processing is carried out automatically on the Sun Workstation 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 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 BGS local area network is connected to the Internet which enables transfer to academic and commercial users world-wide by electronic mail. The Geomagnetism Information and Forecasting Service (GIFS) was created to provide "user-friendly" access to the data sets, and is available on the world-wide web (*http://ub.nmh.ac.uk/gifs/on_line_gifs.html*). 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 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.

There were no periods in 1996 at any of the three UK observatories in which both the ARGOS and back-up variometers failed simultaneously. Consequently the time-series of one-minute values are complete throughout the year at all three observatories.

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 1996 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. The adopted correction is derived from piecewise 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.

Lerwick (Figure 5)

Absolute measurements were made by BGS staff during service visits to the observatory in February, April, June, August 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 5 nT for H, 0.7 minutes of arc for D and 13 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.

Between the absolute measurements made on the 10th January and 13th February, a change was observed in the difference between the value of F calculated from the fluxgate data and F measured by the observatory PPM in the absolute hut. This was also observed in the difference between measurements of F made by the ARGOS PPM and the observatory PPM, while no corresponding change was seen between the fluxgate derived F and the ARGOS PPM. This implies that there was some form of step change in the magnetic field in the absolute hut. There is no record of any significant building work being carried out on the site during this time which may have given rise to this step change. The size of the step was estimated by examining the variometer baselines and adjusting them so that the difference between F calculated from the fluxgate measurements and F measured by the ARGOS PPM was approximately constant. It transpired that no step was observed in the D or H components, but a step of 6 nT in F, 8 nT in

Z and 0.5 minute of arc in I was necessary to match the 1995 baselines. This was confirmed independently by examining the difference between the observatory PPM and the ARGOS PPM, which was found to be 6 nT.

When compared with the fluxgate measurements, drifting is observed in the D and H BRMs, particularly during the summer months. It is likely that this drift is related to changes in the outside air temperature causing mechanical deformation of the coils. The steps in the BRMs at the beginning of July and August were caused by adjustments during service visits. Despite these drifts, the BRMs are still useful at times for allowing greater confidence in interpolating zero-field offsets between absolute observations. This is important because there are relatively fewer absolute observations at Lerwick than at the other UK observatories.

The table below lists the root mean squared (*rms*) differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1993-95 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1993	1.69 (31)	0.36 (33)	0.93 (30)
1994	0.87 (21)	0.25 (21)	0.66 (21)
1995	0.97 (21)	0.35 (24)	0.85 (23)
1996	1.20 (49)	0.32 (48)	1.03 (47)

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 ranges in the allocated zero-field offset corrections over the year were 8 nT for H, 1 minute of arc for D and 8 nT for Z. The temperature variation in the variometer chamber was kept to within ±0.5°C over the year. As in previous years the baselines have shown some irregular drift throughout the year, but the BRMs are stable enough to provide additional information when allocating baseline values.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1992-94 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1993	1.44 (40)	0.41 (42)	0.85 (41)
1994	1.56 (28)	0.45 (29)	0.92 (28)
1995	1.31 (44)	0.29 (42)	0.97 (45)
1996	1.05 (59)	0.38 (65)	0.98 (59)

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 5 nT for H, 0.4 minutes of arc for D and 10 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.

The BRMs have exhibited large drifts in 1996 which seemed to be related to the increase in daily mean air temperature during the summer.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1992-94 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1993	1.16 (43)	0.28 (51)	1.36 (44)
1994	1.20 (56)	0.25 (56)	0.70 (56)
1995	1.05 (44)	0.21 (46)	1.24 (43)
1996	1.06 (53)	0.20 (51)	0.80 (51)

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 Plots of the daily maximum and minimum values of H, D and Z;
e Tables of monthly and annual mean values of all geomagnetic elements;
f Tables of K indices;
g A list of rapid variations noted during the year;
h Tables of annual mean values of geomagnetic elements;
i 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. The black shading indicates when the daily mean was less than the annual mean, the white part indicates when the daily mean was greater. The plots of daily maximum and minimum values are also plotted relative to the annual means.

The ARGOS one-minute values of H, D and Z are 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 monthly and annual mean values are also calculated using only the five international quiet days and the five international disturbed days in each month.

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 complete set of K indices for each of the UK observatories are tabulated throughout the year. A summary of the occurrence of each K index in 1996 is given below (there were no intervals of missing data at any of the three observatories).

	K Index									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
LER	693	1047	738	317	107	20	4	2	0	0
ESK	433	934	846	537	152	24	2	0	0	0
HAD	86	989	1007	592	202	48	4	0	0	0

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 Provisional Atlas of Rapid Variations (IAGA, 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 (1926-96), Eskdalemuir (1911-96), Abinger (1926-56) and Hartland (1957-96). 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 directly by electronic mail or *ftp* over the Internet. For more information contact:

Data Services		
Geomagnetism Group		
British Geological Survey		
Murchison House	☎:	+44 (0) 131 667 1000
West Mains Road	Fax:	+44 (0) 131 668 4368
Edinburgh EH9 3LA	Telex:	727343 SEISED G
Scotland UK	Internet:	http://ub.nmh.ac.uk/

8 GEOMAGNETISM GROUP STAFF LIST 1996

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Grade 7	D R Barraclough
	Dr T D G Clark
	J C Riddick
SSO	Dr S Macmillan
HSO	S M Flower
	T J Harris
	E M Reader
	Dr A W P Thomson
SO	J G Carrigan
	E Clarke
	C W Turbitt
ASO	J McDonald
Eskdalemuir	
Craftsman	W E Scott
Cleaner	Mrs M Scott
Hartland	
PGS E	C R Pringle

REFERENCES

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

Barton C. 1997. International Geomagnetic Reference Field: The Seventh Generation. *Journal of Geomagnetism and Geoelectricity*, **49**, 123-148.

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

Green, C A. 1985. Geomagnetic hourly average and minute values from digital data. *BGS Geomagnetism Research Group Report 85/19.*

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

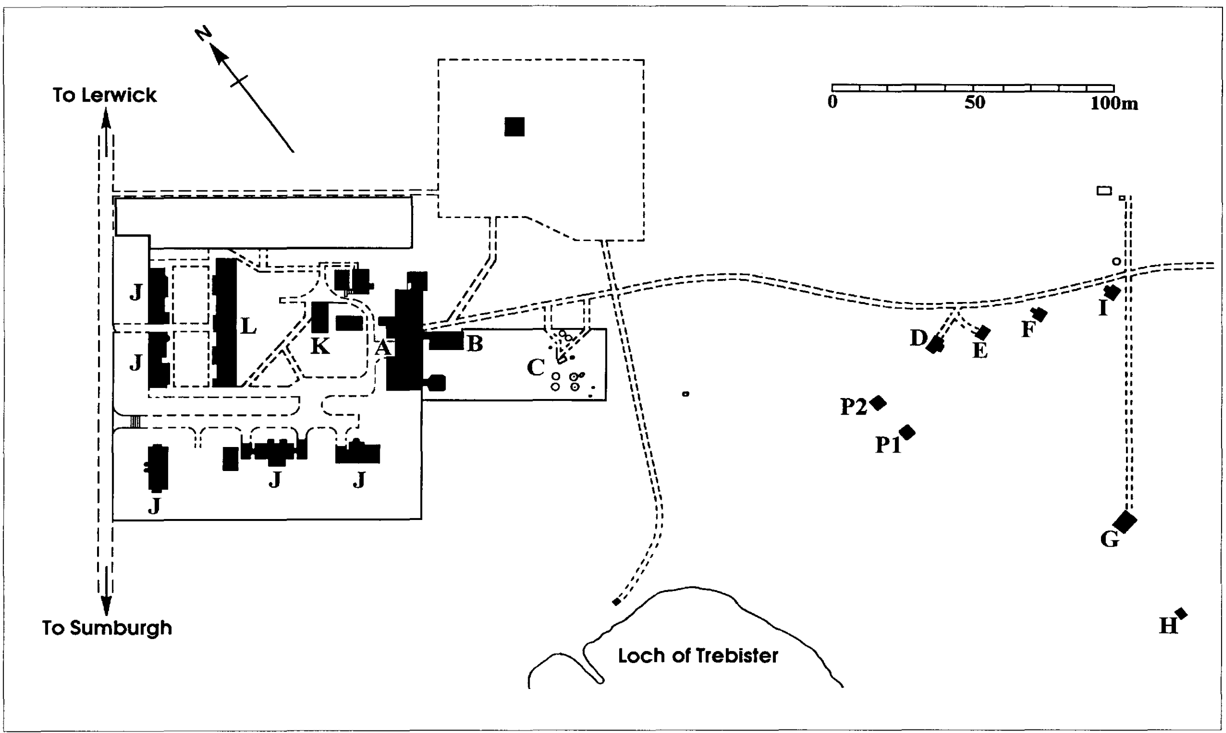
Kerridge, D J and Clark, T D G. 1991. The new standard for absolute observations at the UK geomagnetic observatories. *British Geological Survey Technical Report*, WM/91/17.

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
J	Staff houses
K	Standby generator
L	Staff hostel
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2 & δ/D/δI coils

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 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 $\pm$1°C. The meridian at the time of construction is defined on the north and south walls.

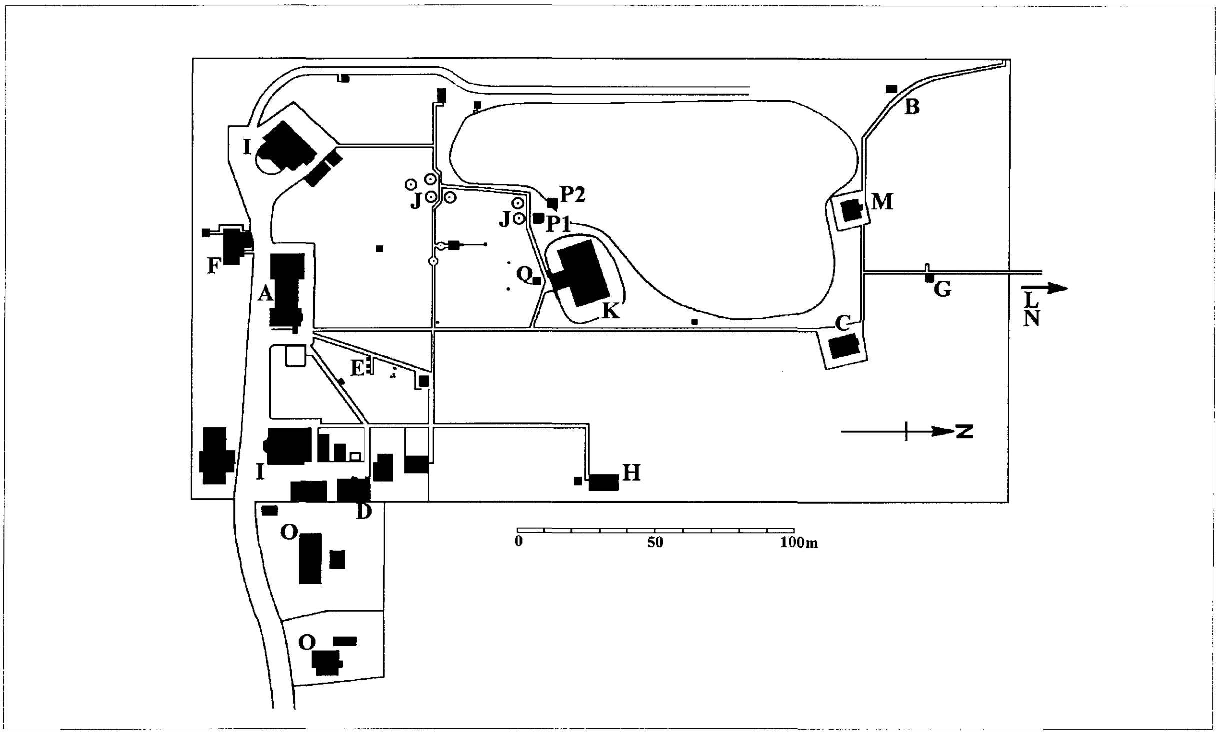
West Hut
Remote Fluxgate magnetometer transmitting via METEOSAT

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 containing remote fluxgate (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 staff housing
P1	Experimental δD/δI coils
P2	ARGOS Proton magnetometer 2 & δD/δI coils
Q	METEOSAT transmitter

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.

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

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 ±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.

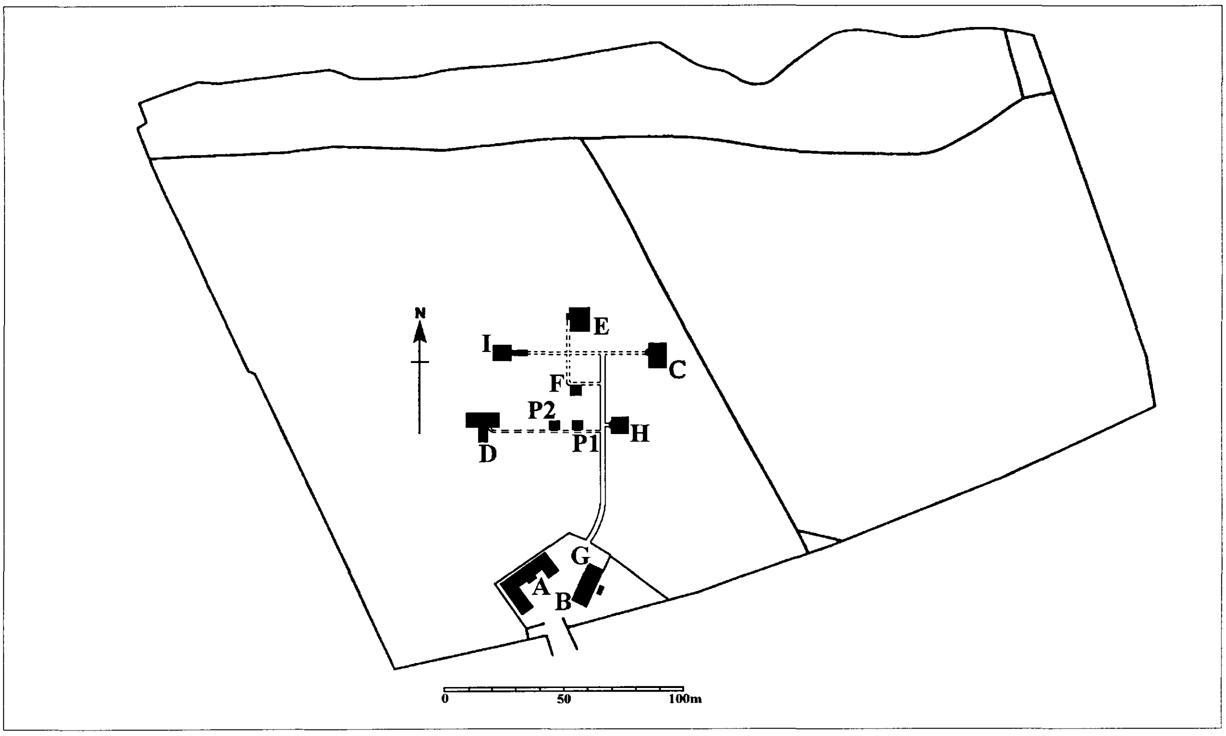
West Absolute Hut
The hut contains three instrument piers. The fixed mark is viewed from the central pillar at a bearing of 4° 36' 08" W of S through a shutter in the south wall.

The Non-Magnetic Laboratory
The laboratory is used for instrument development and testing. It contains 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 Hut 2
I	Test Hut 1
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2 & δD/ δI coils

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.

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 where the backup system and sensors are located . This is connected to a data collection platform transmitting to the METEOSAT satellite. A second fluxgate system transmits data to the GOES satellite

Variometer House
ARGOS fluxgate sensors (X,Y,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 supplied. 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

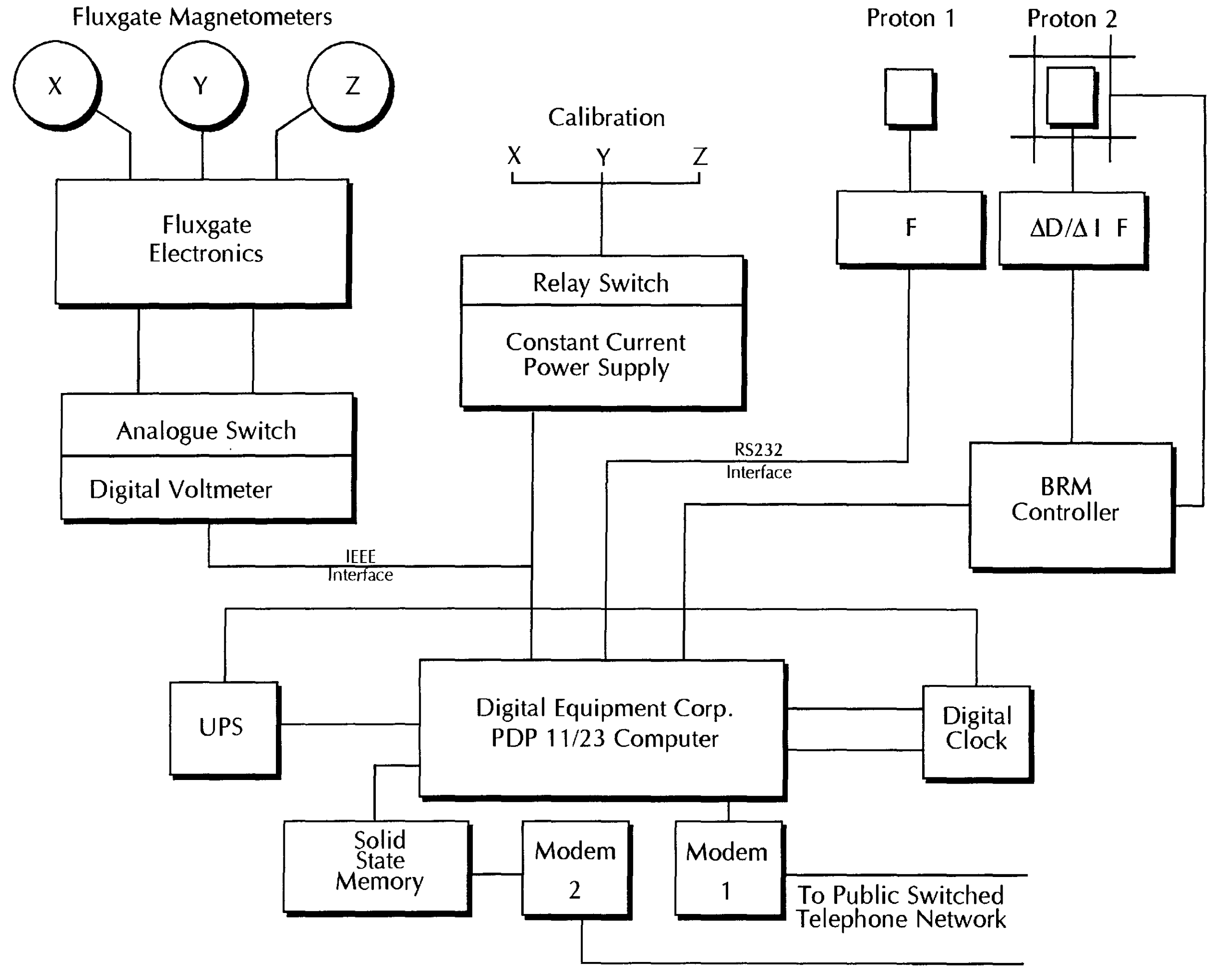


Figure 4a. Block diagram of ARGOS

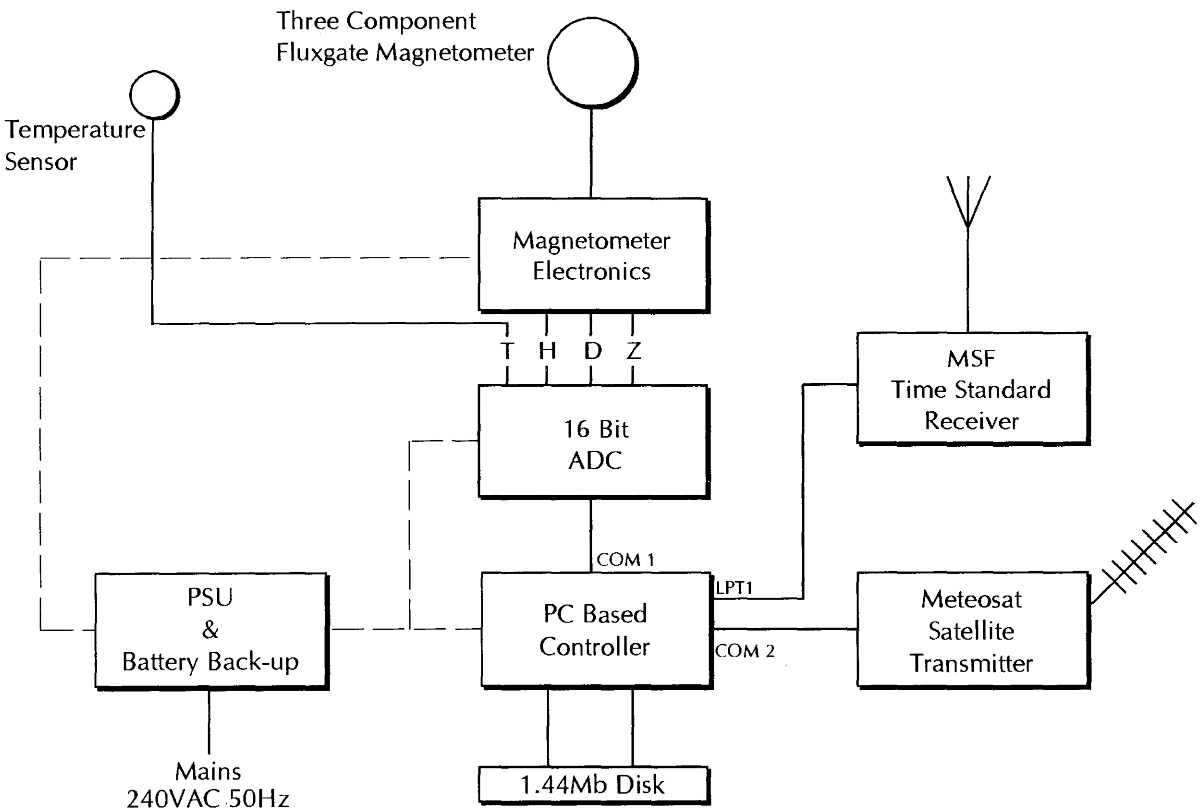


Figure 4b. Block diagram of back-up system

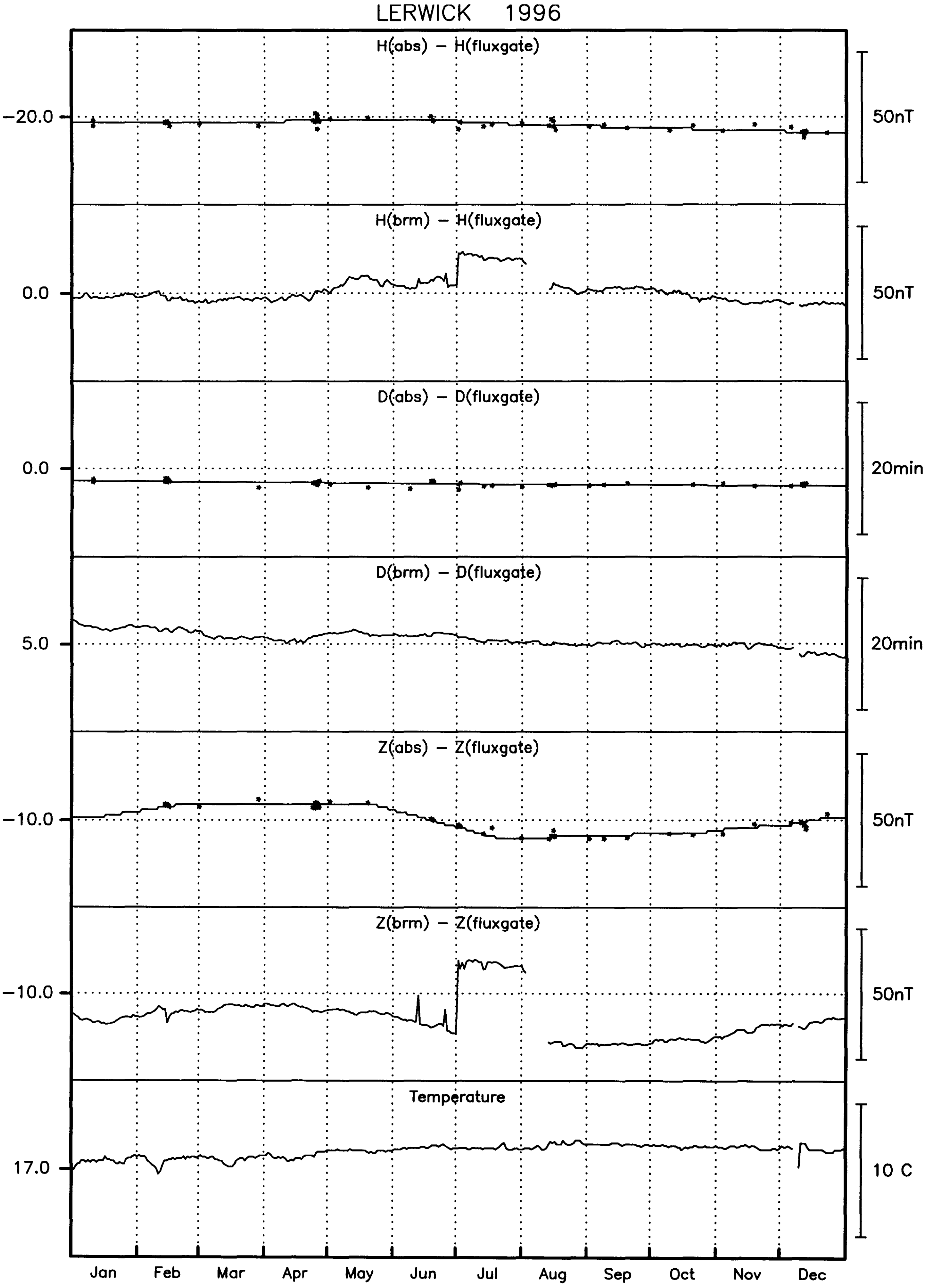


Figure 5. Zero-field corrections and BRMs, Lerwick 1996

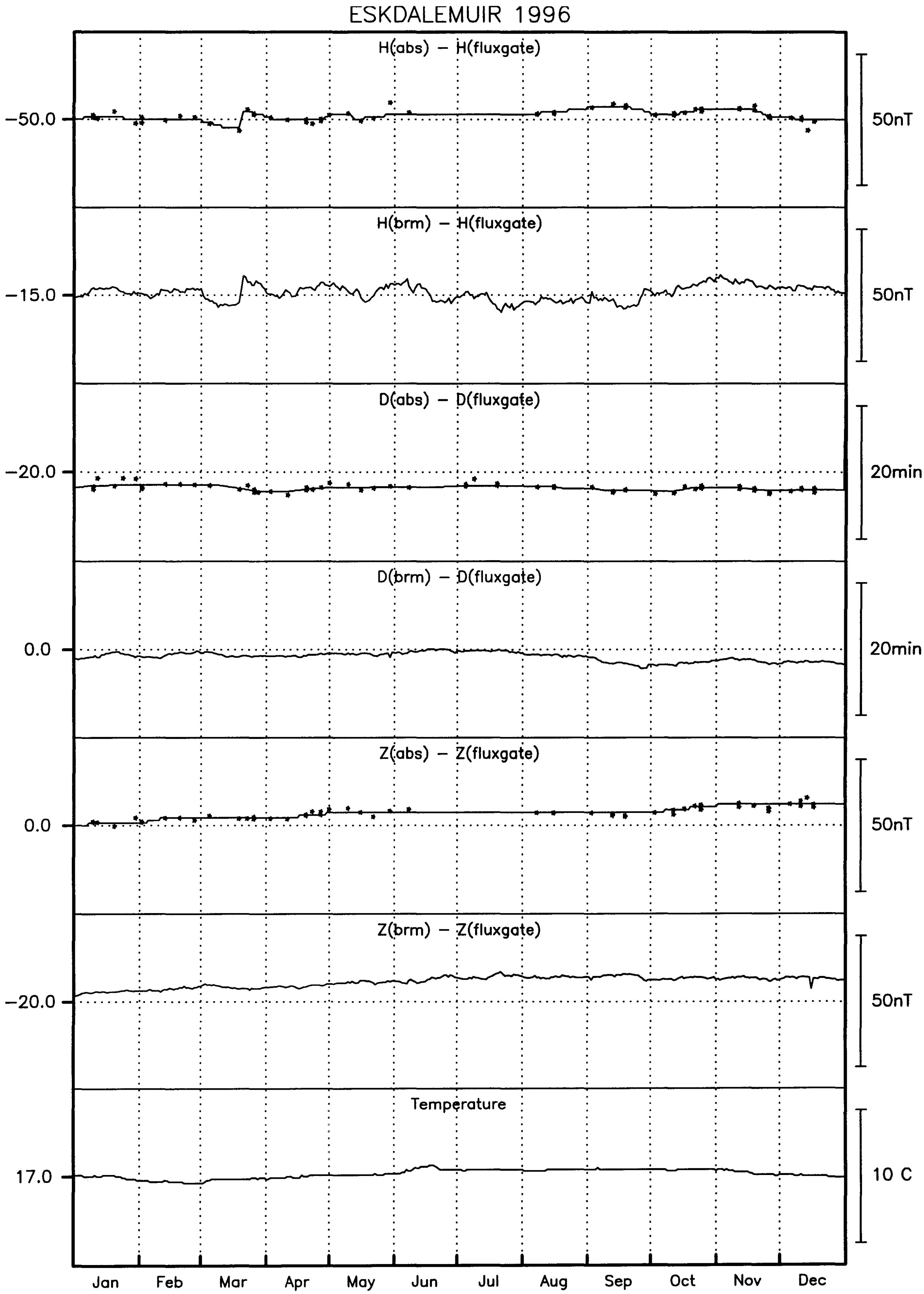


Figure 6. Zero-field corrections and BRMs, Eskdalemuir 1996

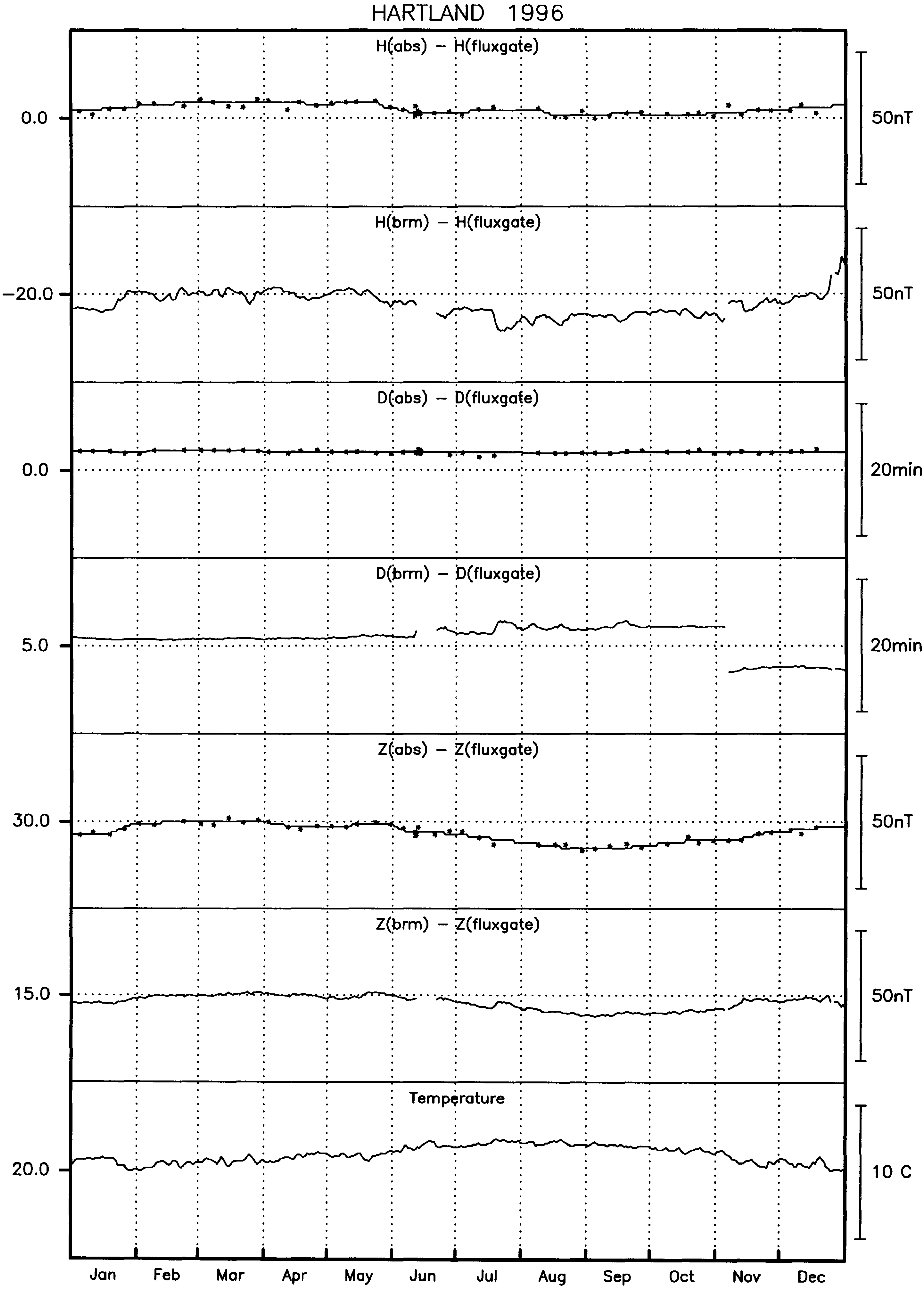
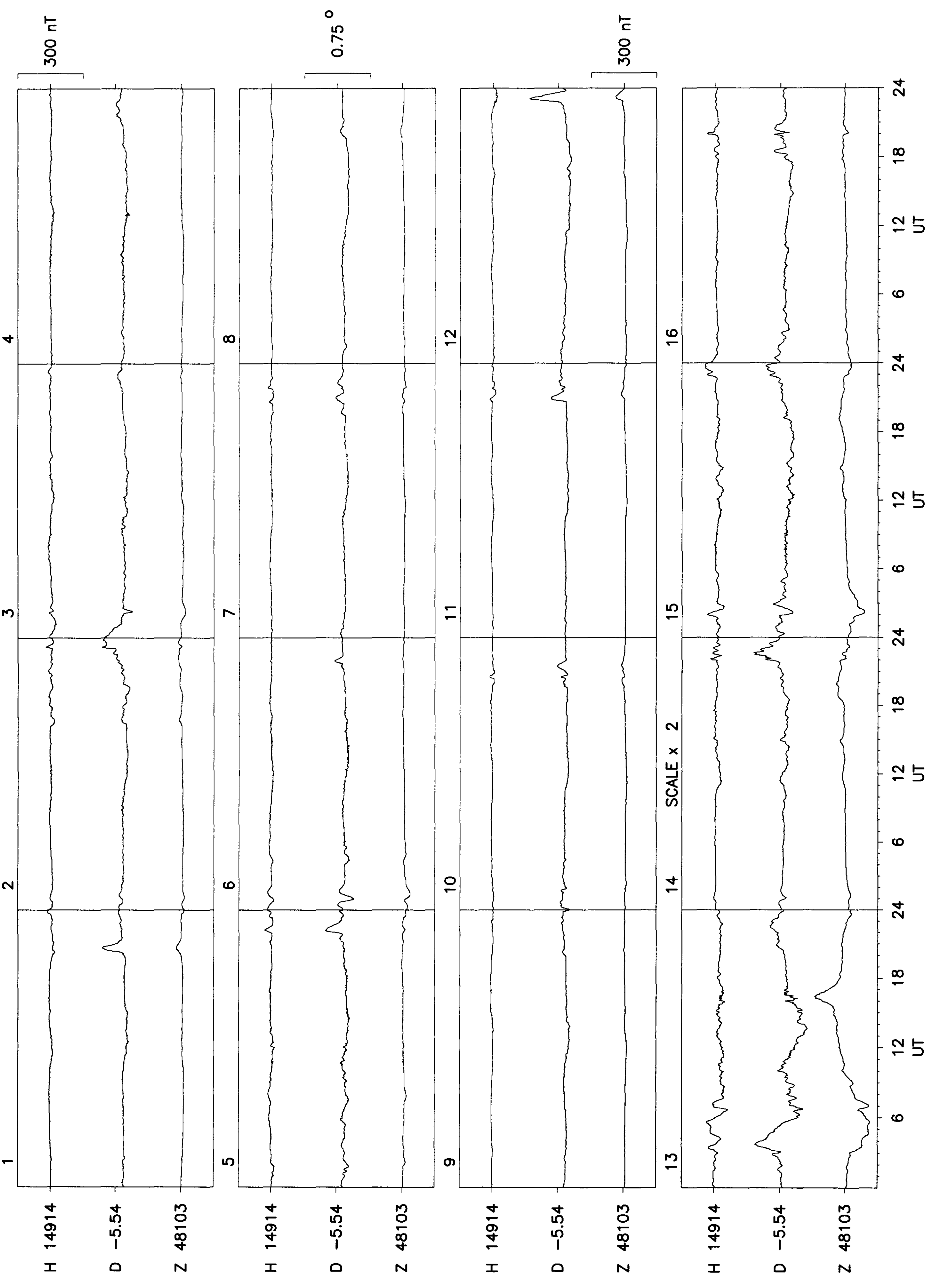


Figure 7. Zero-field corrections and BRMs, Hartland 1996

Lerwick 1996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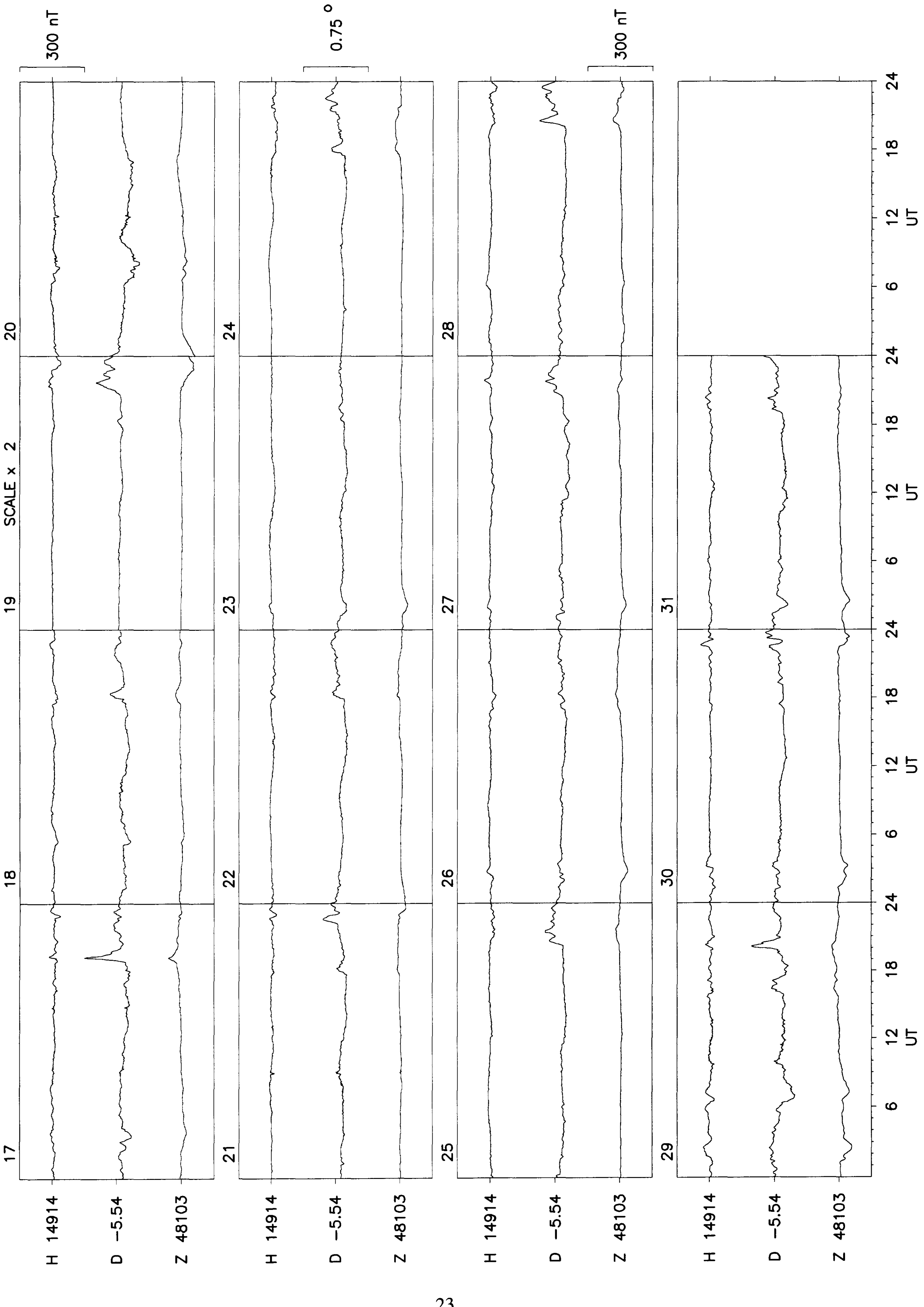
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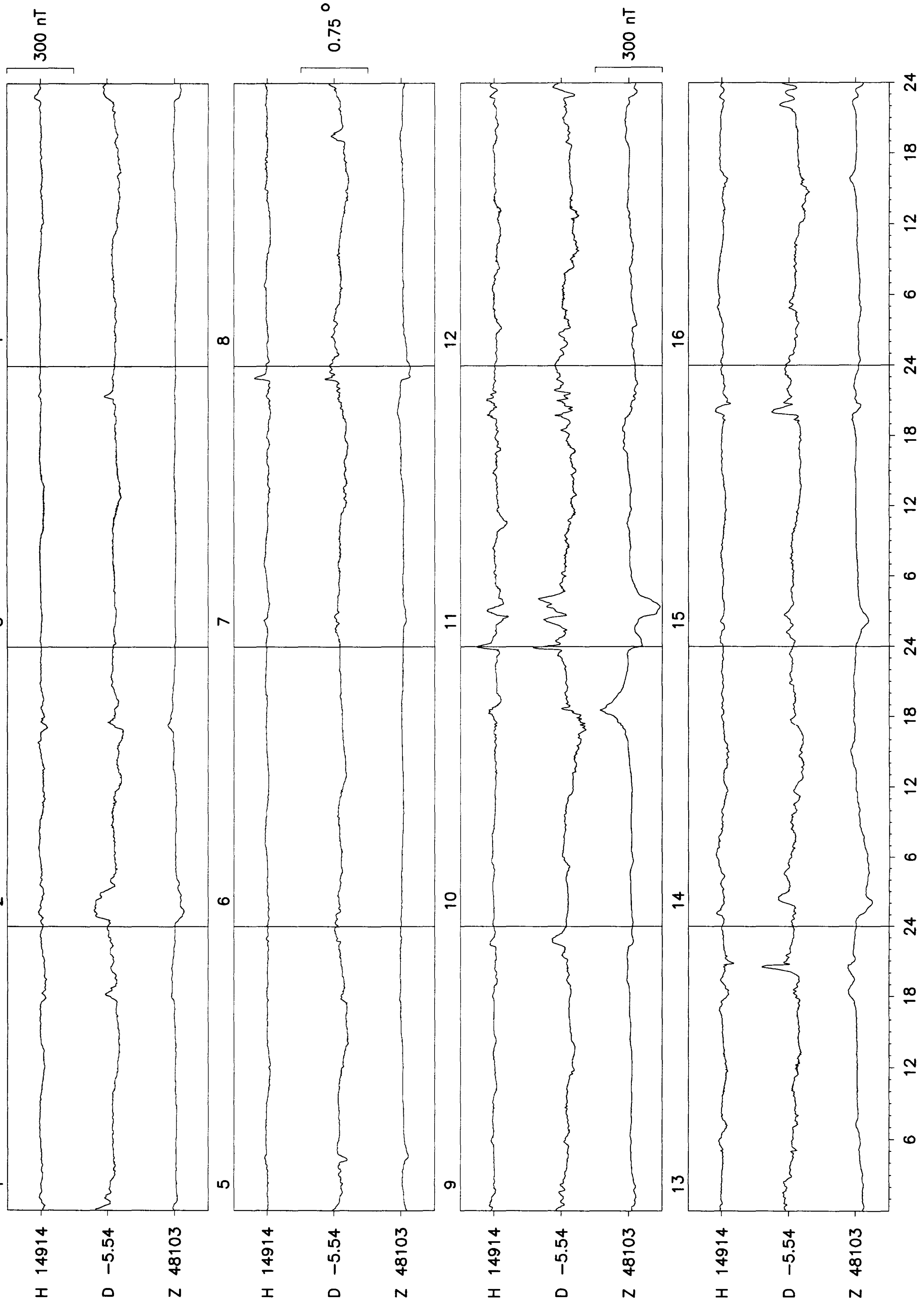
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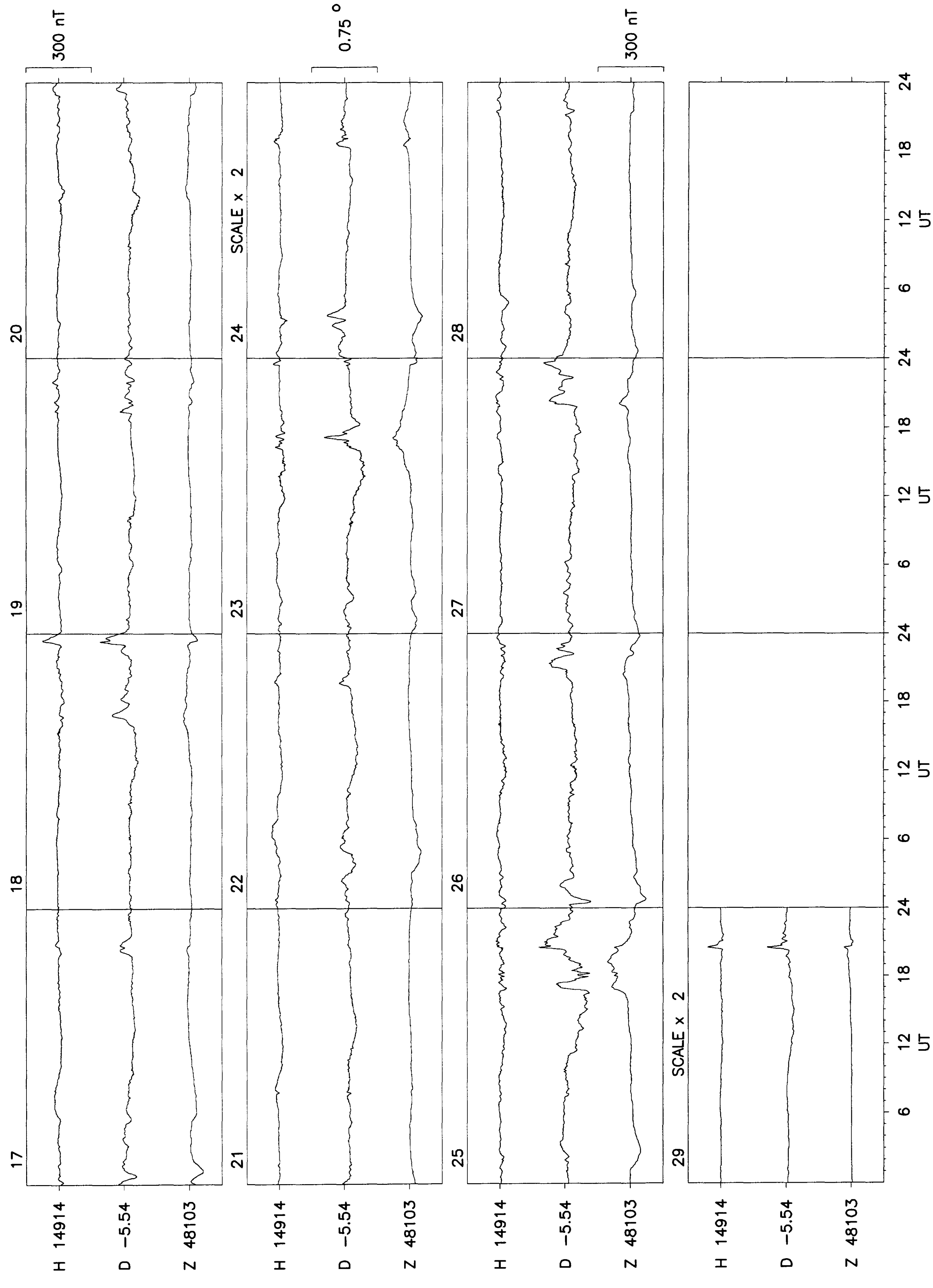

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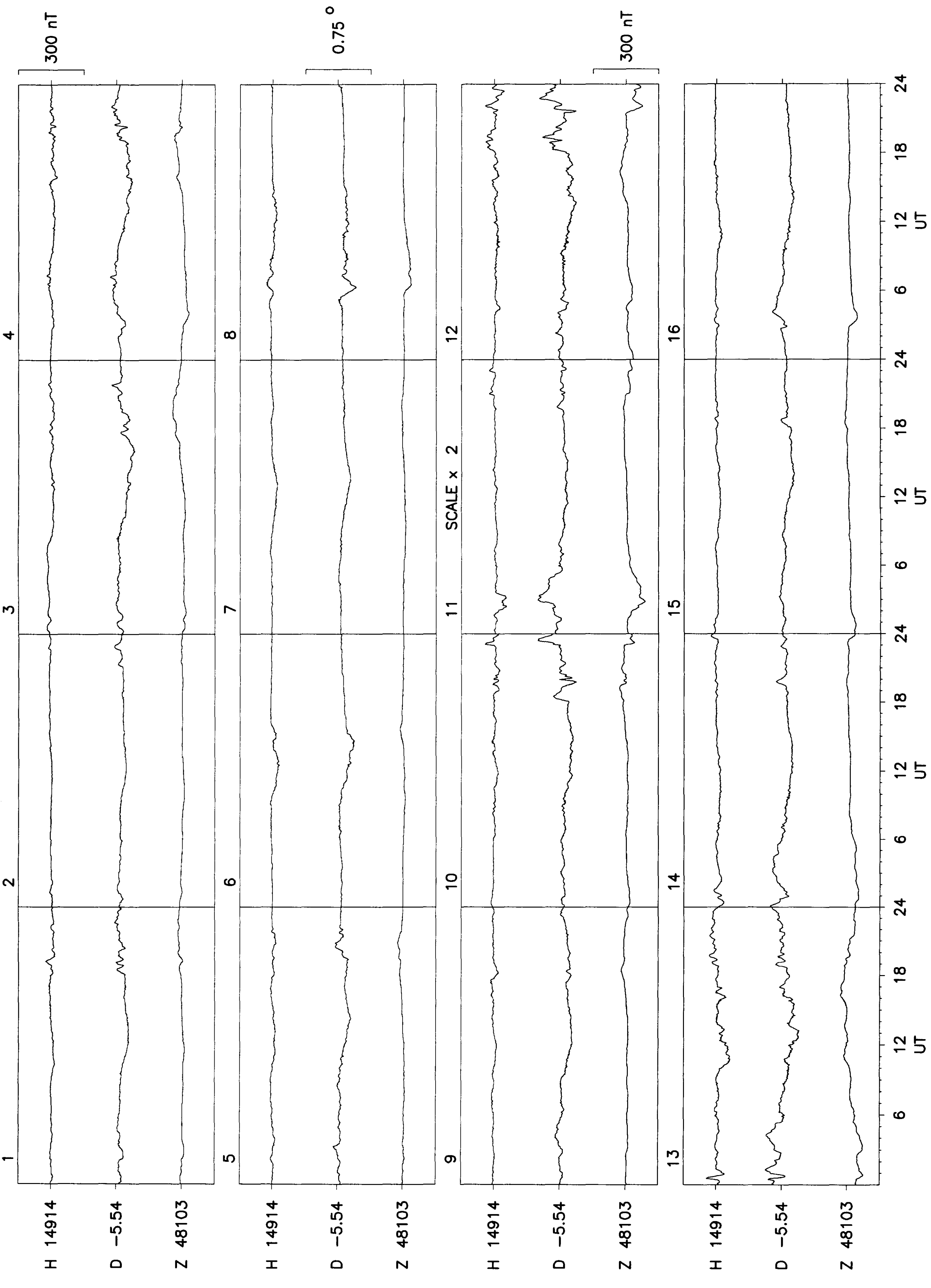
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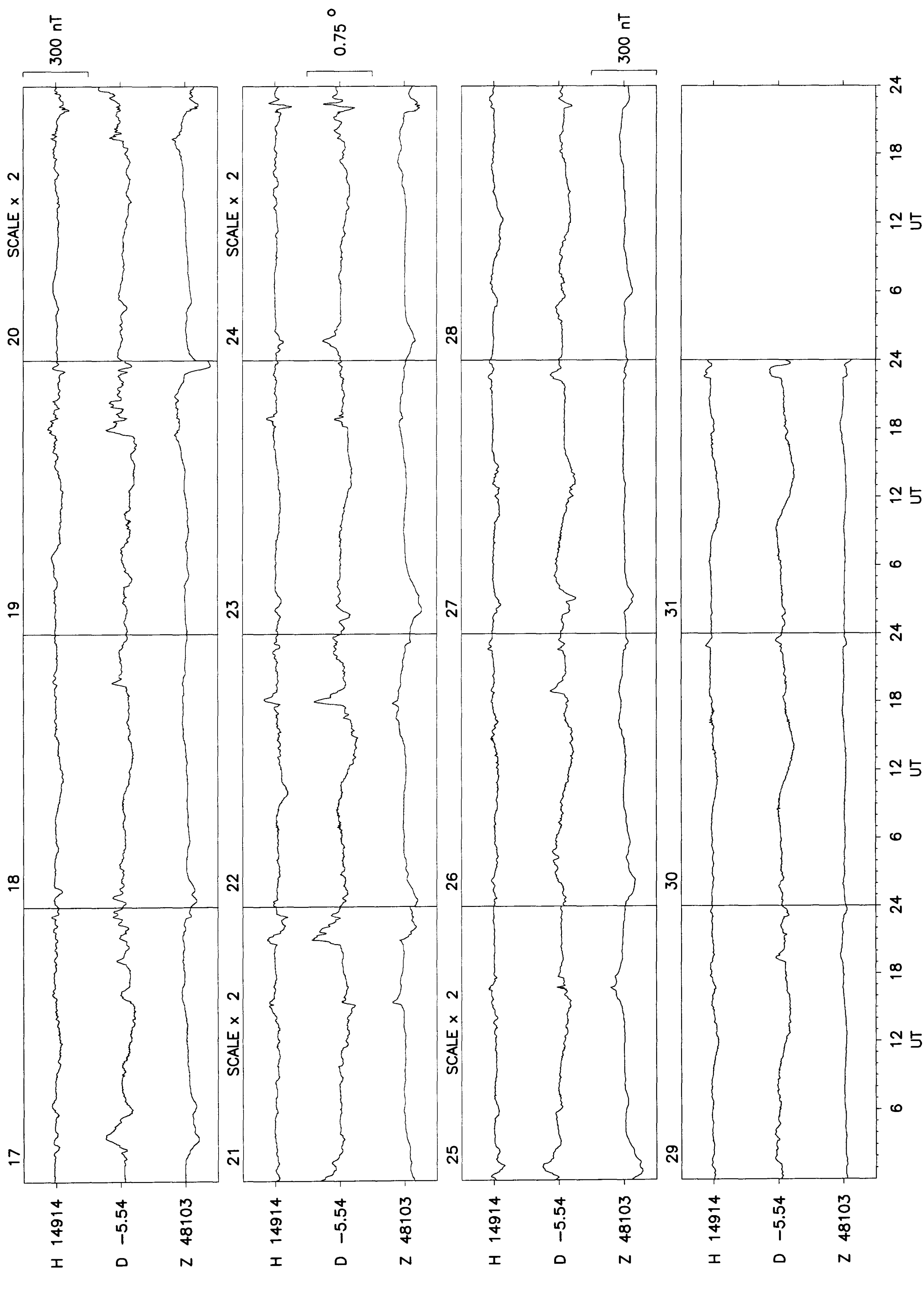
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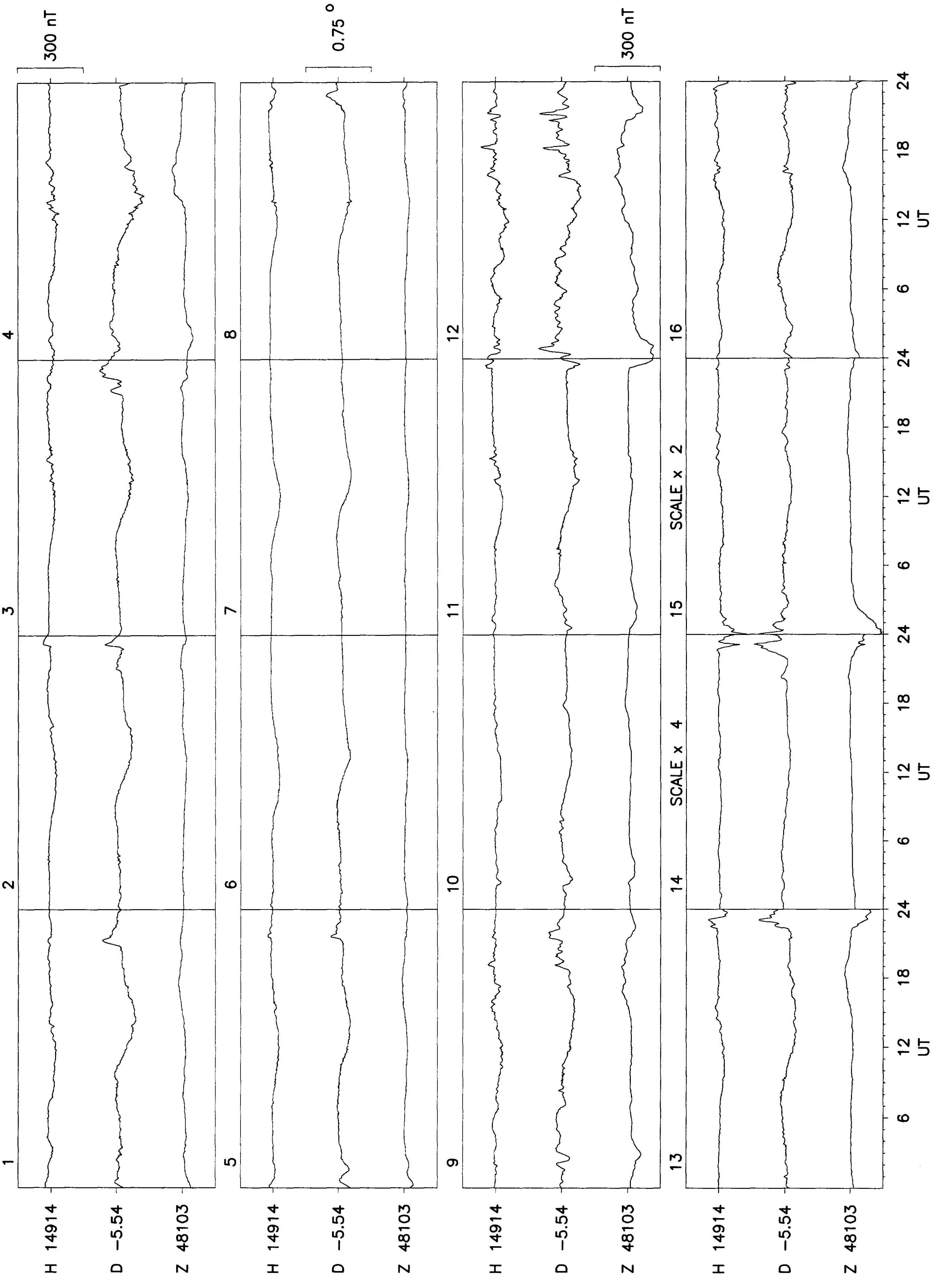
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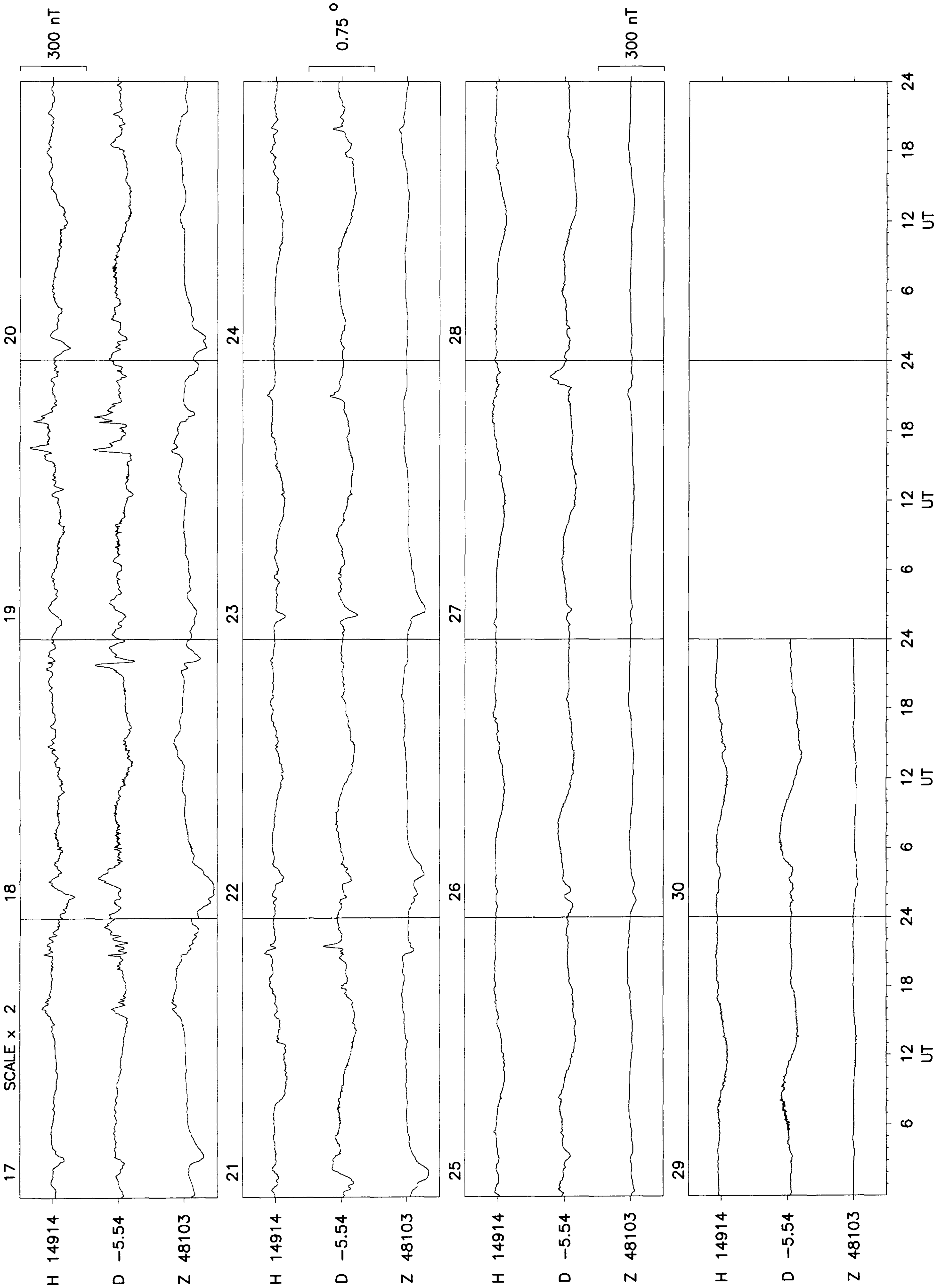
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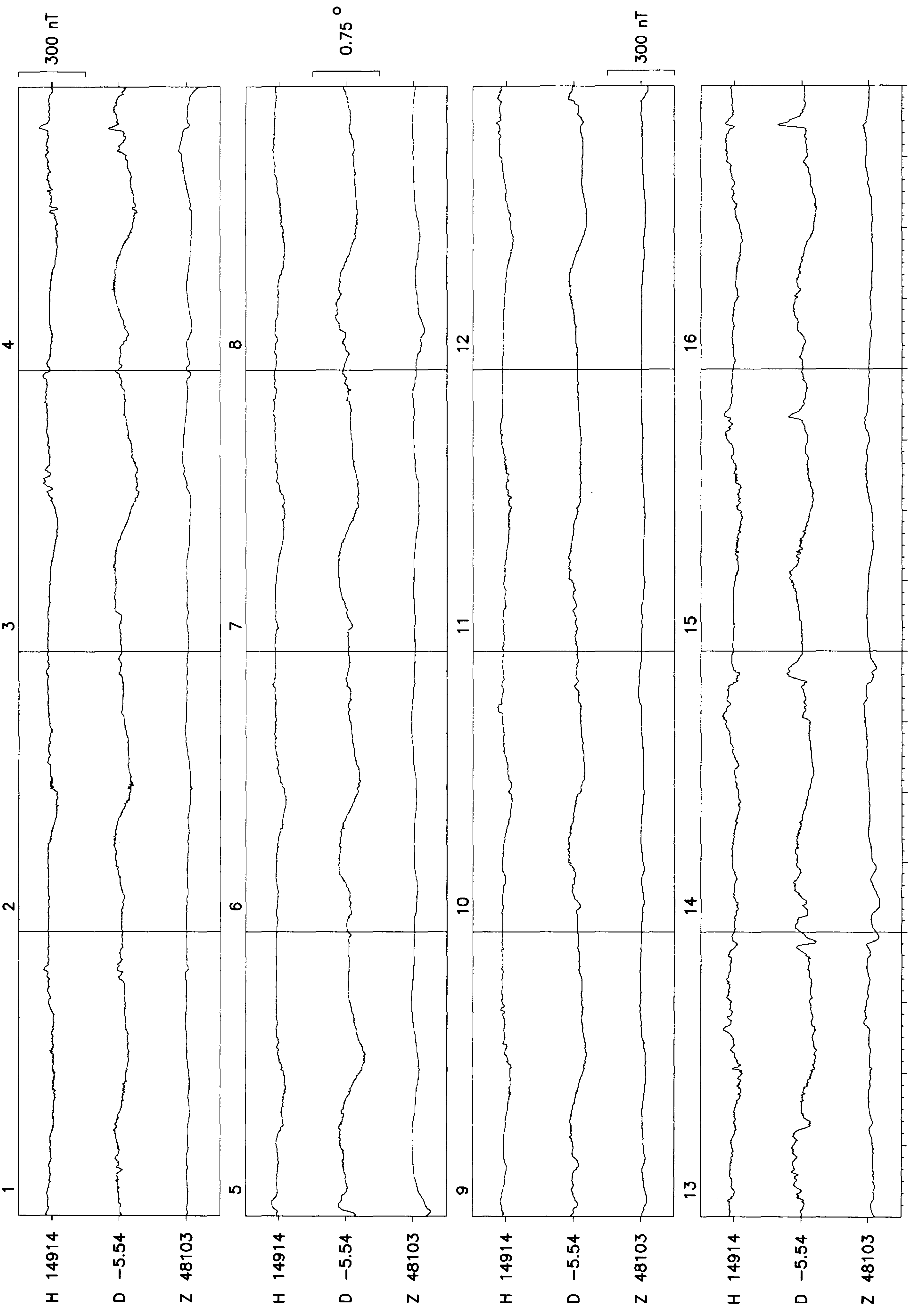
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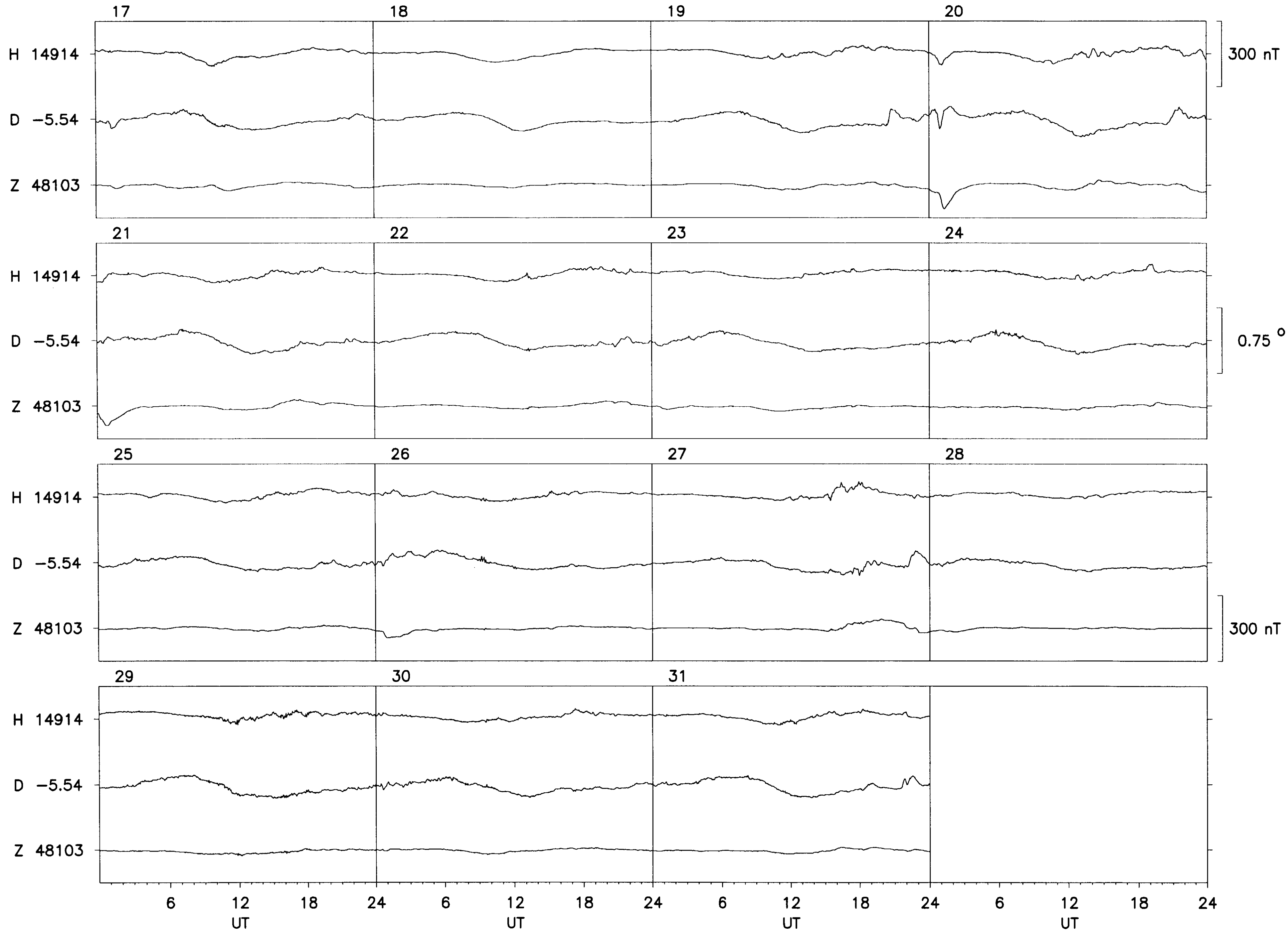
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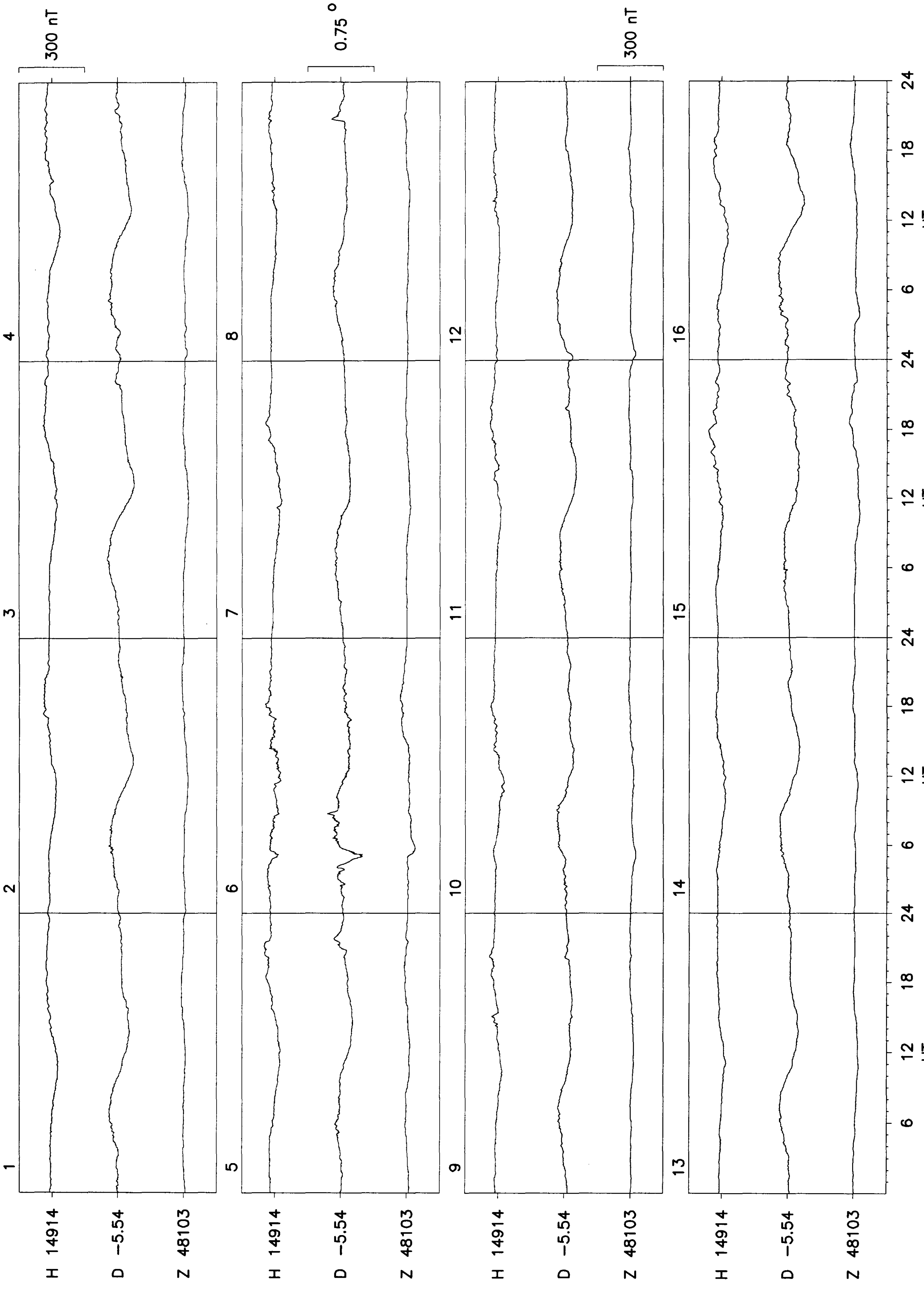
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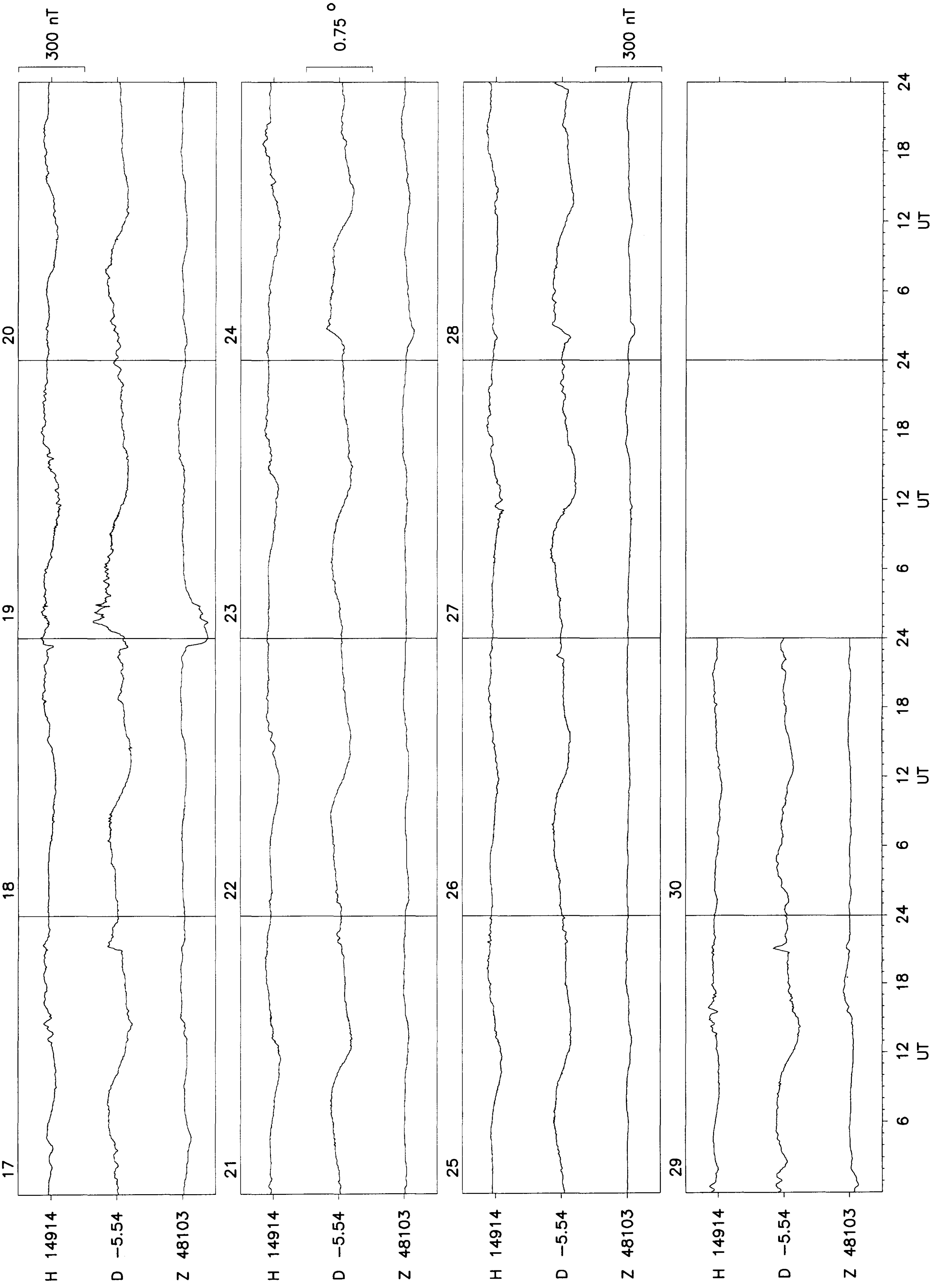
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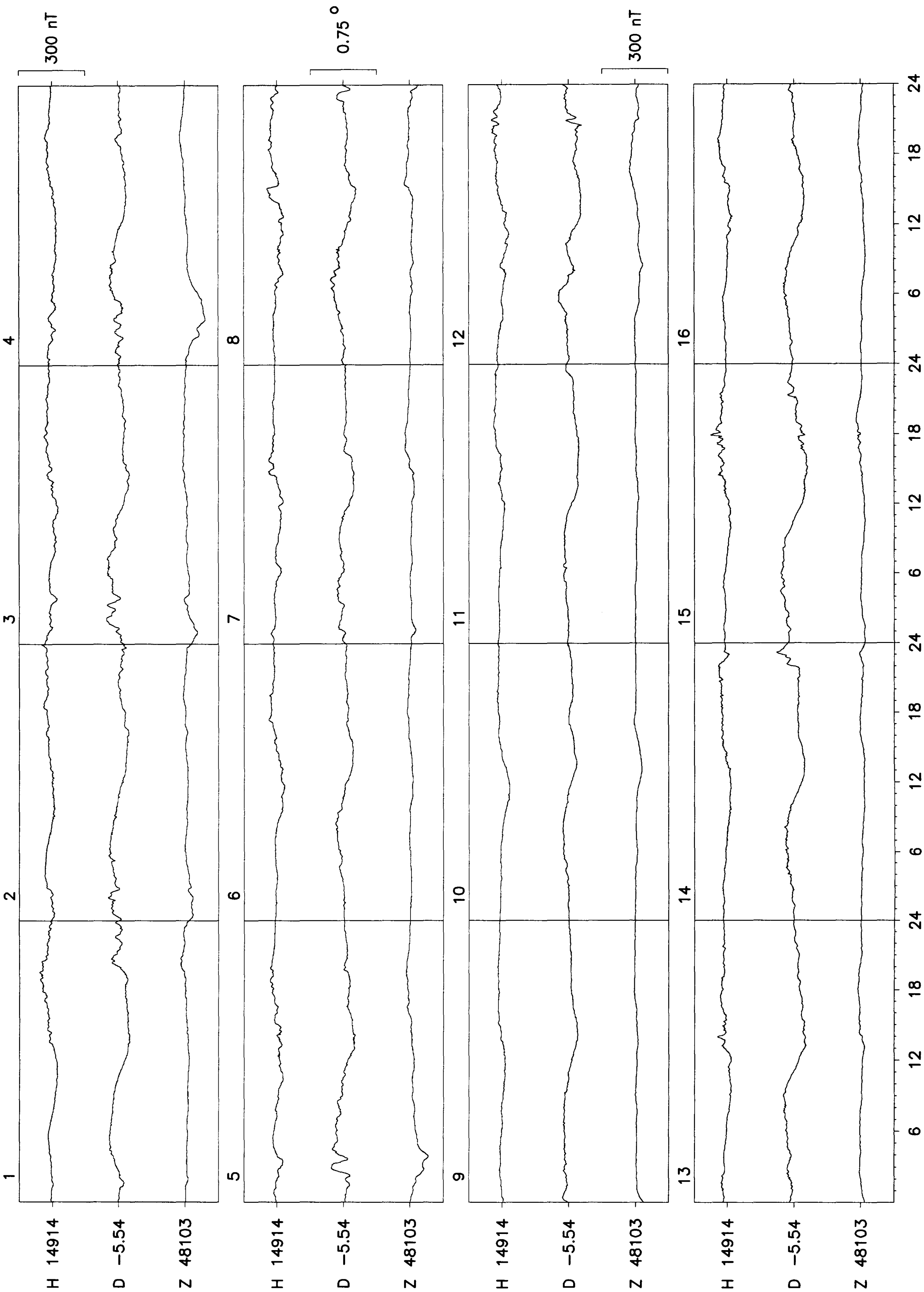
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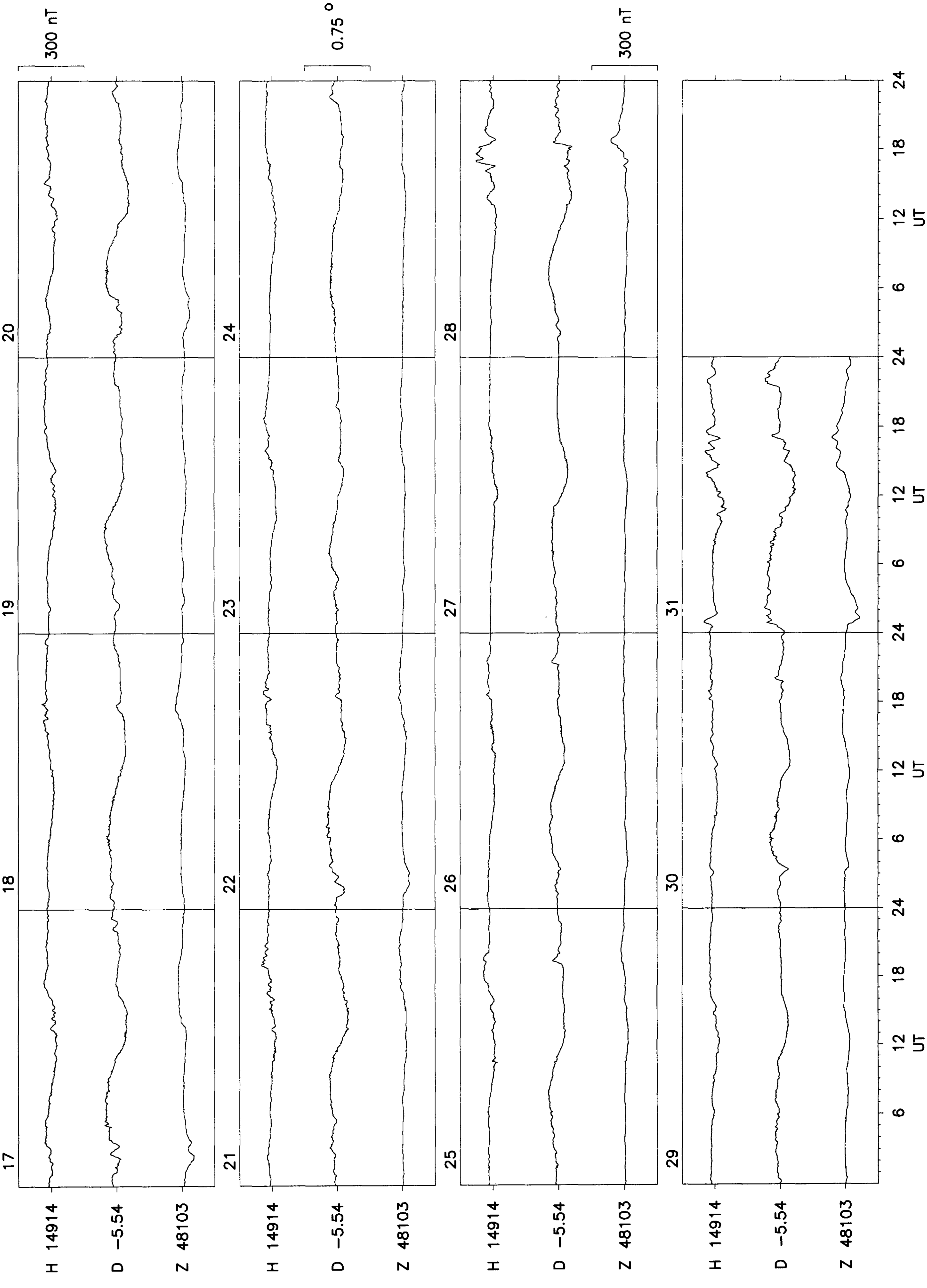
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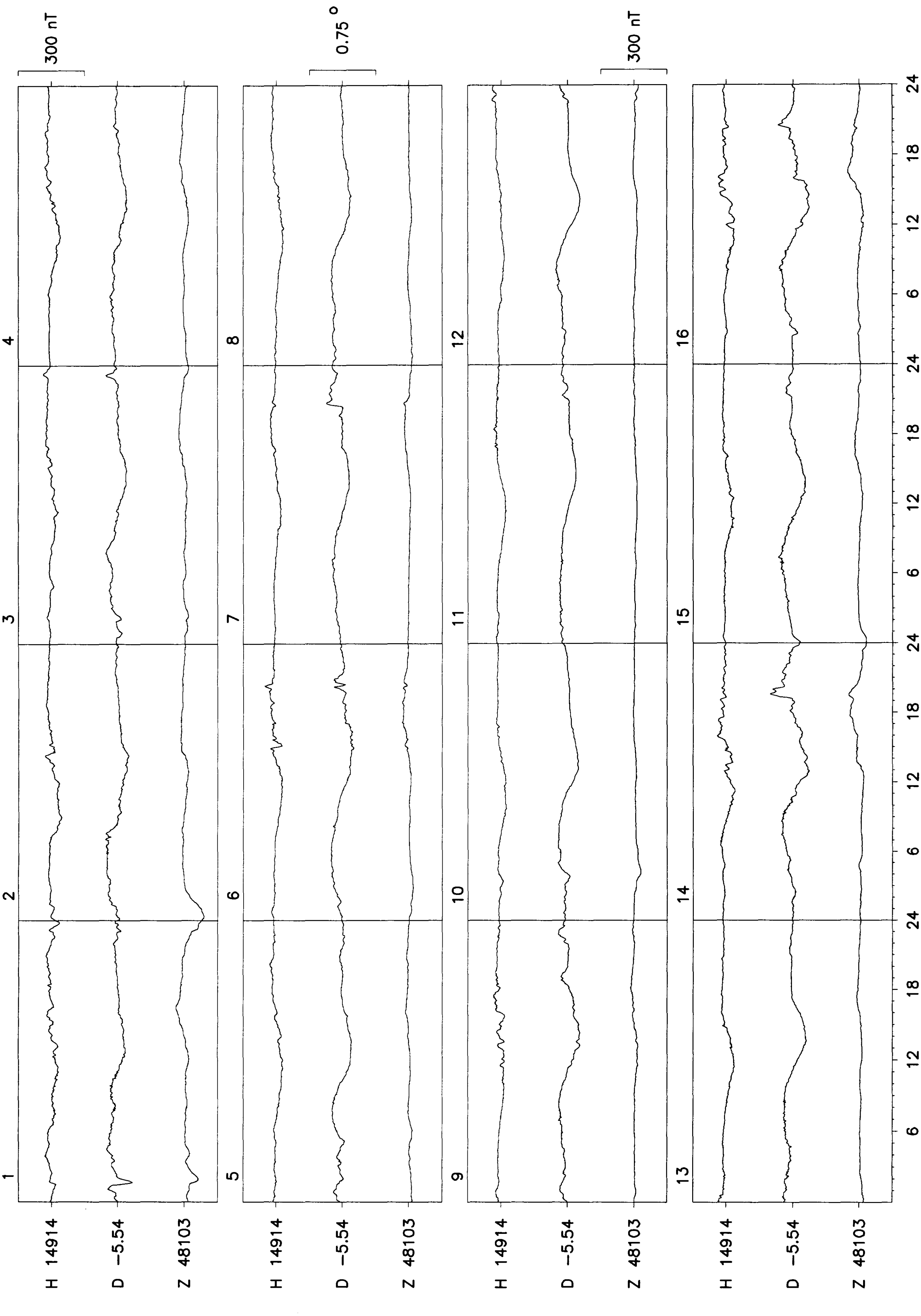

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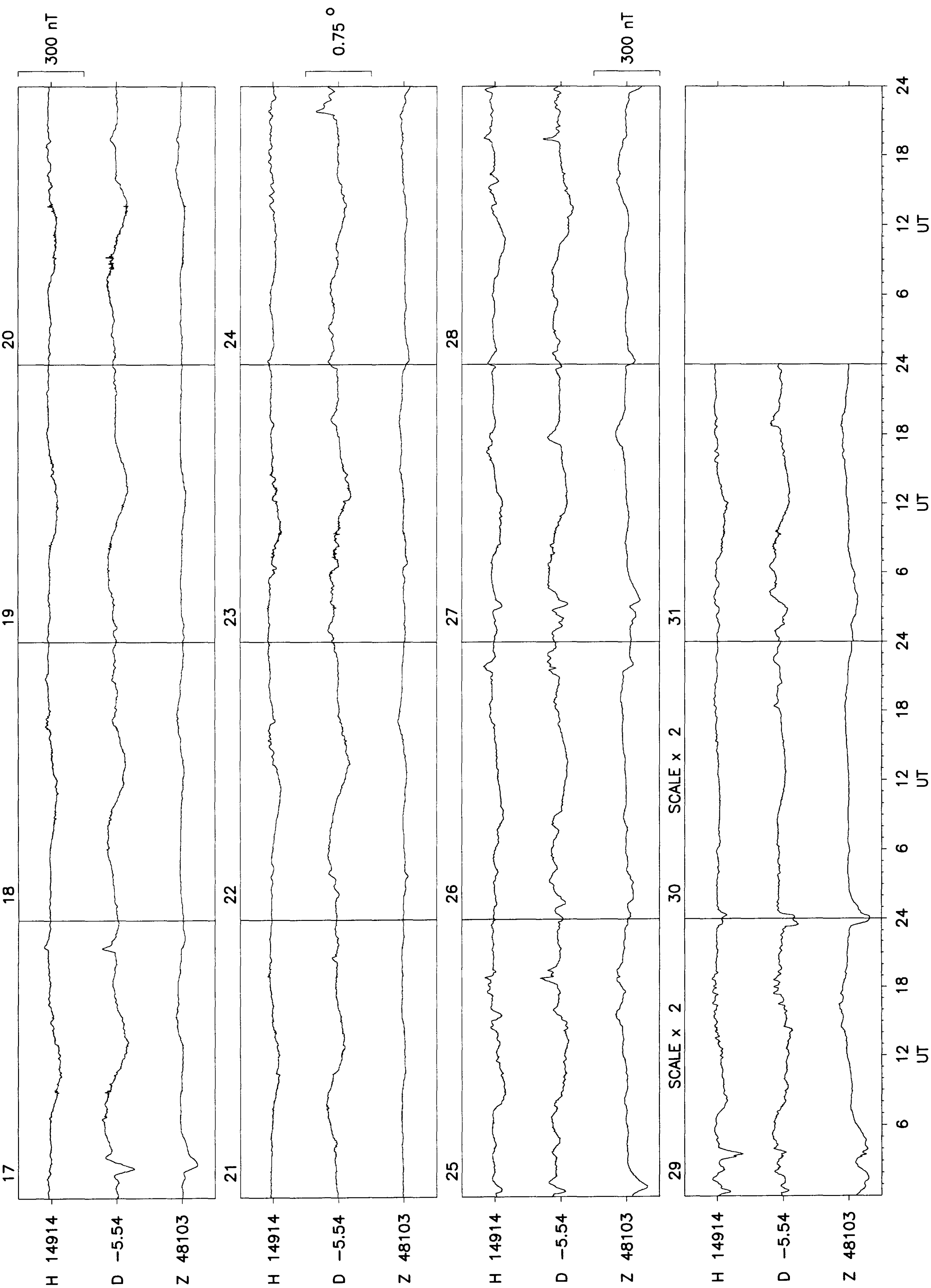

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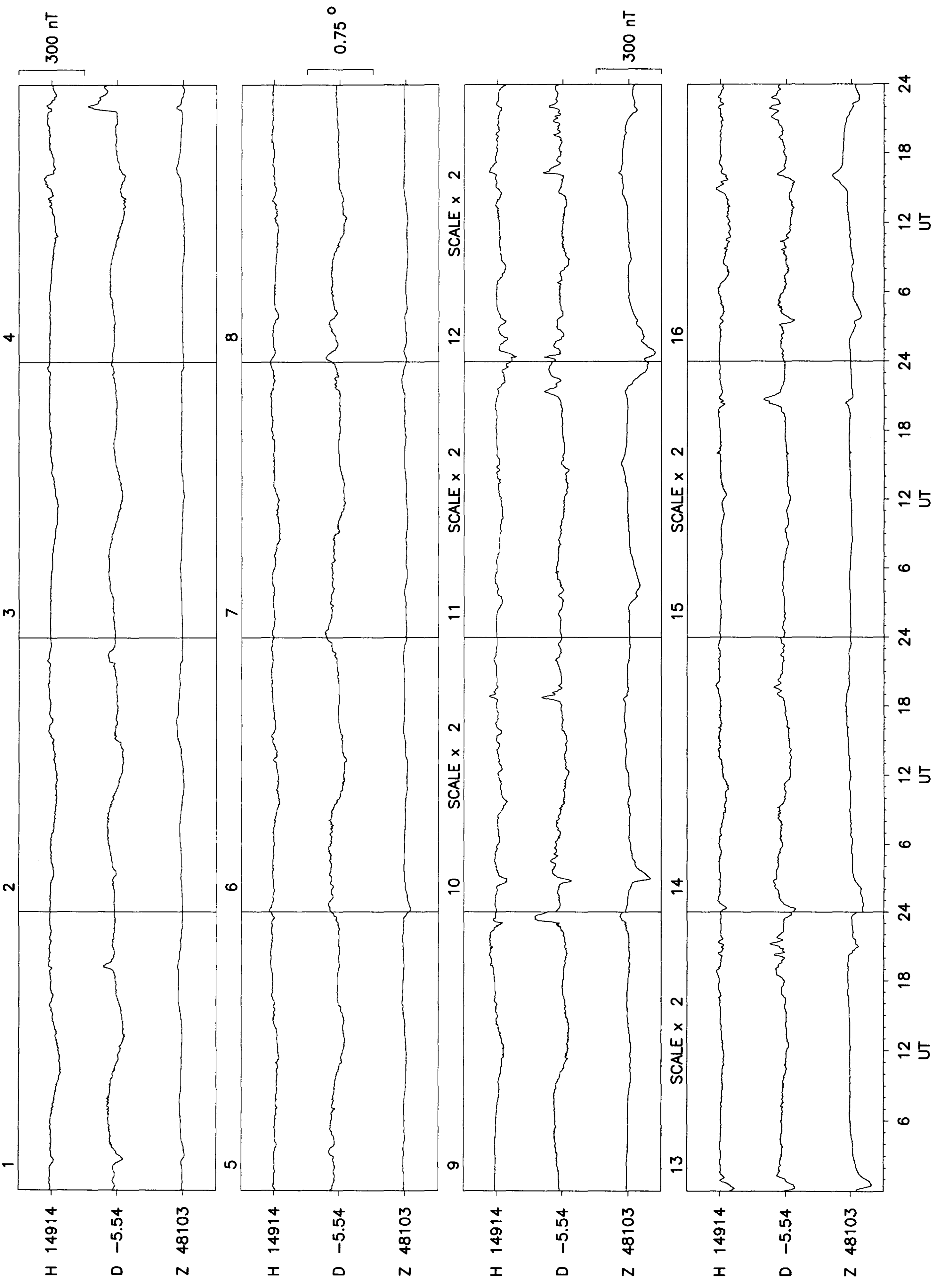

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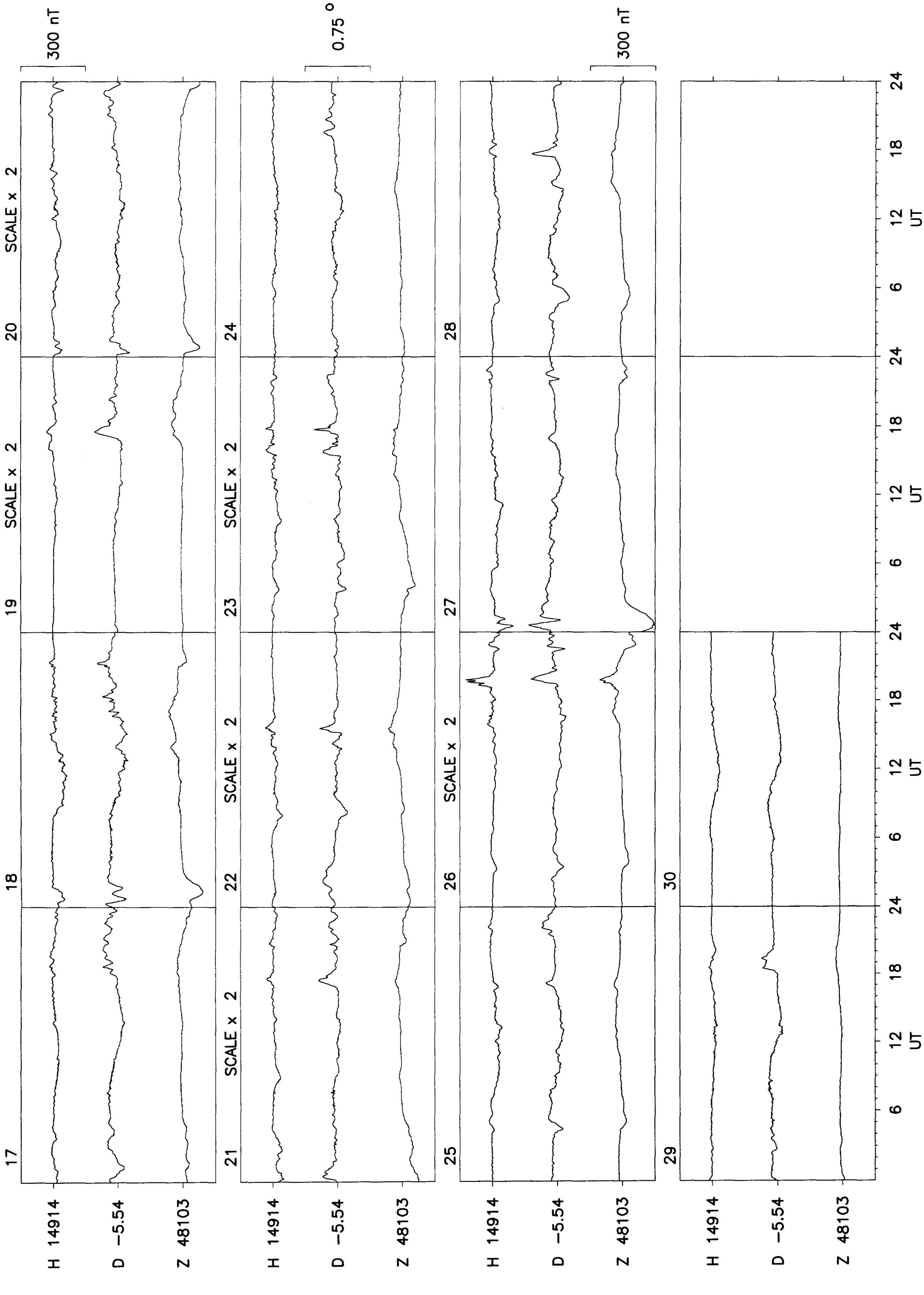
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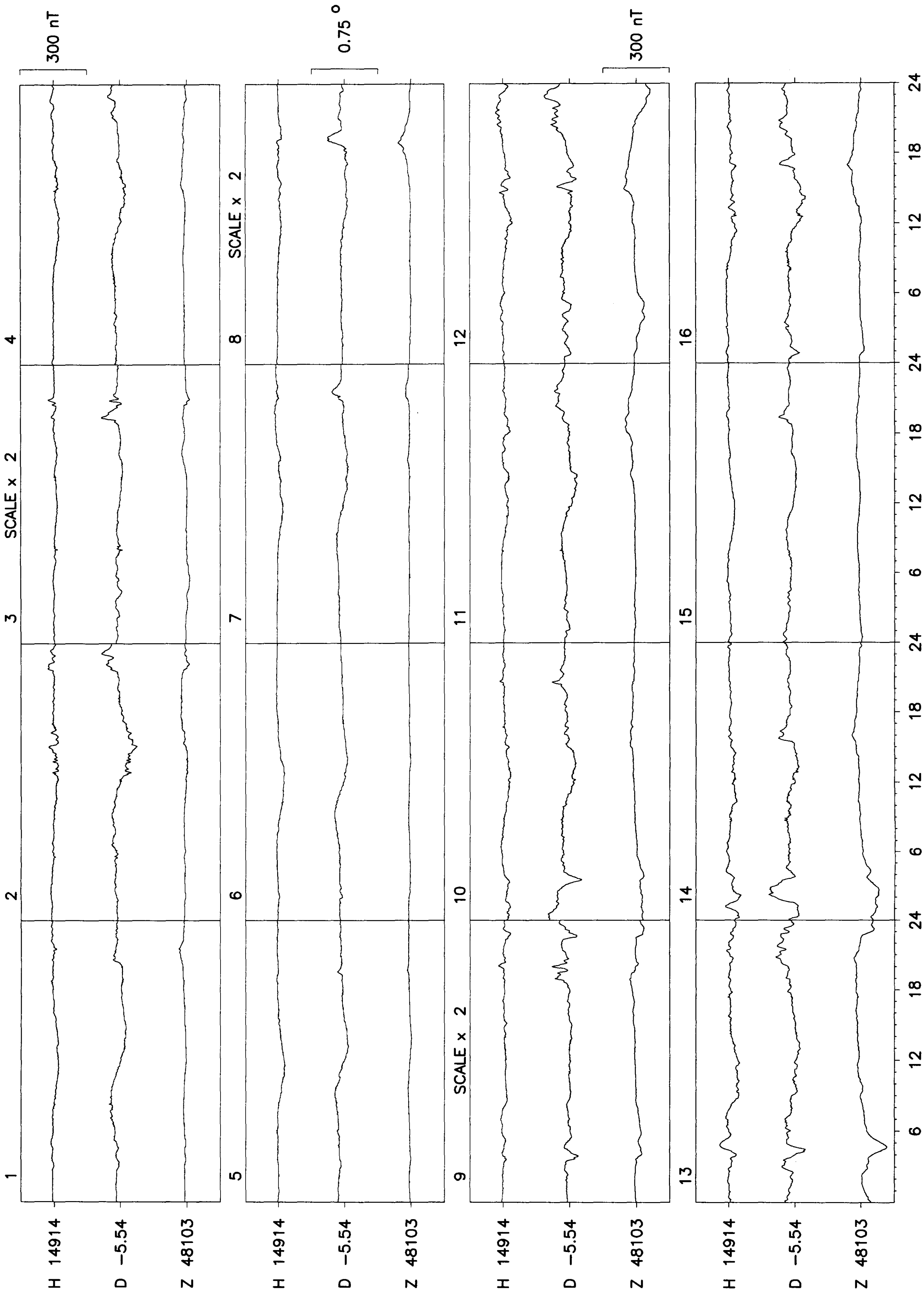
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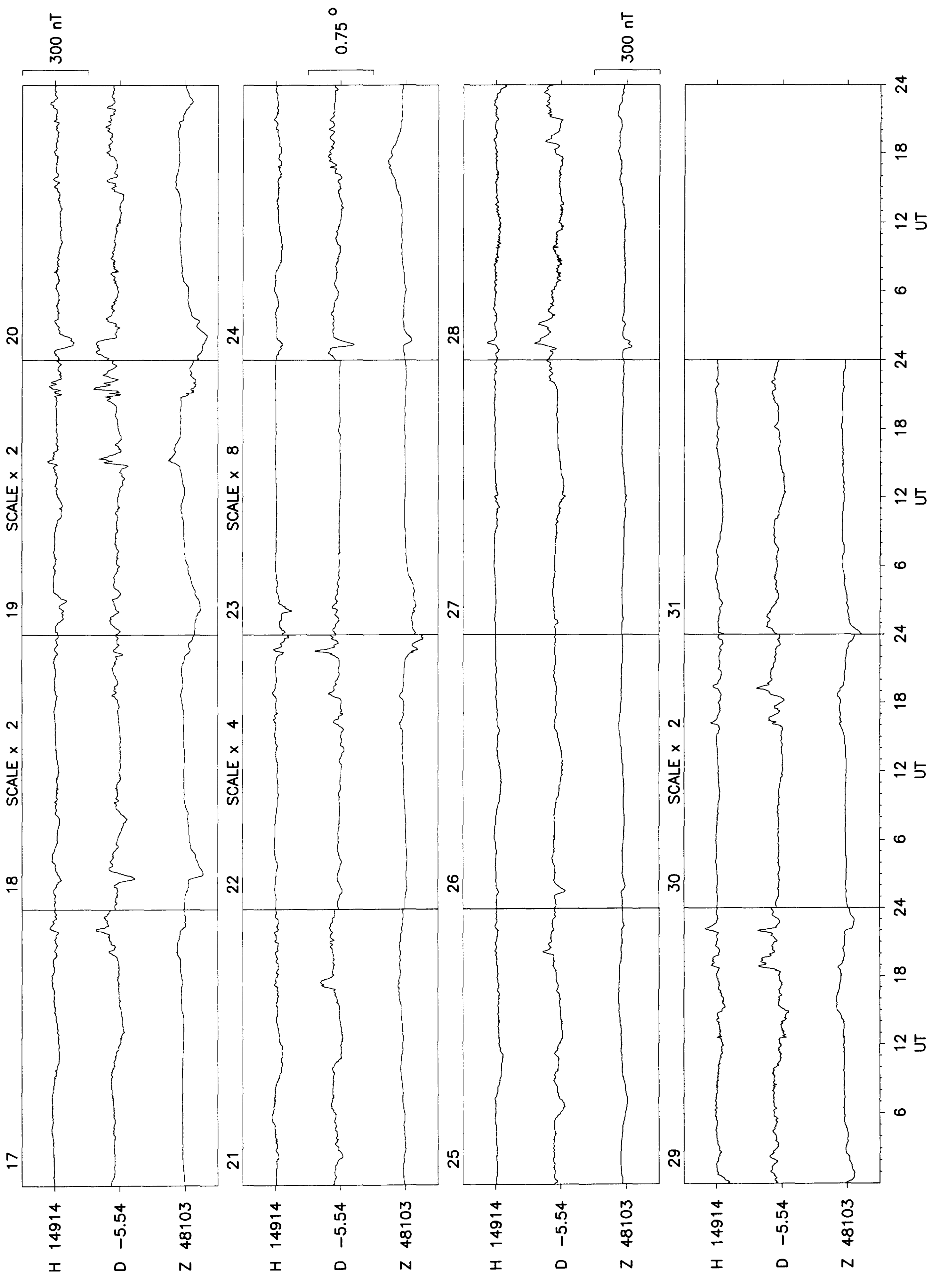

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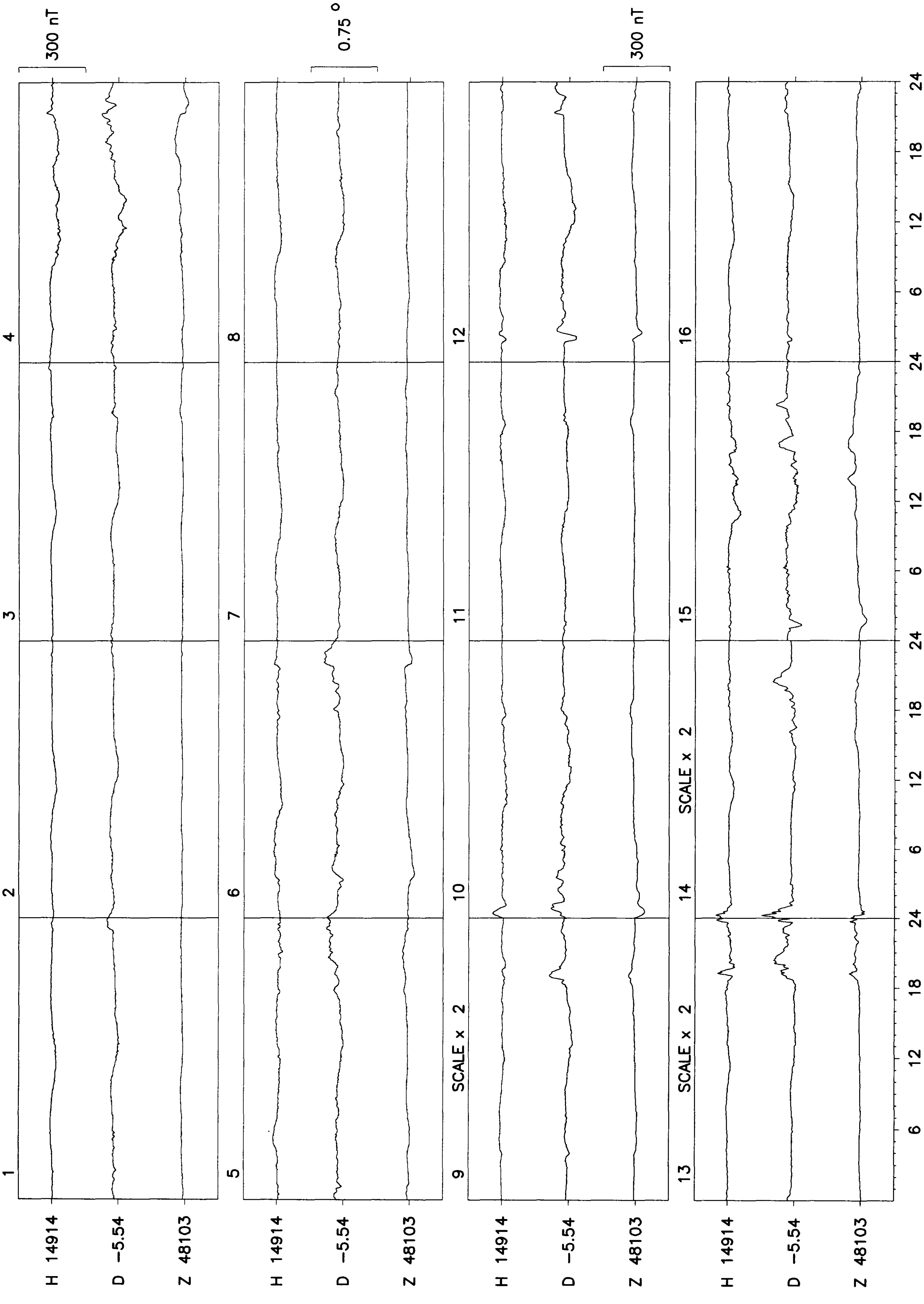
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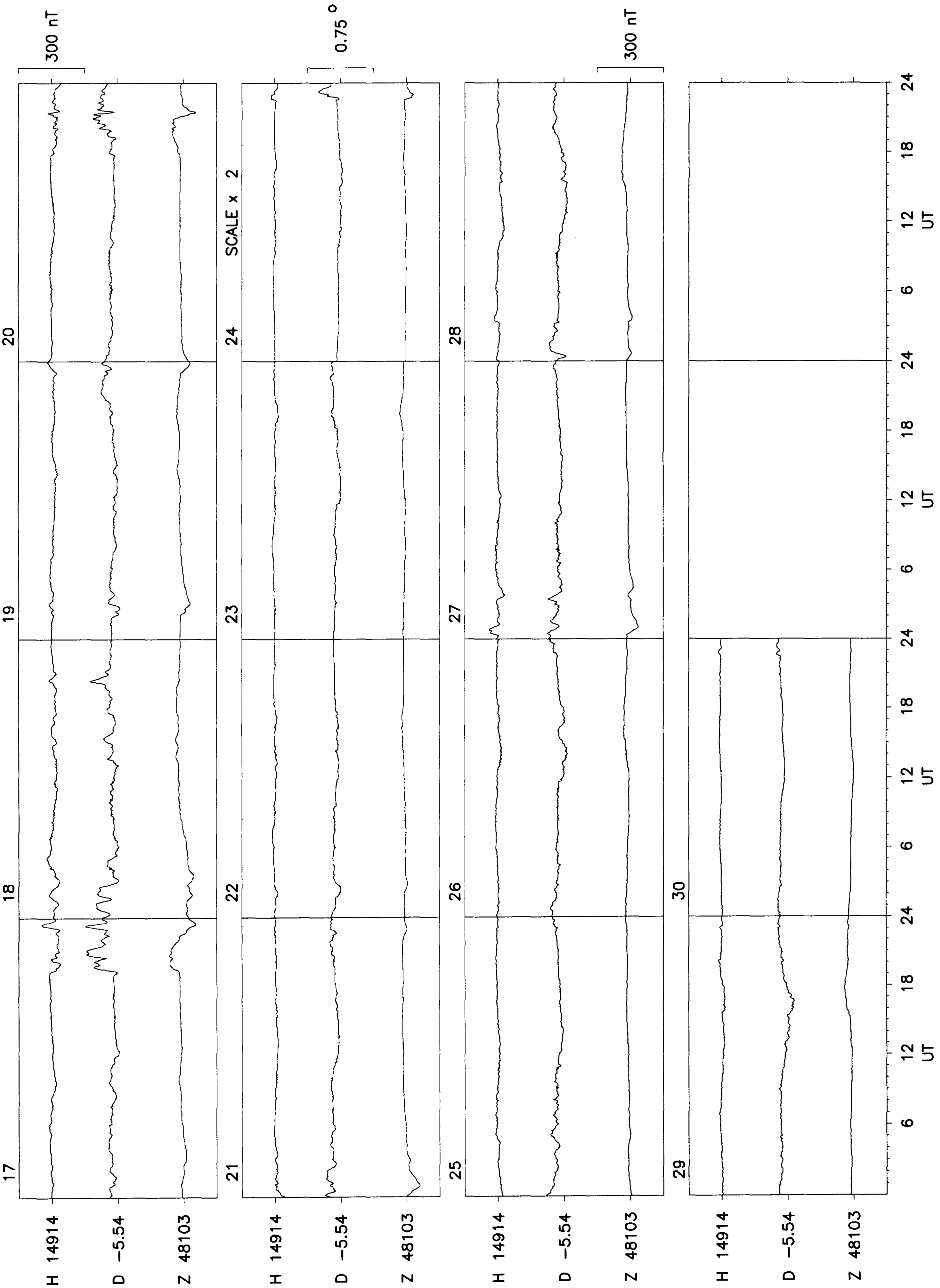
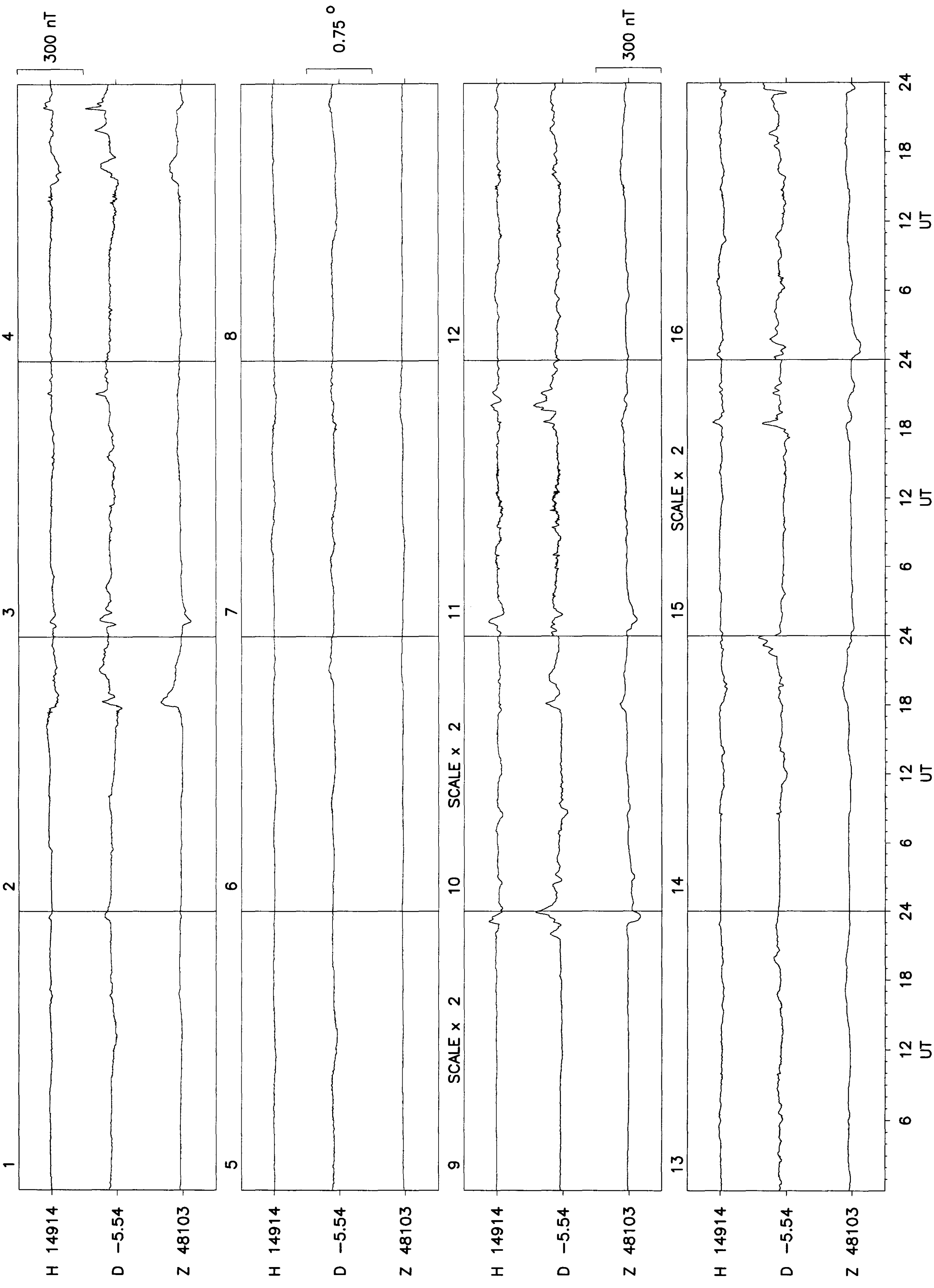
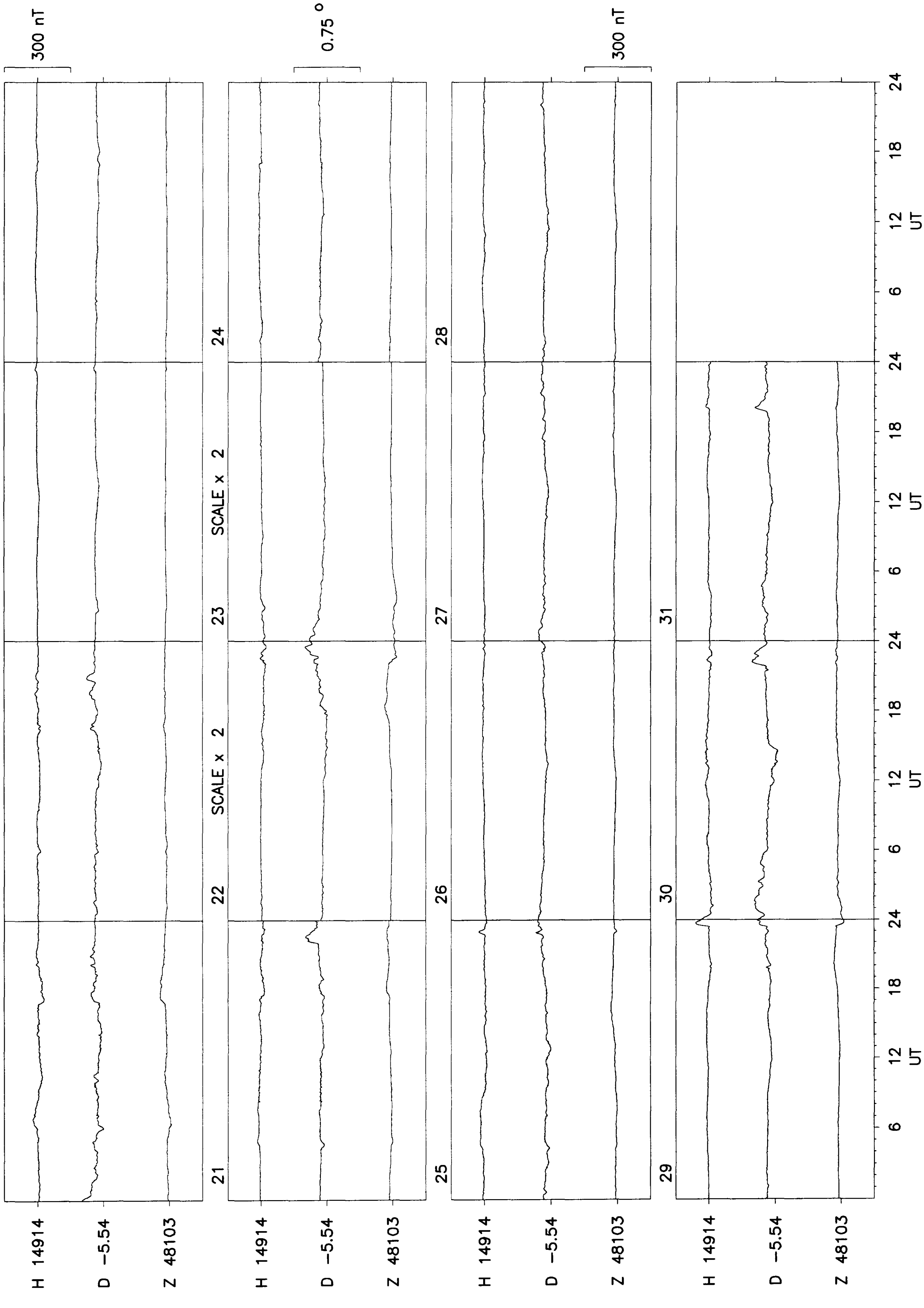
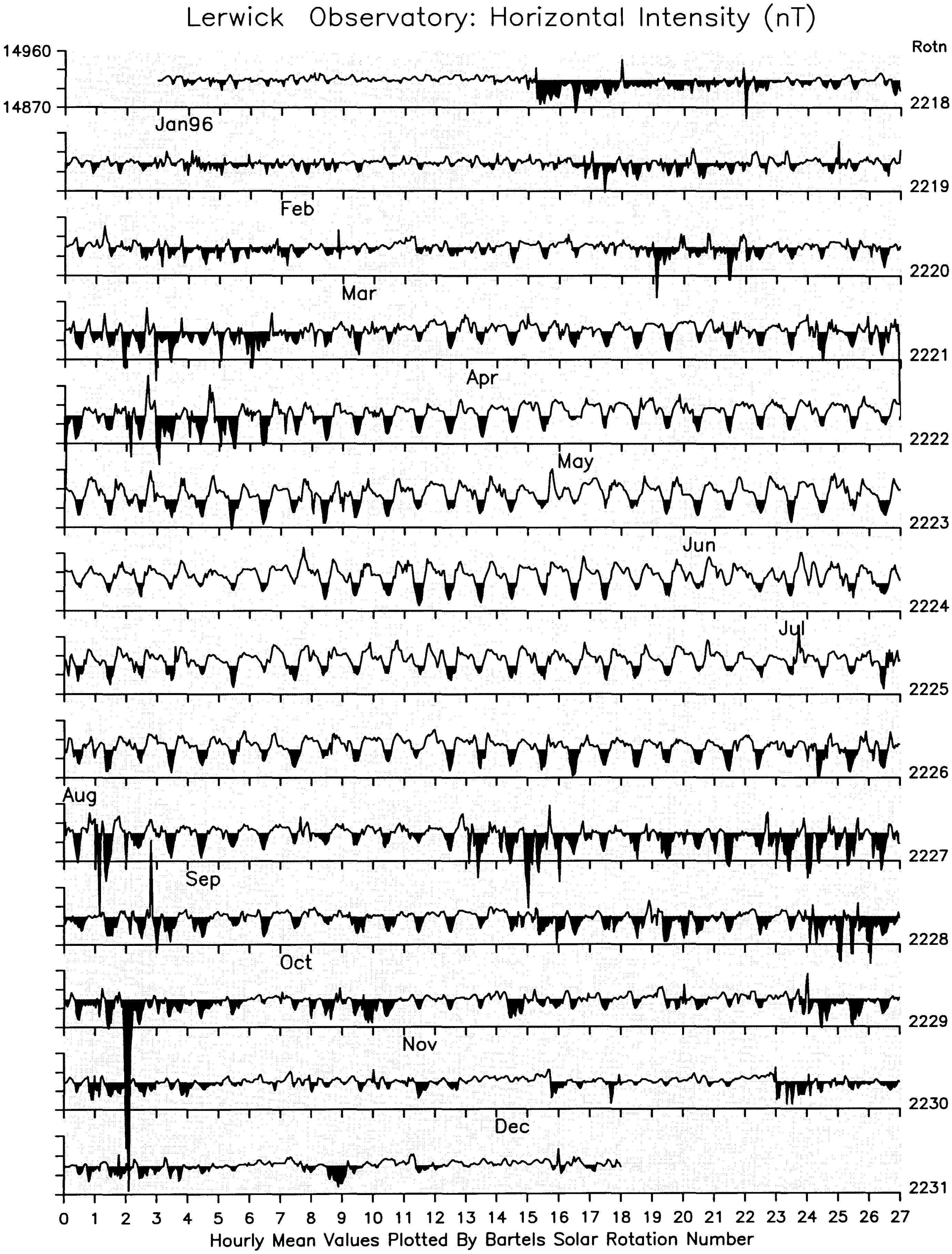

300 nT
0.75 °
300 nT
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 14914
D −5.54
Z 48103
6
12
18
24
UT

LE 11 96

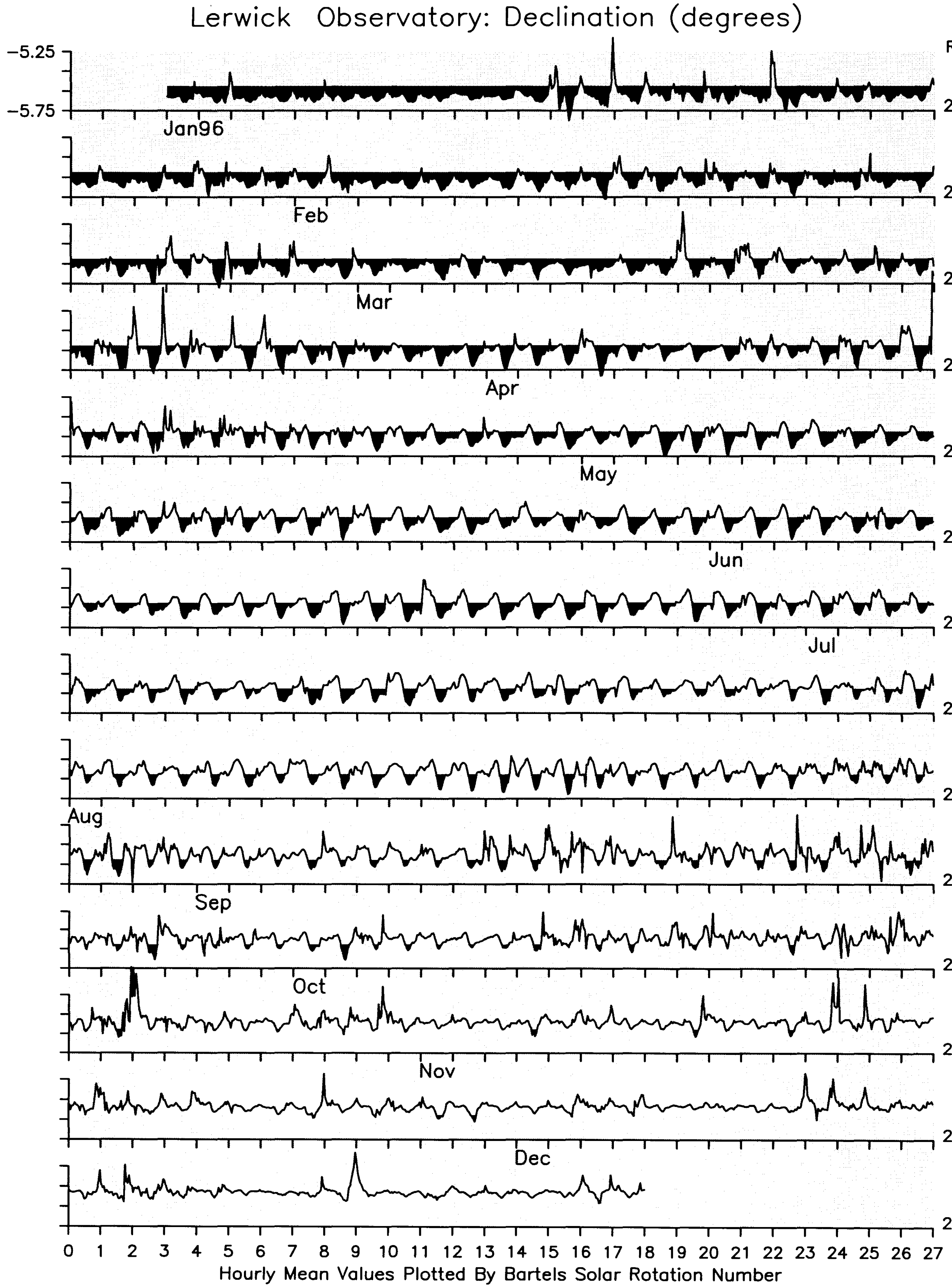

300 nT
0.75 °
300 nT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
SCALE x 2
SCALE x 2
H 14914
D −5.54
Z 48103
UT


300 nT
0.75 °
300 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 2
H 14914
D −5.54
Z 48103
H 14914
D −5.54
Z 48103
H 14914
D −5.54
Z 48103
H 14914
D −5.54
Z 48103
6
12
18
24
UT

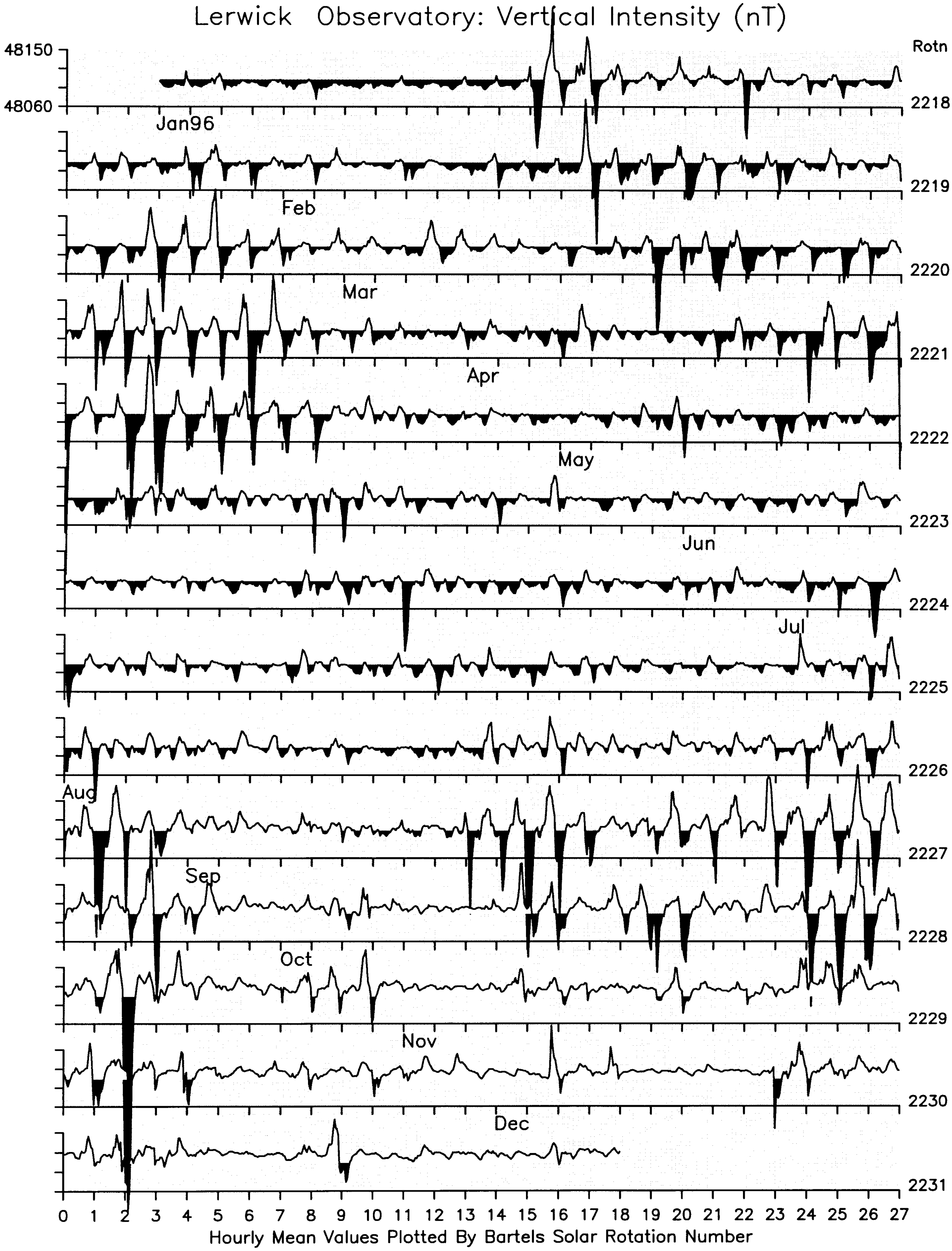
LE 12 96



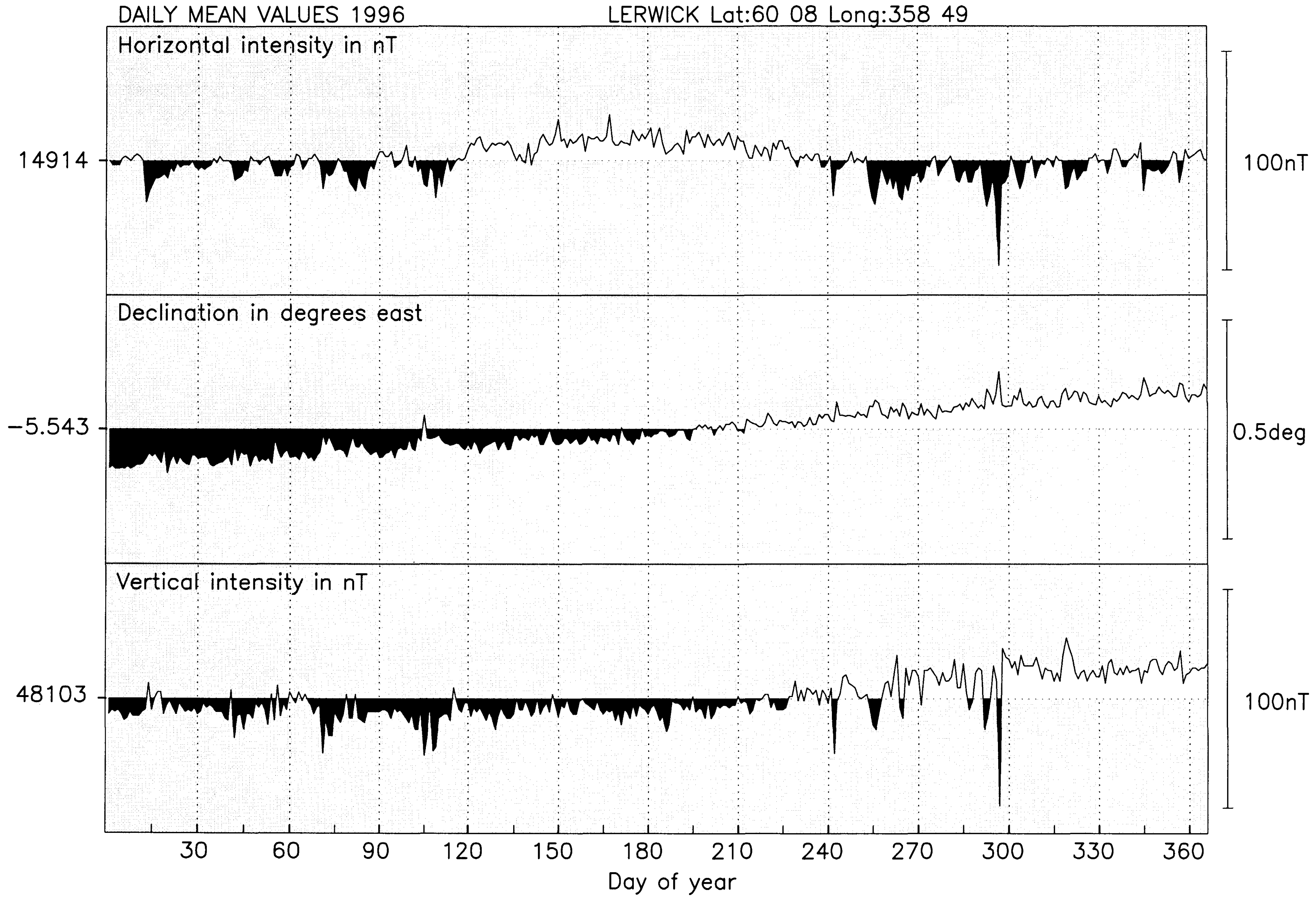
Lerwick Observatory: Horizontal Intensity (nT)
14960
14870
Rotn
2218
Jan96
2219
Feb
2220
Mar
2221
Apr
2222
May
2223
Jun
2224
Jul
2225
2226
Aug
2227
Sep
2228
Oct
2229
Nov
2230
Dec
2231
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number

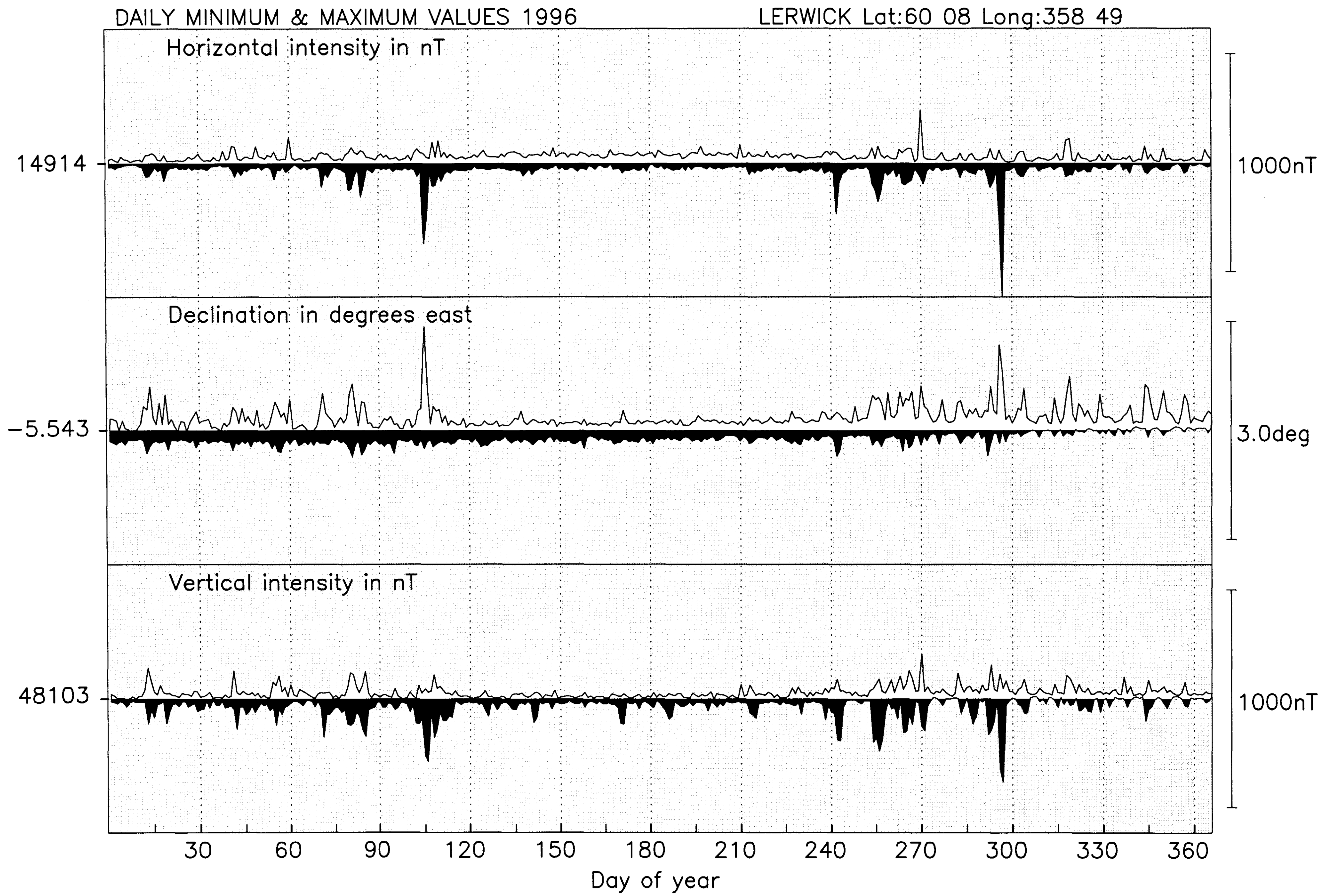


Lerwick Observatory: Declination (degrees)
-5.25
-5.75
Rotn
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231
Jan96
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number



Lerwick Observatory: Vertical Intensity (nT)
48150
48060
Rotn
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231
Jan96
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 1996
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
14914
100nT
Declination in degrees east
-5.543
0.5deg
Vertical intensity in nT
48103
100nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year



DAILY MINIMUM & MAXIMUM VALUES 1996
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
14914
-5.543
48103
1000nT
3.0deg
1000nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Lerwick 1996

Month	D ° '	H nT	I ° '	X nT	Y nT	Z nT	F nT
Based on All Days							
Jan	-5 37.1	14911	72 46.6	14839	-1460	48098	50356
Feb	-5 36.5	14911	72 46.6	14840	-1457	48098	50356
Mar	-5 35.5	14910	72 46.6	14839	-1453	48097	50355
Apr	-5 34.6	14912	72 46.4	14841	-1449	48095	50354
May	-5 34.3	14921	72 45.9	14851	-1449	48098	50359
Jun	-5 33.9	14924	72 45.7	14854	-1447	48098	50360
Jul	-5 32.7	14923	72 45.8	14853	-1442	48099	50361
Aug	-5 31.5	14916	72 46.3	14847	-1436	48102	50362
Sep	-5 30.2	14907	72 47.0	14838	-1430	48107	50364
Oct	-5 29.1	14906	72 47.1	14838	-1425	48111	50367
Nov	-5 28.7	14912	72 46.9	14844	-1424	48117	50375
Dec	-5 27.7	14913	72 46.8	14845	-1419	48117	50375
Annual	**-5 32.6**	**14914**	**72 46.5**	**14844**	**-1441**	**48103**	**50362**
International quiet day means							
Jan	-5 37.7	14916	72 46.2	14844	-1463	48095	50355
Feb	-5 37.3	14914	72 46.4	14842	-1461	48098	50357
Mar	-5 36.4	14915	72 46.4	14844	-1457	48101	50360
Apr	-5 35.0	14916	72 46.2	14845	-1451	48099	50359
May	-5 34.4	14921	72 45.9	14850	-1449	48098	50359
Jun	-5 33.9	14922	72 45.8	14852	-1447	48098	50360
Jul	-5 32.6	14922	72 45.9	14852	-1441	48100	50361
Aug	-5 31.7	14919	72 46.1	14850	-1437	48099	50360
Sep	-5 30.5	14913	72 46.7	14844	-1432	48112	50370
Oct	-5 29.9	14913	72 46.8	14844	-1429	48115	50373
Nov	-5 29.1	14915	72 46.7	14847	-1426	48117	50376
Dec	-5 28.2	14916	72 46.6	14848	-1422	48116	50375
Annual	**-5 33.1**	**14917**	**72 46.3**	**14847**	**-1443**	**48104**	**50364**
International disturbed day means							
Jan	-5 36.7	14903	72 47.1	14832	-1457	48101	50357
Feb	-5 35.6	14907	72 46.8	14836	-1453	48097	50354
Mar	-5 34.0	14903	72 46.9	14833	-1446	48089	50345
Apr	-5 33.0	14905	72 46.7	14835	-1442	48084	50341
May	-5 34.3	14917	72 46.1	14847	-1448	48096	50356
Jun	-5 33.8	14924	72 45.7	14854	-1447	48097	50359
Jul	-5 32.6	14921	72 45.9	14851	-1441	48098	50359
Aug	-5 30.7	14910	72 46.6	14841	-1432	48099	50357
Sep	-5 29.7	14900	72 47.3	14832	-1427	48099	50354
Oct	-5 27.8	14892	72 47.7	14824	-1418	48091	50344
Nov	-5 27.7	14907	72 47.3	14839	-1419	48121	50377
Dec	-5 26.9	14908	72 47.1	14841	-1415	48116	50373
Annual	**-5 31.9**	**14908**	**72 46.8**	**14839**	**-1437**	**48099**	**50356**

Lerwick Observatory K Indices 1996

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0000 1032	3000 1221	1100 1132	2211 2123	1211 1121	0100 1101	2100 1232	3221 2223	2201 1220	1110 1022	1000 0001	0000 0101
2	1000 0223	3211 1311	1000 0002	0000 1213	1111 2211	1100 1211	2100 1122	2121 3211	0100 1212	0110 3312	1000 0000	0100 1232
3	4011 1101	0000 1002	1010 1222	1001 2223	1100 2212	0000 1111	2311 2111	2112 1212	0000 1101	2221 2243	0000 0011	3101 1212
4	0001 1102	0001 1112	2220 1222	2211 3202	3211 2233	2100 1211	2211 1120	0111 1211	0001 2324	0100 2212	2112 2223	1100 2333
5	2111 1113	2200 0111	1211 0121	2001 1112	3121 1101	1110 0122	3311 2210	2210 2111	1111 1111	0000 0010	2210 1122	0000 0000
6	3100 0102	1000 0000	0001 2100	1000 1000	1100 1111	1322 3220	0111 1211	1000 2232	1011 2202	1000 1000	2211 0123	0000 0011
7	0000 0022	1001 1113	0000 1010	0000 1100	1001 2111	0102 1220	2221 3210	0000 1132	1111 1112	0000 1112	1100 0101	0010 0011
8	1000 0010	2110 1122	0231 1001	0000 2113	2211 1111	0000 1122	1121 3312	1101 1110	2200 2010	1111 2242	0101 0000	0000 0001
9	0000 1012	2111 1023	1211 1221	2221 2333	2200 2100	0000 2220	1010 1100	2002 2322	0001 2114	2431 2244	0211 2142	0000 0125
10	2000 0022	0111 1234	1111 2134	2111 1110	1101 1121	0101 2110	0000 0110	1200 1101	4433 3342	2311 1231	3211 1210	5232 3343
11	0000 0033	4313 1233	5522 2233	1110 2213	0100 2110	0100 2111	0000 2111	1000 0112	3322 2224	1111 2222	0000 0120	3122 2133
12	0000 0104	2222 2023	2212 2234	4233 3344	0001 1012	1000 2110	1231 2132	1100 1102	5442 3434	2212 3323	3221 1002	1111 1221
13	3433 2323	2221 1242	4323 2323	1001 2224	2232 3323	0101 0000	1111 3211	2101 2110	4112 1234	2322 1223	1101 1254	0110 0110
14	3013 3335	3212 2211	3111 1022	3222 3237	2211 2223	0101 1010	1110 1113	1112 2333	3112 1121	4312 2301	5112 2343	0011 2123
15	3211 2223	2110 0142	1110 1021	6231 2222	0121 2231	0101 2221	1101 2322	1011 1211	1122 3243	1100 0120	3112 2321	2201 2243
16	3211 1231	2200 2213	1211 1100	2110 2213	2110 1243	1210 1111	0101 1211	2112 3322	1332 3323	2211 2321	1000 1101	3121 1223
17	2211 1243	3210 0022	2421 1232	4421 2445	2112 2111	1210 2212	2211 2211	3222 1113	3211 1123	1001 1123	2111 1144	2221 1220
18	1211 1232	0111 1334	3111 1132	4322 3224	0000 1100	0110 1223	1111 1211	0011 1211	3122 3333	4433 2123	3311 2231	1110 1222
19	0011 1234	2111 0032	1222 2433	3222 3443	0002 2233	4212 2222	1101 2101	1110 1101	1012 2532	4423 4445	2211 1113	1000 0001
20	2132 2101	2101 2112	2321 2344	4312 3232	3111 3223	2211 1111	2211 2311	1122 2220	4324 3335	4221 2222	1011 0133	0000 0100
21	1021 0223	2121 1001	4223 4455	3221 2223	2211 2221	1000 2101	1201 2221	0101 1111	4433 2433	2111 1311	2100 0002	0100 0222
22	2000 1122	2321 1121	2112 1442	2301 2121	0000 2122	1000 1110	2110 1121	1100 1211	3343 3412	3322 3456	2011 1100	1000 2224
23	2000 1010	2212 2422	3210 0032	3211 2133	2100 1110	0000 2110	1100 1210	2221 2122	2333 3533	7432 1322	0001 0011	3211 0100
24	0000 1322	4421 1242	4112 2335	1101 1231	1211 2131	3101 1220	0100 1102	2211 2213	1111 2122	3111 1221	0011 1214	1000 0100
25	1100 1023	2112 2453	4331 3421	2210 1100	1201 1221	0000 1101	1012 2221	3221 2331	0311 2212	1121 1021	2211 1001	1100 1002
26	2110 0221	4112 2133	2211 2232	2000 1210	2211 1210	1010 1112	1110 1122	2221 0223	2321 2364	2000 0110	1101 1211	0000 0001
27	2101 1123	1221 2244	3312 2113	1001 1123	0101 2433	0012 2221	0001 1100	3321 1222	4222 2203	1002 1001	3211 1001	1000 0101
28	1110 0043	2311 1112	1211 2112	1100 1100	1110 1100	3200 2112	1000 3442	2111 2333	1321 2422	3322 2233	3201 1211	1000 0001
29	3232 1342	0000 1143	1111 1222	0111 1110	1112 2221	3100 2333	1111 1100	5642 3434	2111 2120	3111 2233	0000 1111	0000 0013
30	2200 1113		1000 1212	1201 2110	2112 1221	1100 1011	2311 2021	4221 1233	0111 1100	1111 1453	0000 0001	3111 2103
31	3111 2123		1011 0213		1111 2222		3113 3323	2212 2221		2111 1112		1100 0121

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
6	2	19	49	SI*	C	6	-0.7	
10	3	22	58	SSC*	B	41	5.2	-33
24	3	08	56	SSC*	B	10	3.3	-3
3	4	10	06	SSC*	B	9	0.6	2
8	4	13	34	SSC*	A	21	-3.3	2
13	4	09	08	SSC*	C	5	1.5	-3
6	6	05	10	SSC*	B	11	5.8	-6
19	6	02	44	SI*	C	-24	7.7	9
20	6	10	23	SI*	C	-10	-1.9	2
27	6	06	29	SSC*	C	-7	1.5	-2
17	8	15	25	SSC*	C	8	1.0	-3
23	8	07	19	SI*	B	16	2.7	3
15	9	15	55	SI*	B	34	3.3	-12
17	9	10	34	SSC*	B	13	-1.3	-3
18	9	12	43	SSC*	C	-8	-3.0	7
11	11	15	27	SSC*	A	9	-0.7	-5
13	11	12	59	SSC*	B	11	-1.2	-2
24	11	09	26	SSC*	C	6	-0.4	-4
1	12	11	52	SSC*	B	-6	-1.0	2
2	12	09	59	SSC*	B	3	1.1	-2
2	12	17	23	SI*	C	-23	1.6	7
4	12	13	53	SI*	B	-17	-1.9	6
14	12	08	27	SSC*	B	14	+2.9/-2.5	-4
24	12	12	38	SI*	C	-5	1.0	

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				
9	7	09	09	09	12	09	16		0.8	-3

Notes

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

Annual Values of Geomagnetic Elements

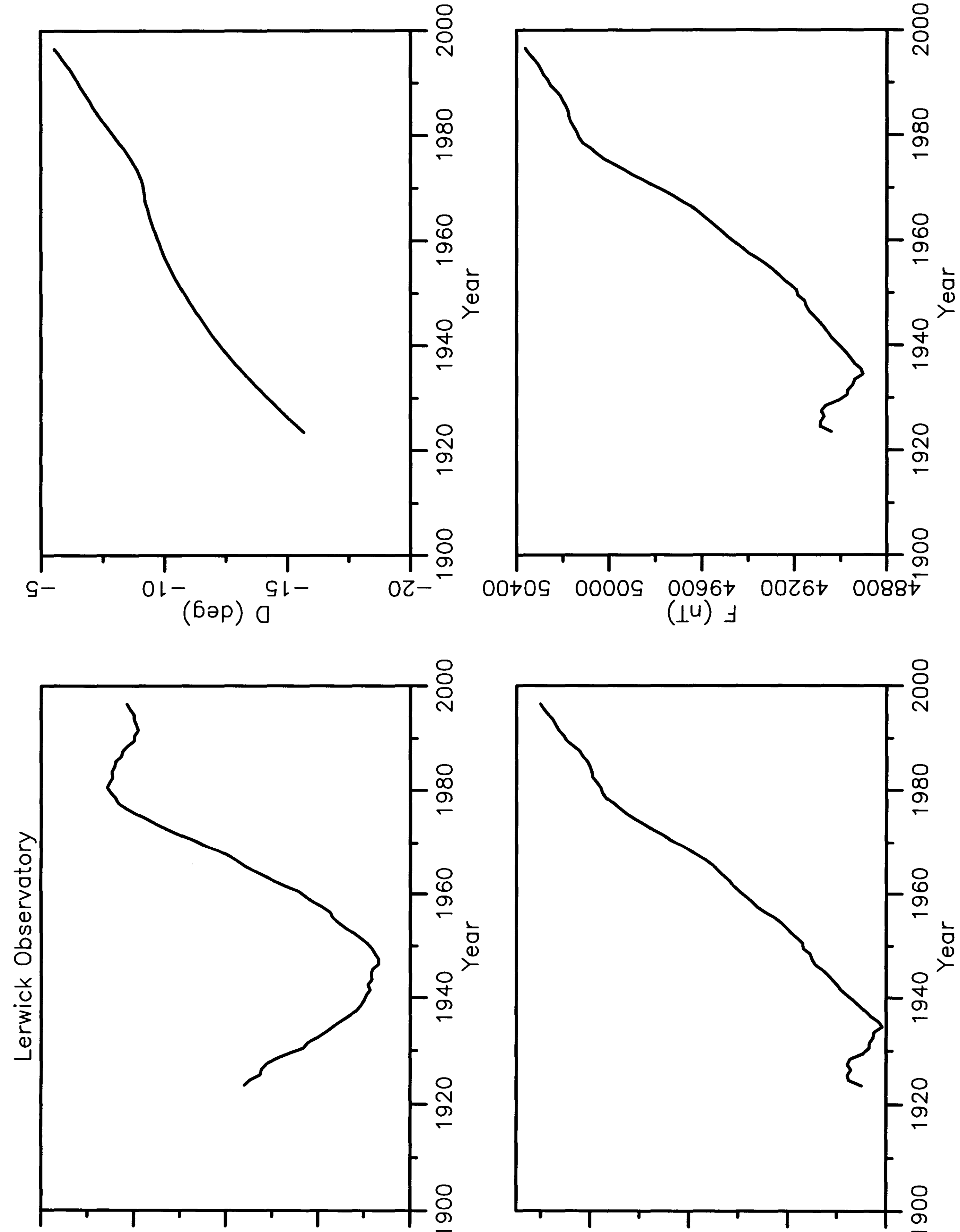
Lerwick

	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

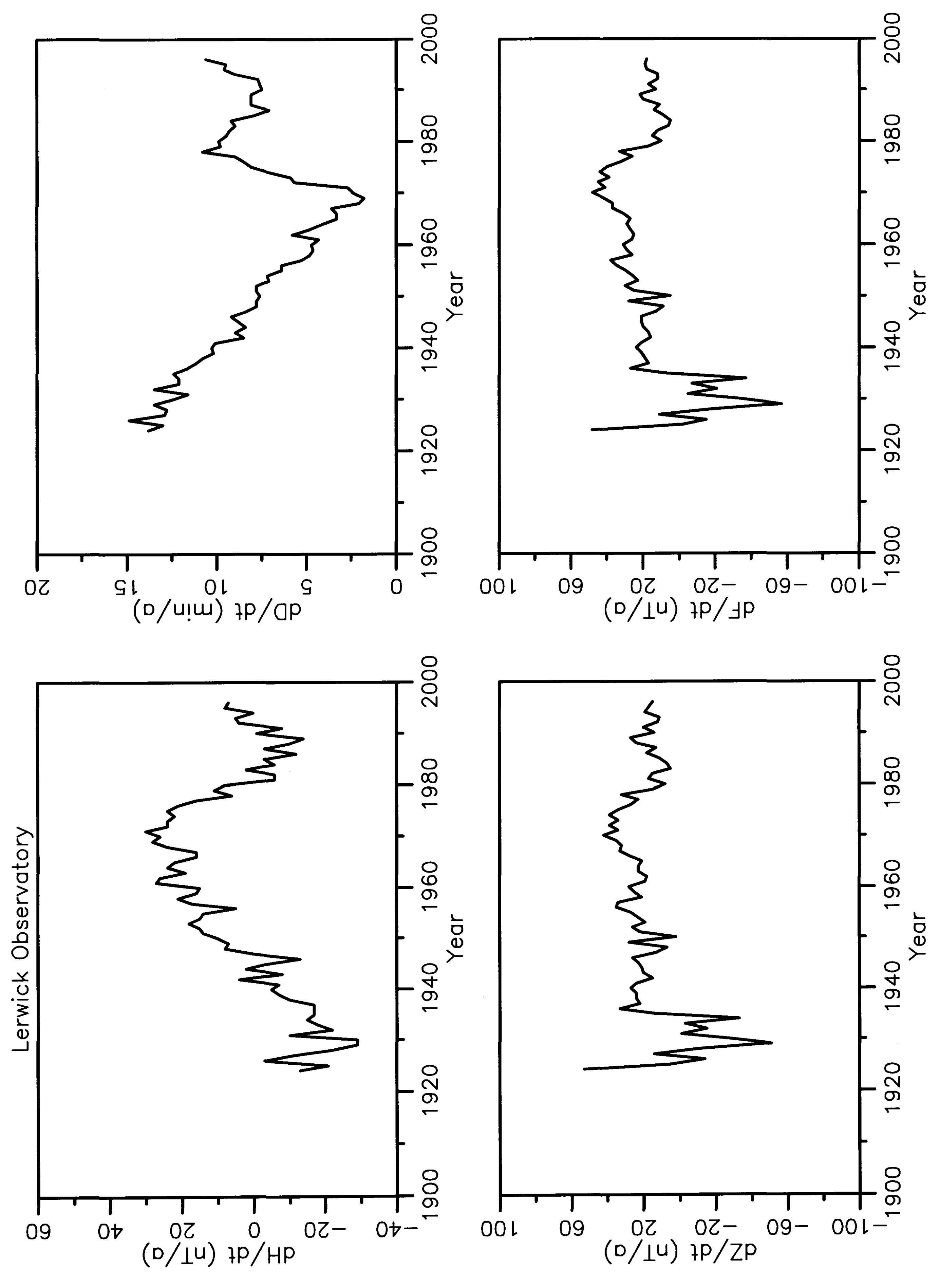
	Year	D	H	I	X	Y	Z	F
	1984.5	-7 13.4	14936	72 40.9	14818	-1878	47902	50177
	1985.5	-7 5.5	14933	72 41.3	14819	-1844	47913	50186
	1986.5	-6 58.4	14921	72 42.5	14811	-1811	47931	50200
	1987.5	-6 50.3	14918	72 43.0	14812	-1776	47944	50211
	1988.5	-6 42.2	14908	72 44.1	14806	-1740	47968	50231
	1989.5	-6 34.1	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
	1994.5	-5 52.7	14899	72 46.6	14821	-1526	48063	50319
	1995.5	-5 43.2	14907	72 46.5	14833	-1486	48080	50338
Note 3		0 0.0	0	0 0.5	0	0	8	6
	1996.5	-5 32.6	14914	72 46.5	14844	-1441	48103	50362

1 Site differences 1 Jan 1934 (new value - old value)
2 Site differences 1 Jan 1990 (new value - old value)
3 Site differences 1 Jan 1996 (new value - old value)

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

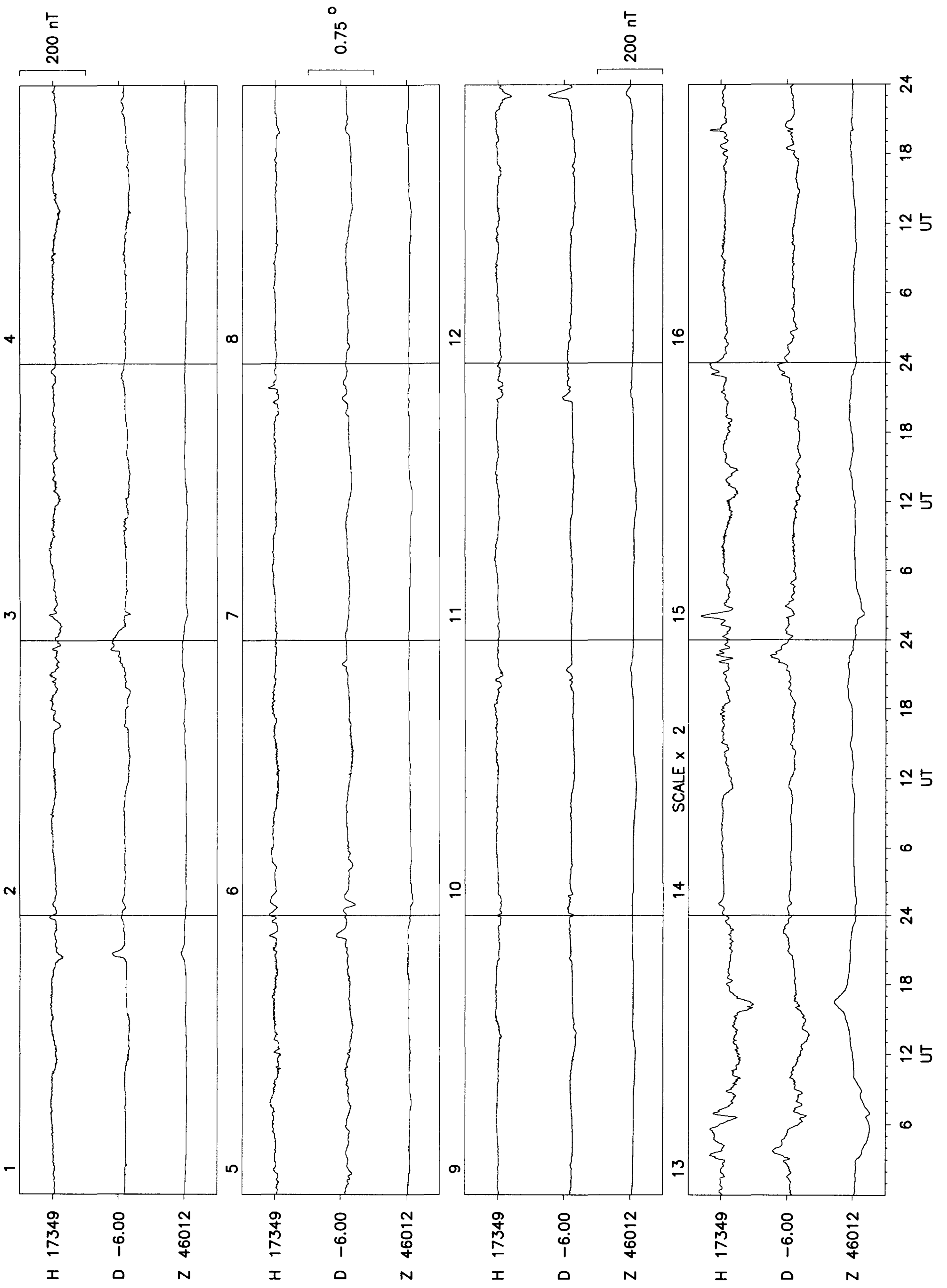


Annual mean values of H, D, Z & F at Lerwick



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

Eskdalemuir 1996


200 nT
0.75 °
200 nT
SCALE x 2
1
2
3
4
5
6
7
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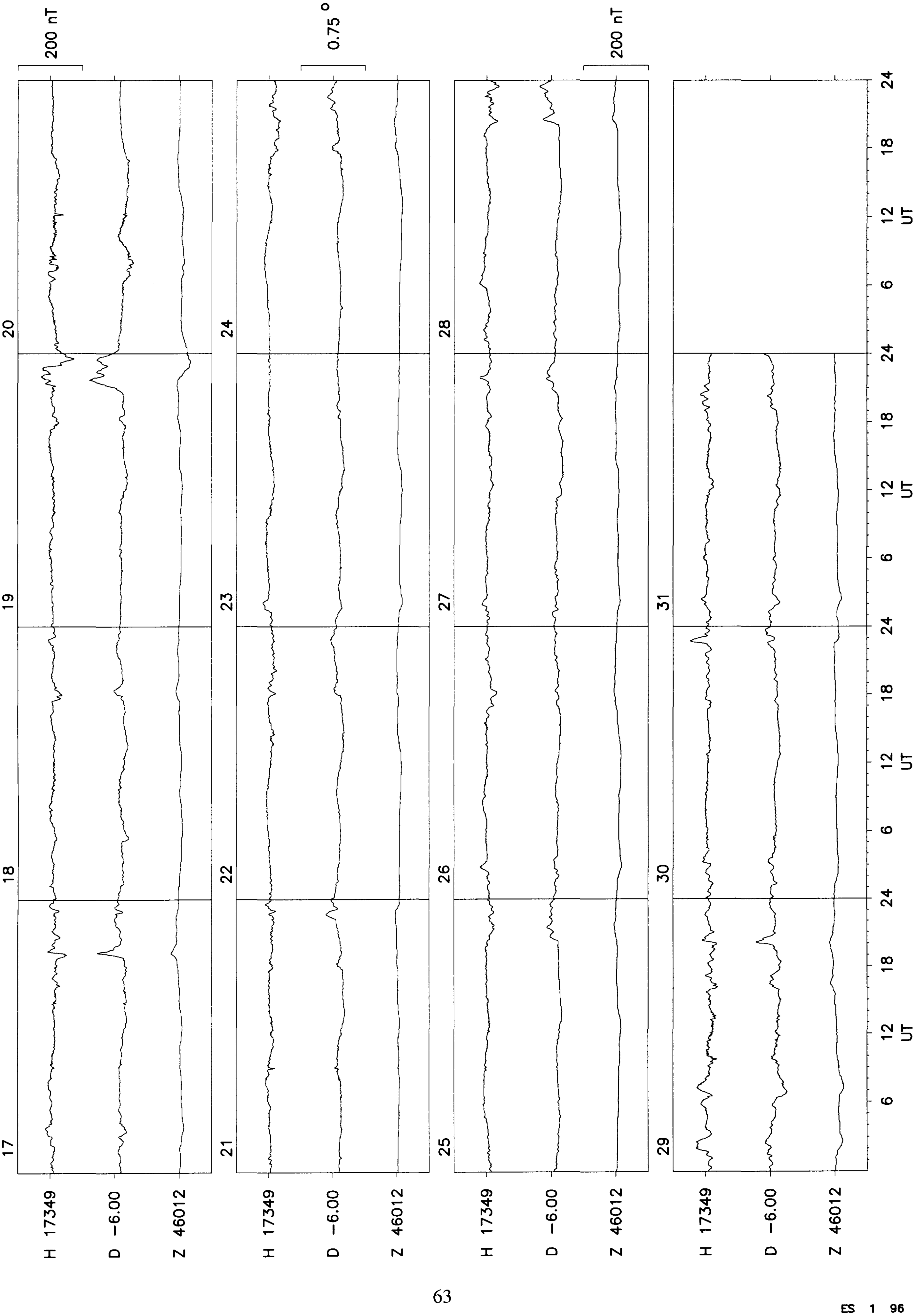
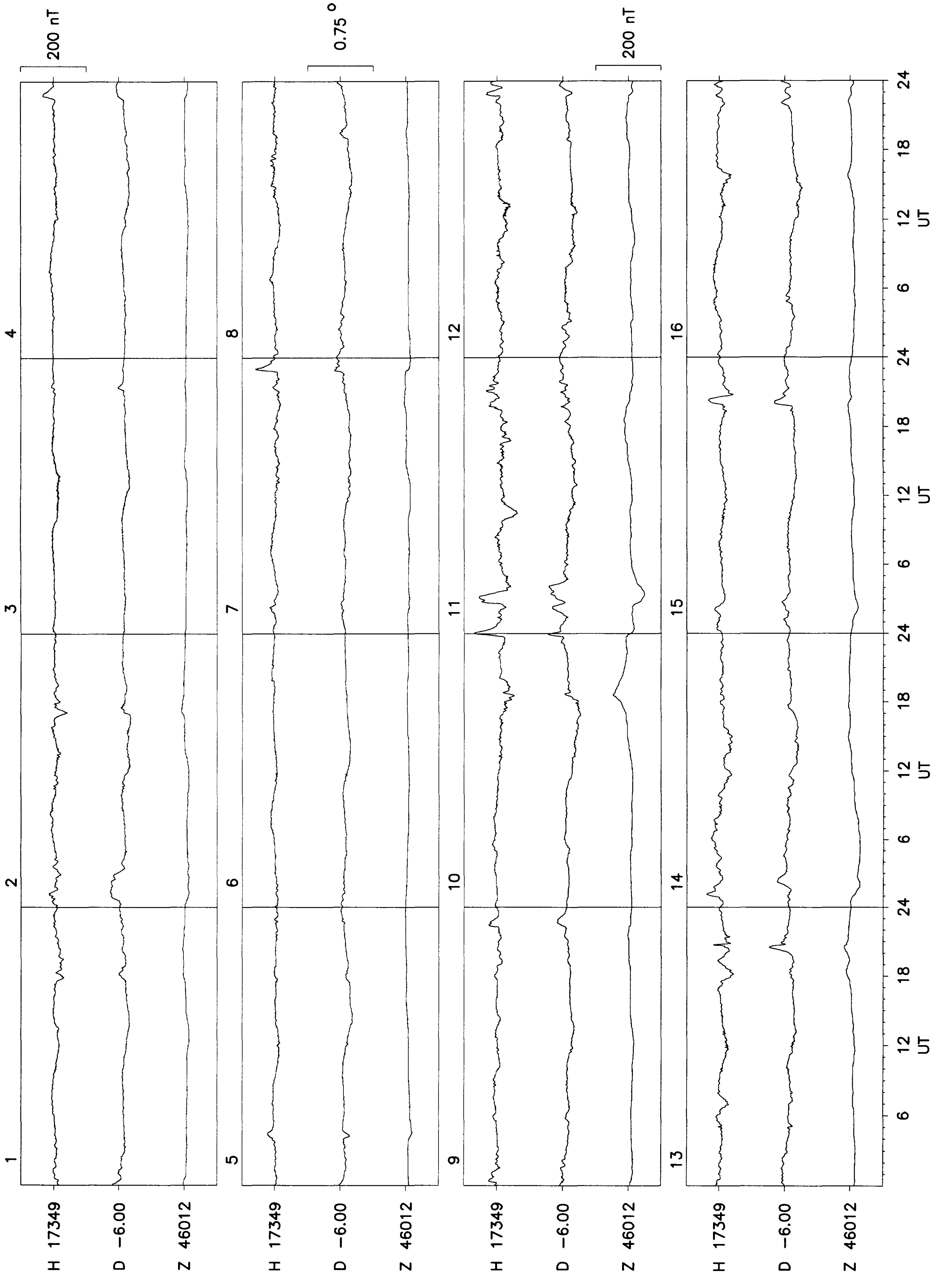
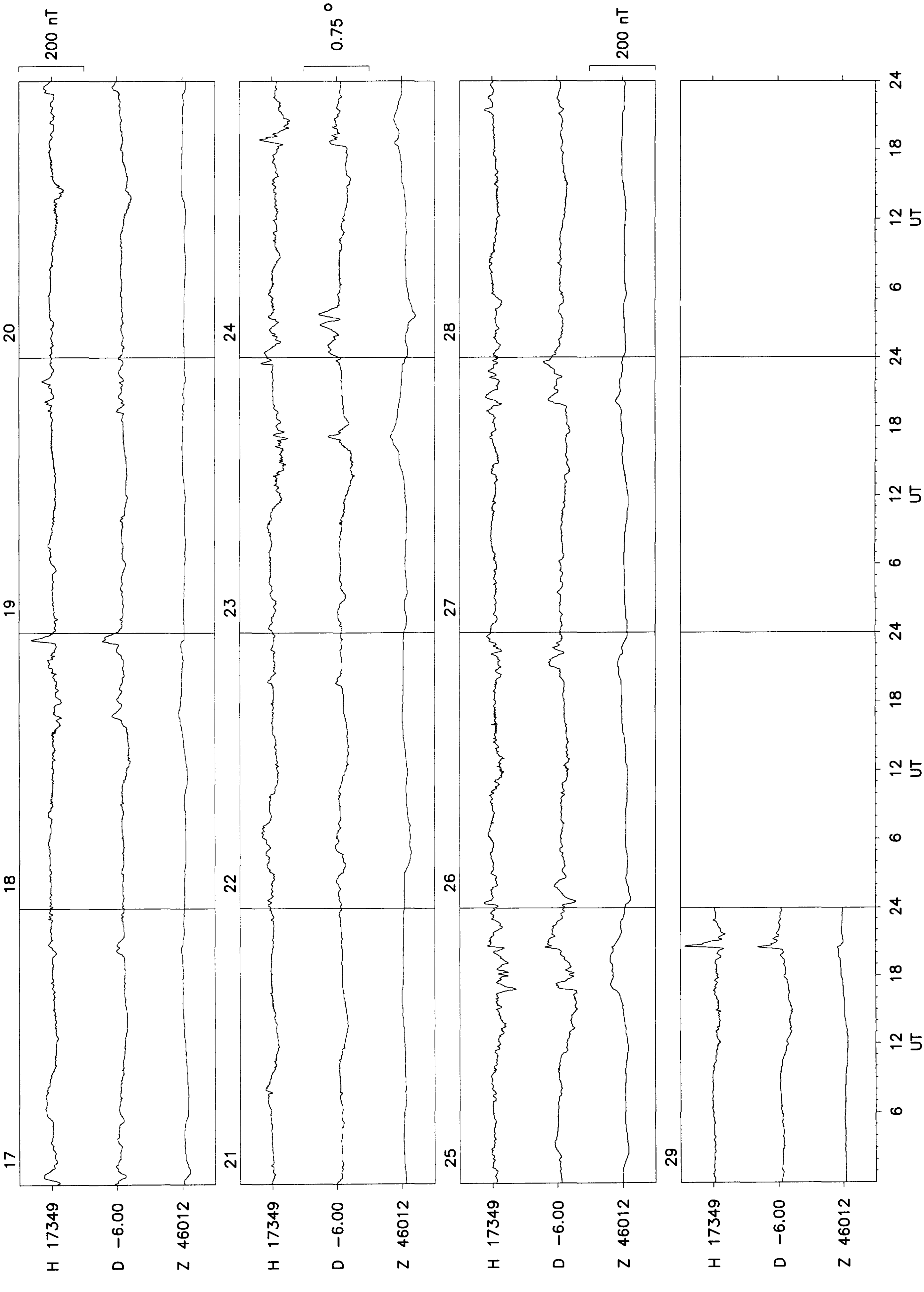
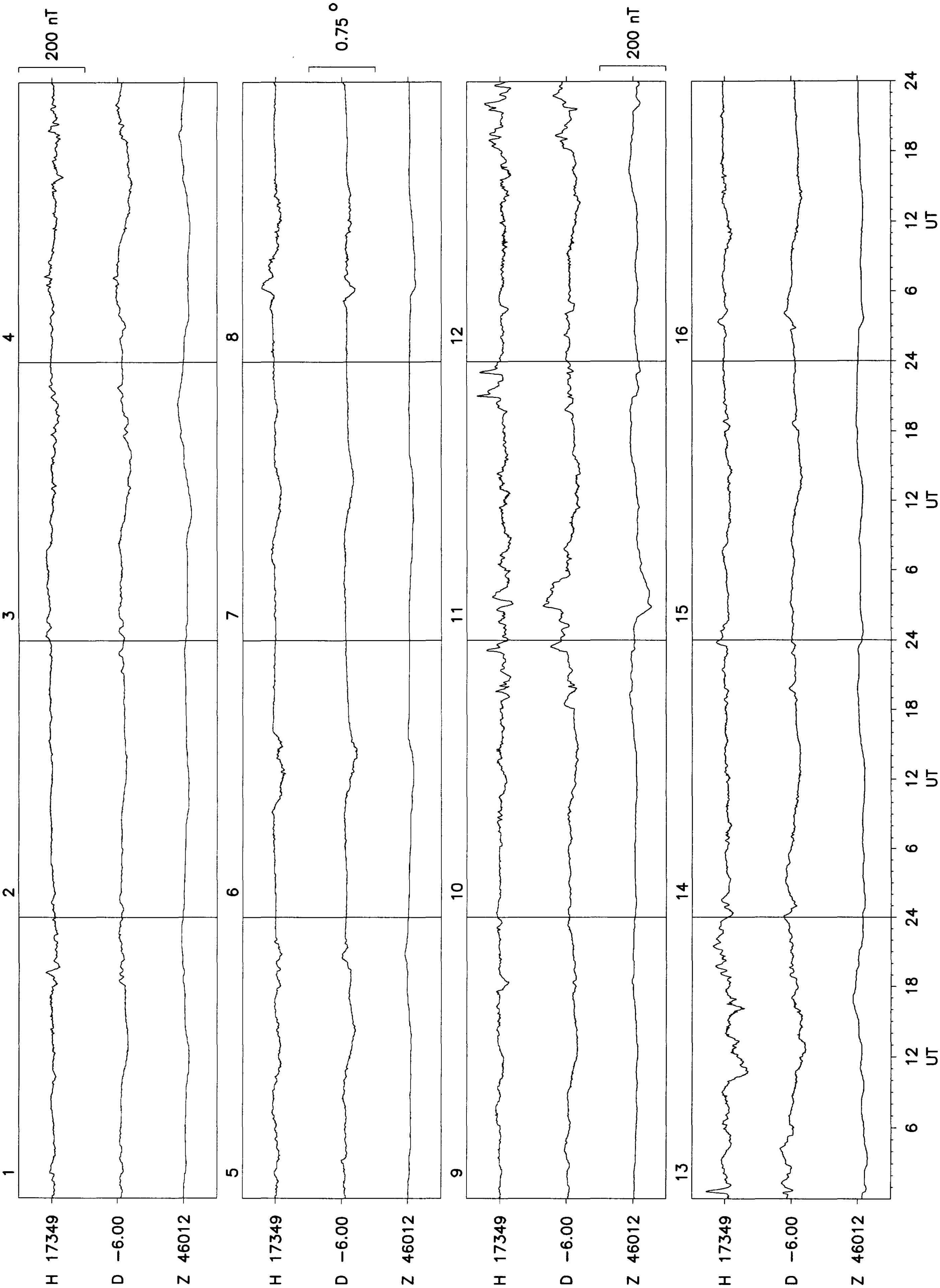
9
10
11
12
13
14
15
16
H 17349
D -6.00
Z 46012
6
12
18
24
UT

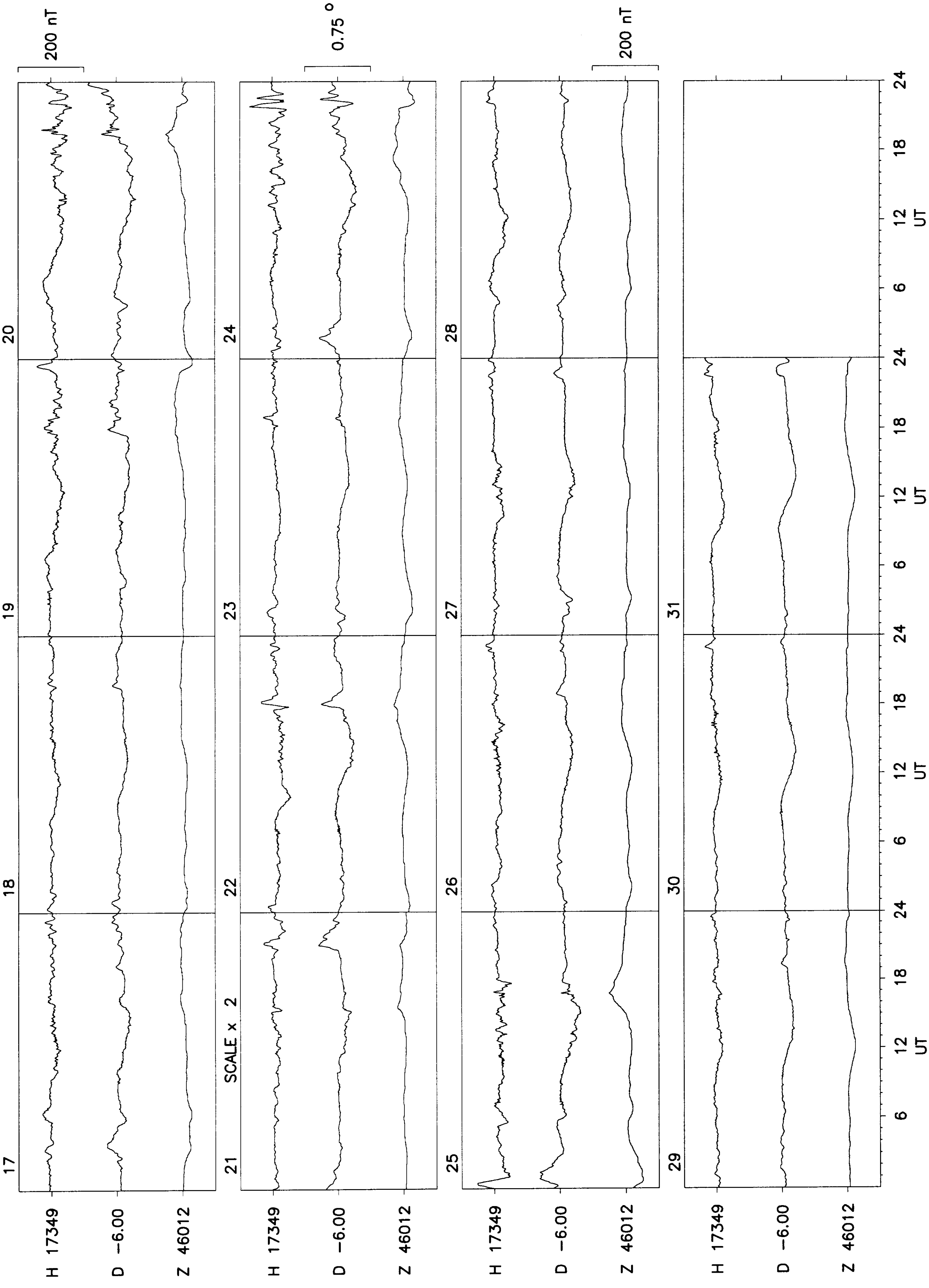

200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
H 17349
D −6.00
Z 46012
6
12
18
24
UT


H 17349
D −6.00
Z 46012
200 nT
0.75 °
UT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16


200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
H 17349
D −6.00
Z 46012
6
12
18
24
UT

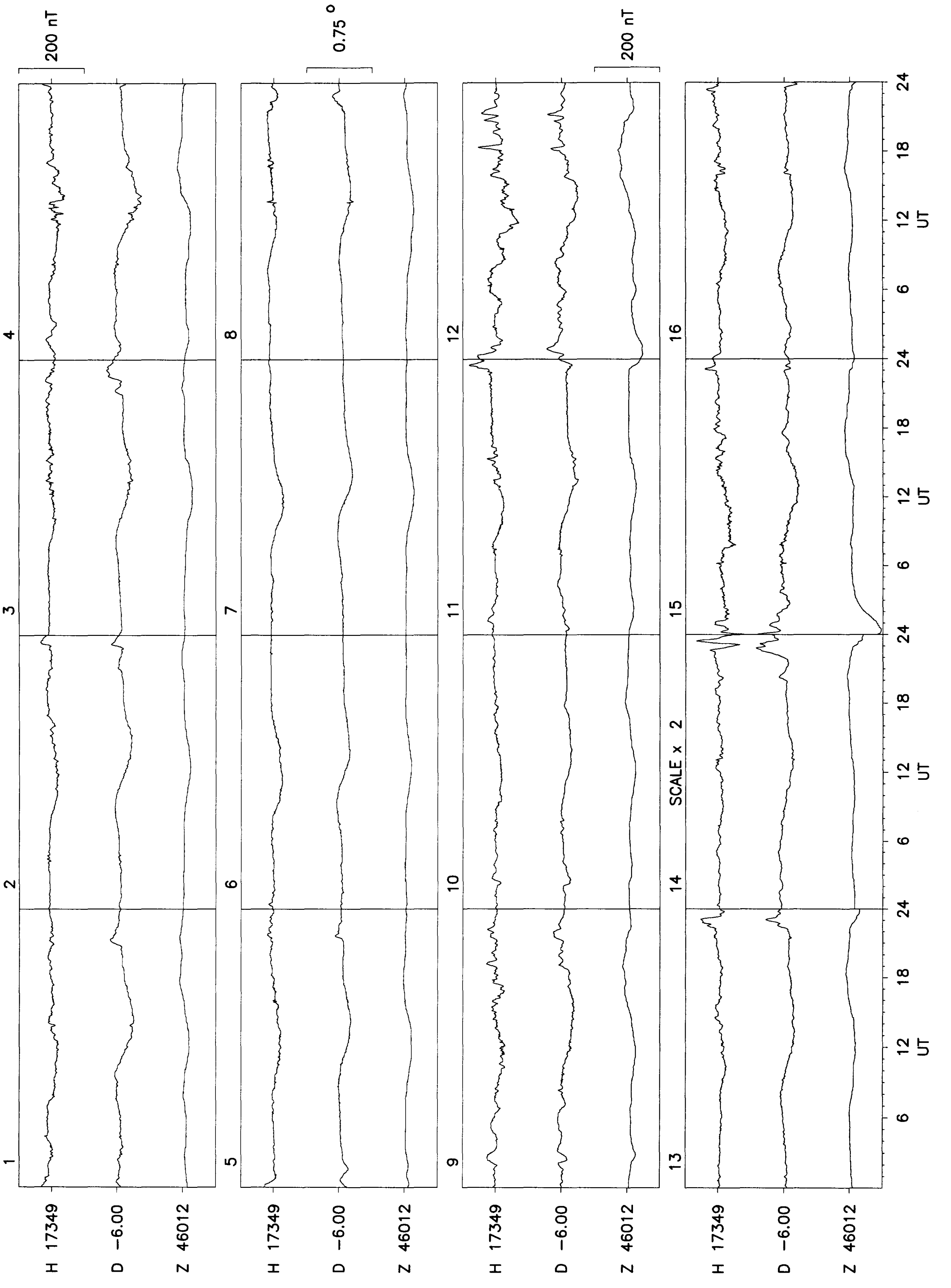


Eskdalemuir March 1996



H 17349
D -6.00
Z 46012
200 nT
0.75 °
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
UT
6
12
18
24

ES 3 96



200 nT
0.75 °
200 nT
H 17349
D −6.00
Z 46012
1
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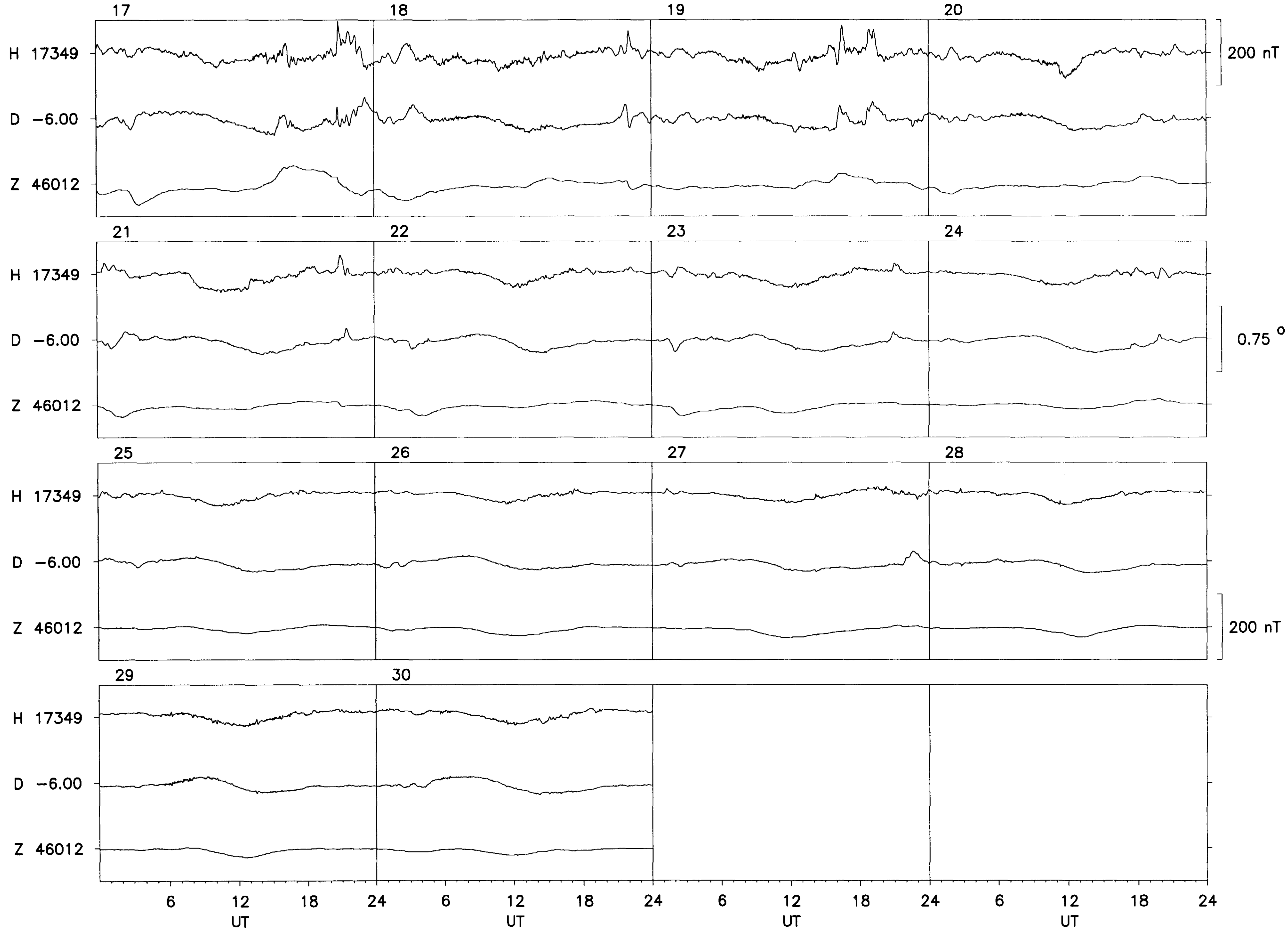
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
6
12
18
24
UT



17
18
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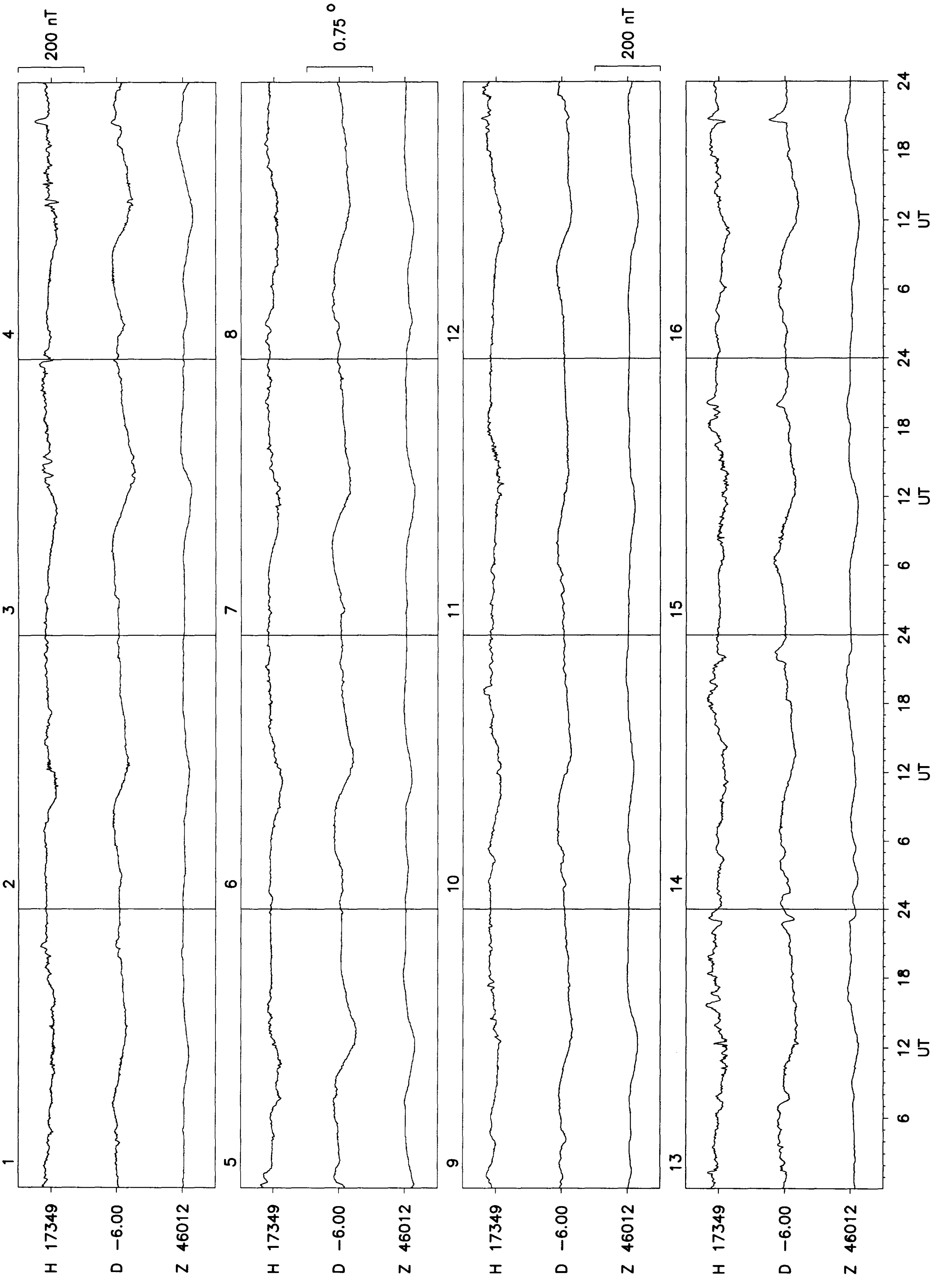
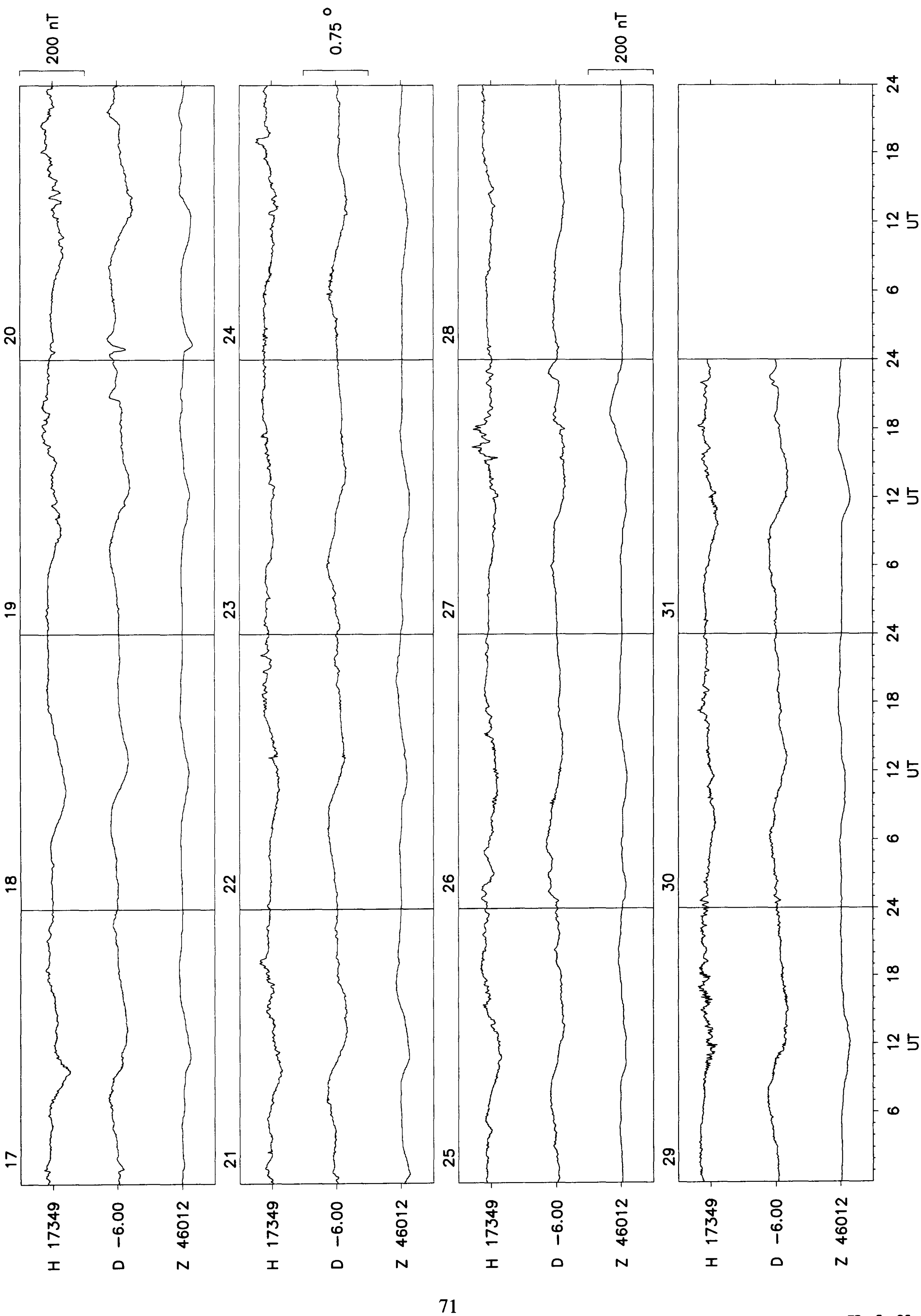
21
22
23
24
25
26
27
28
29
30
H 17349
D −6.00
Z 46012
200 nT
0.75 °
200 nT
6
12
18
24
UT

ES 4 96



H 17349
D −6.00
Z 46012
200 nT
0.75 °
UT



H 17349
D −6.00
Z 46012
200 nT
0.75 °
17
18
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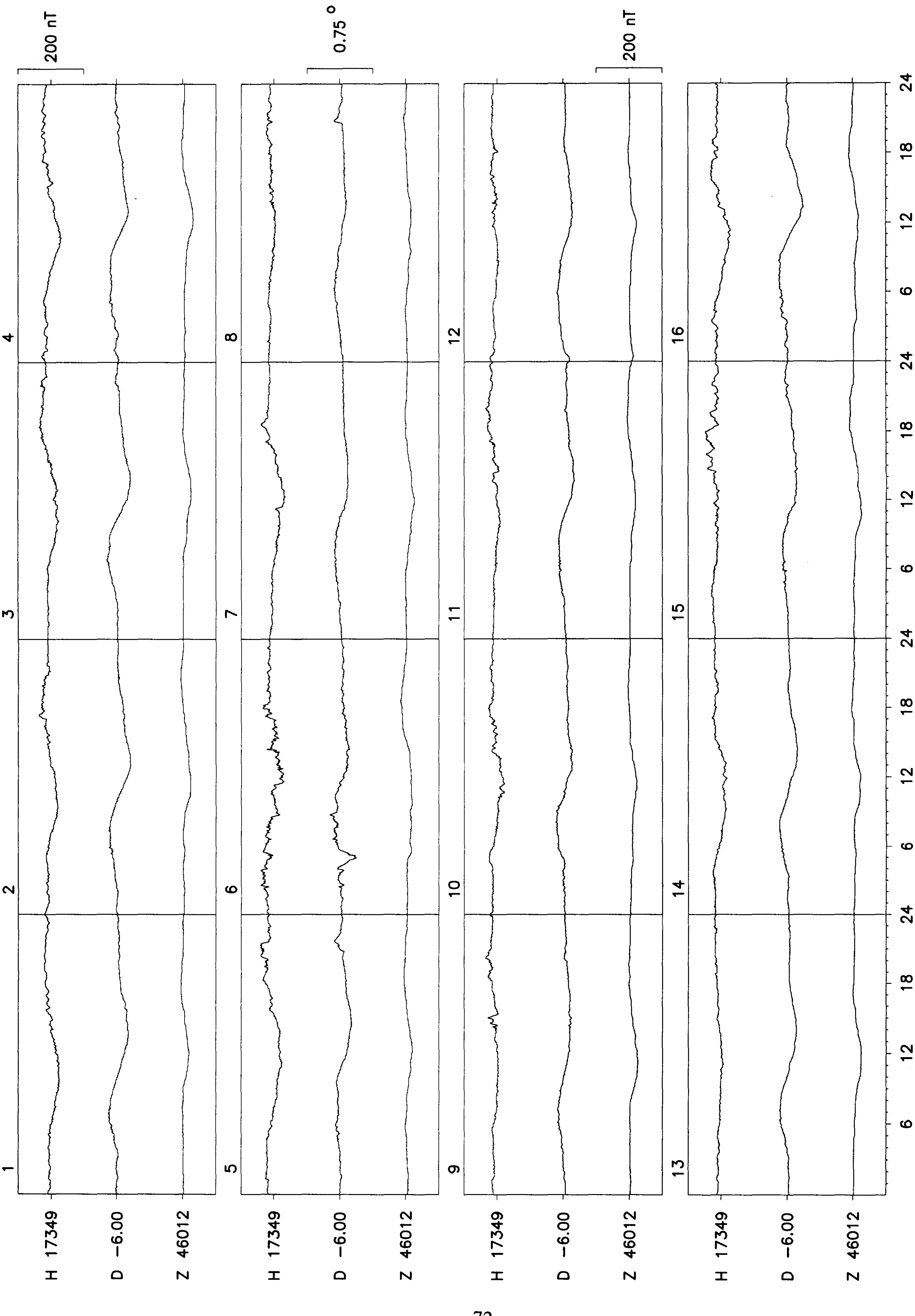
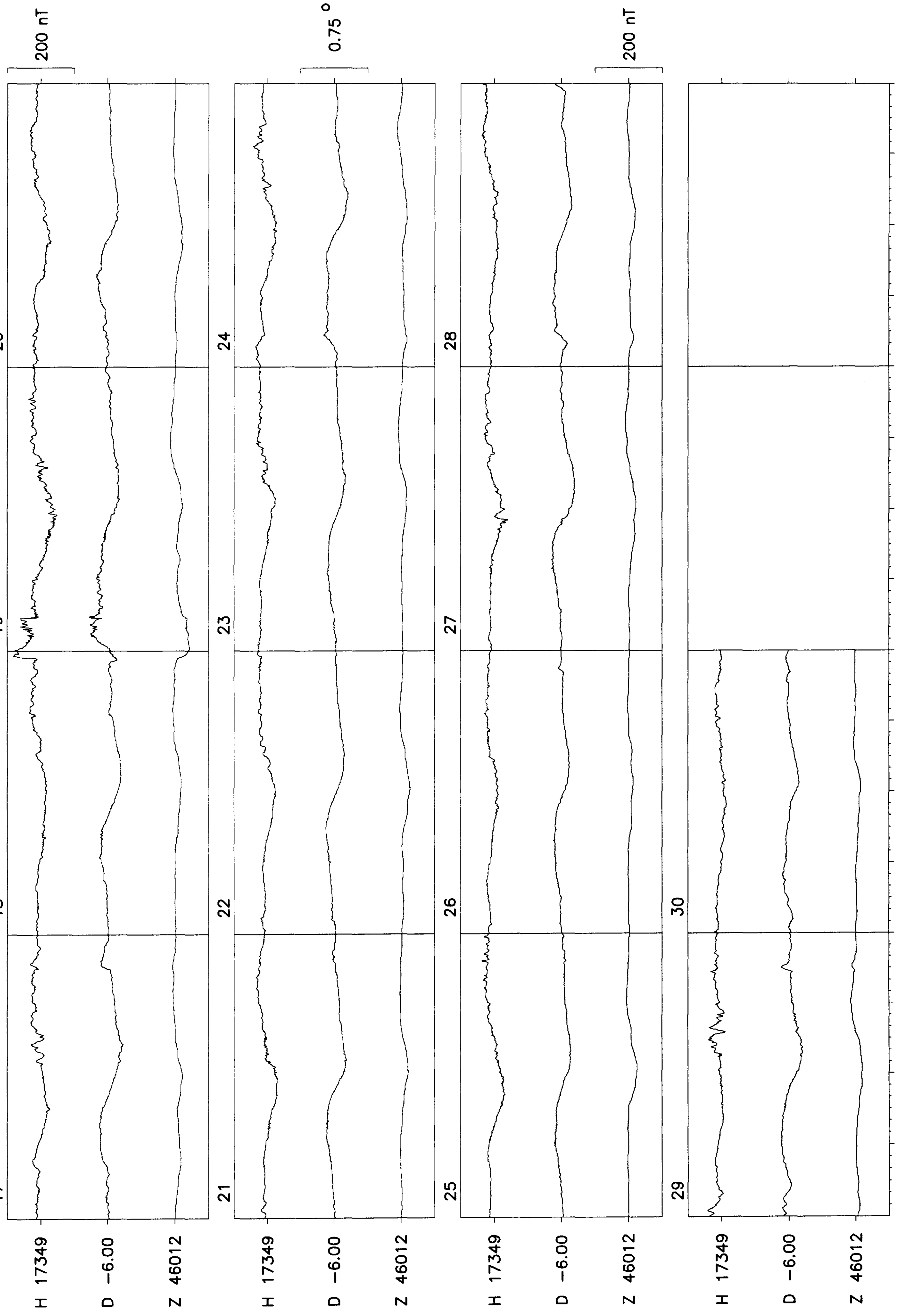
22
23
24
25
26
27
28
29
30
31
6
12
18
24
UT

ES 5 96


200 nT
0.75 °
200 nT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
H 17349
D −6.00
Z 46012
6
12
18
24
UT



200 nT
0.75 °
200 nT
17
18
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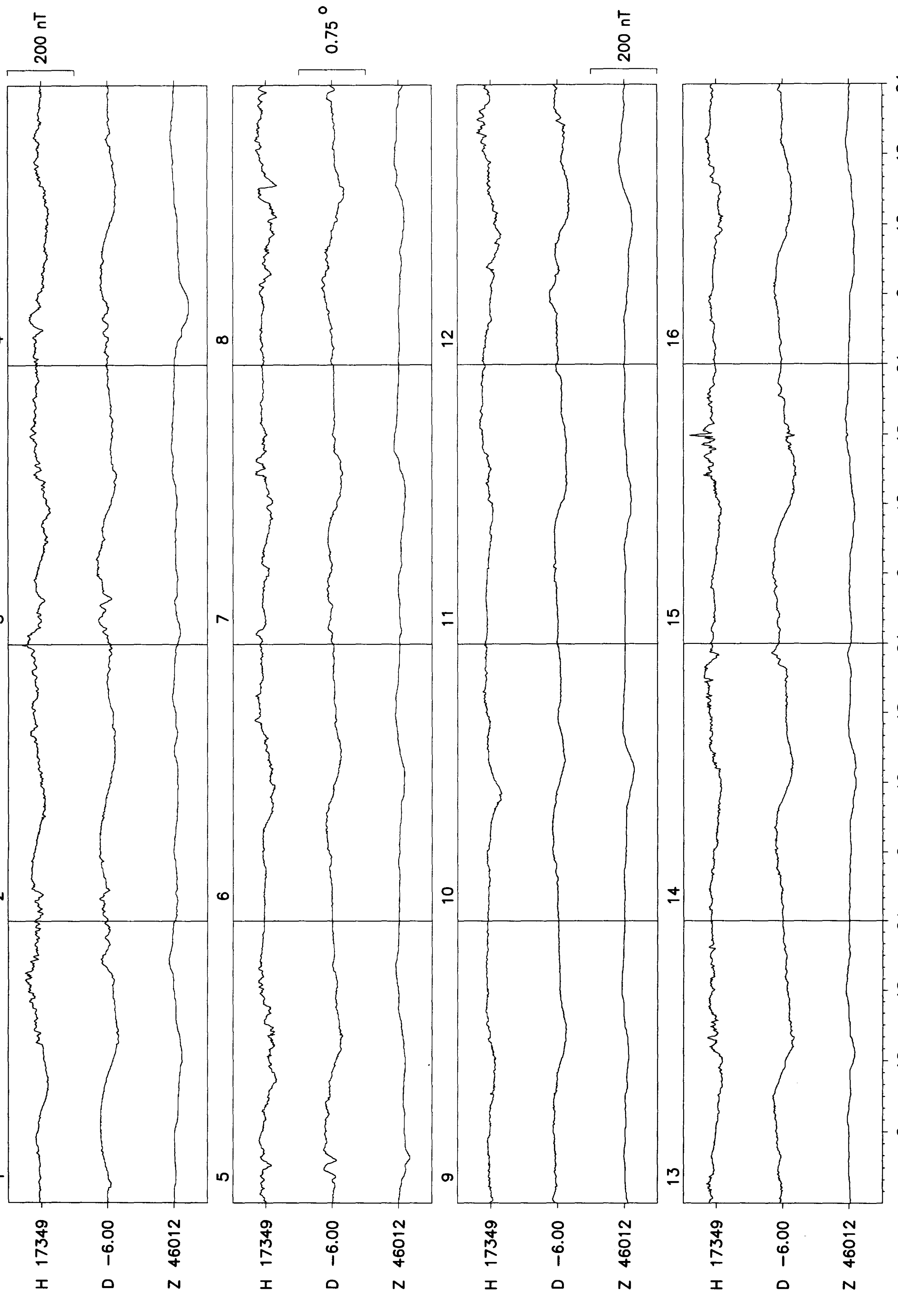
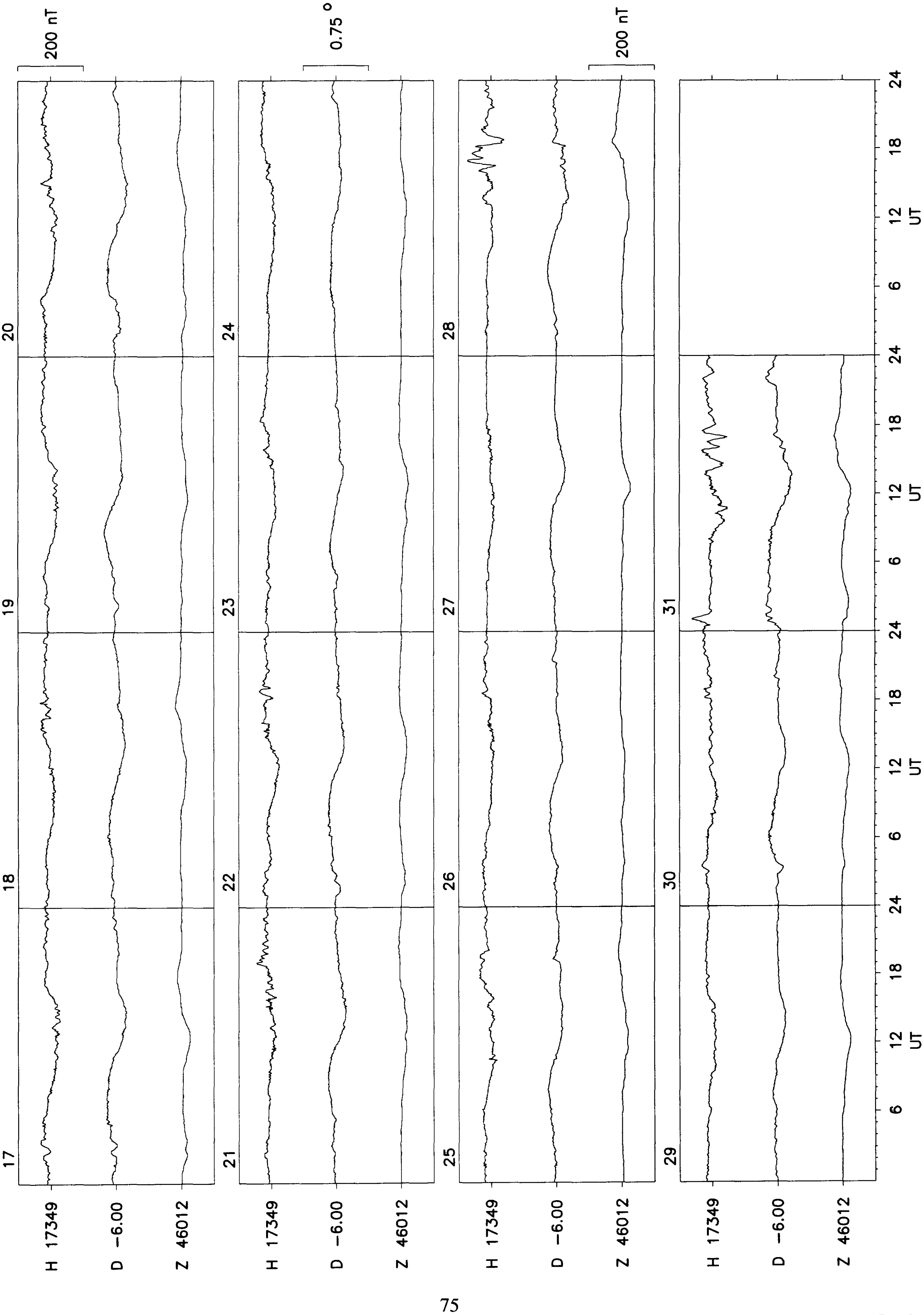
27
28
29
30
H 17349
D −6.00
Z 46012
6
12
18
24
UT

ES 6 96


200 nT
0.75 °
200 nT
H 17349
D −6.00
Z 46012
UT



200 nT
0.75 °
200 nT
H 17349
D −6.00
Z 46012
17
18
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24
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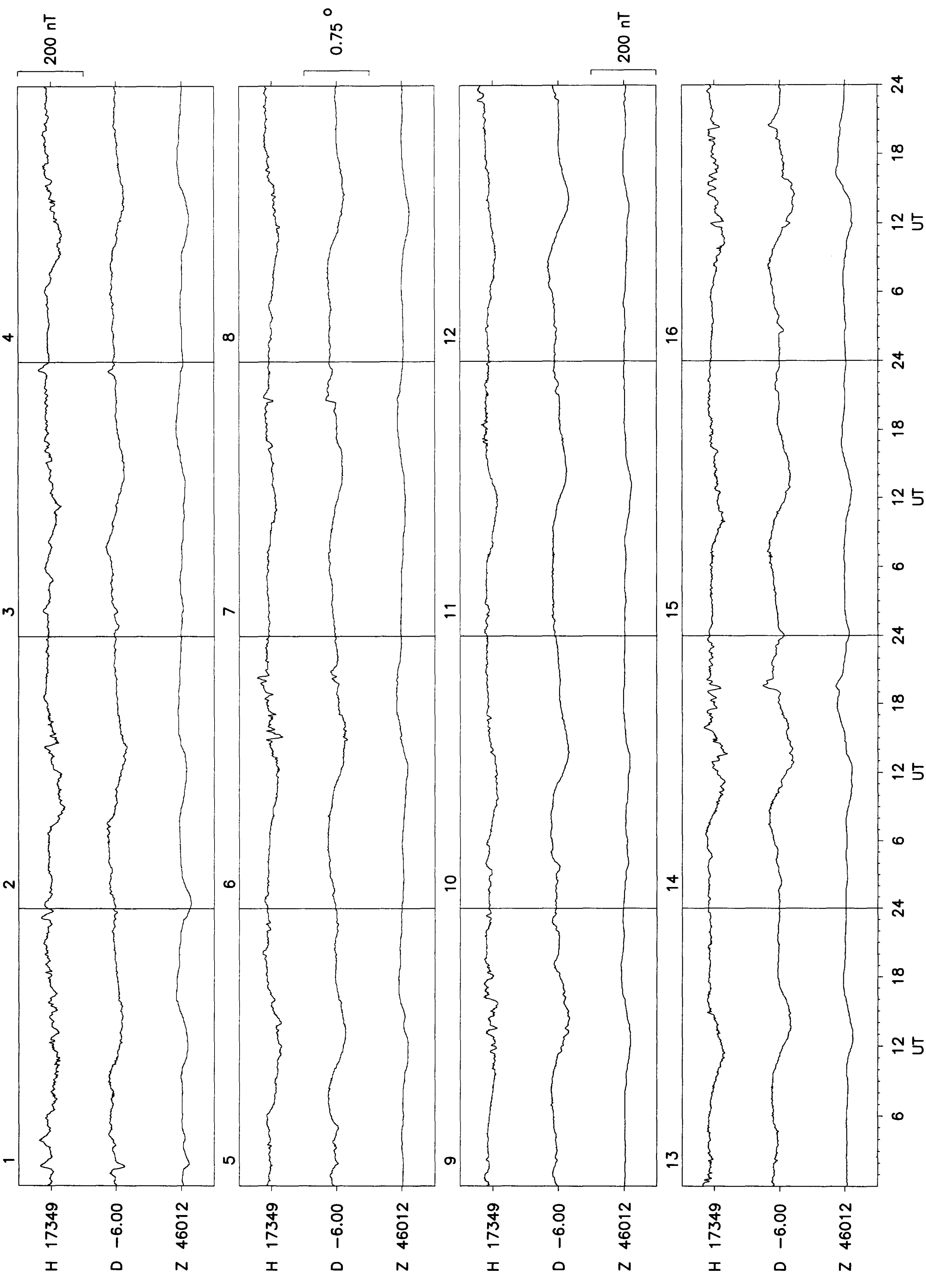
6
12
18
24
UT



200 nT
0.75 °
200 nT
1
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4
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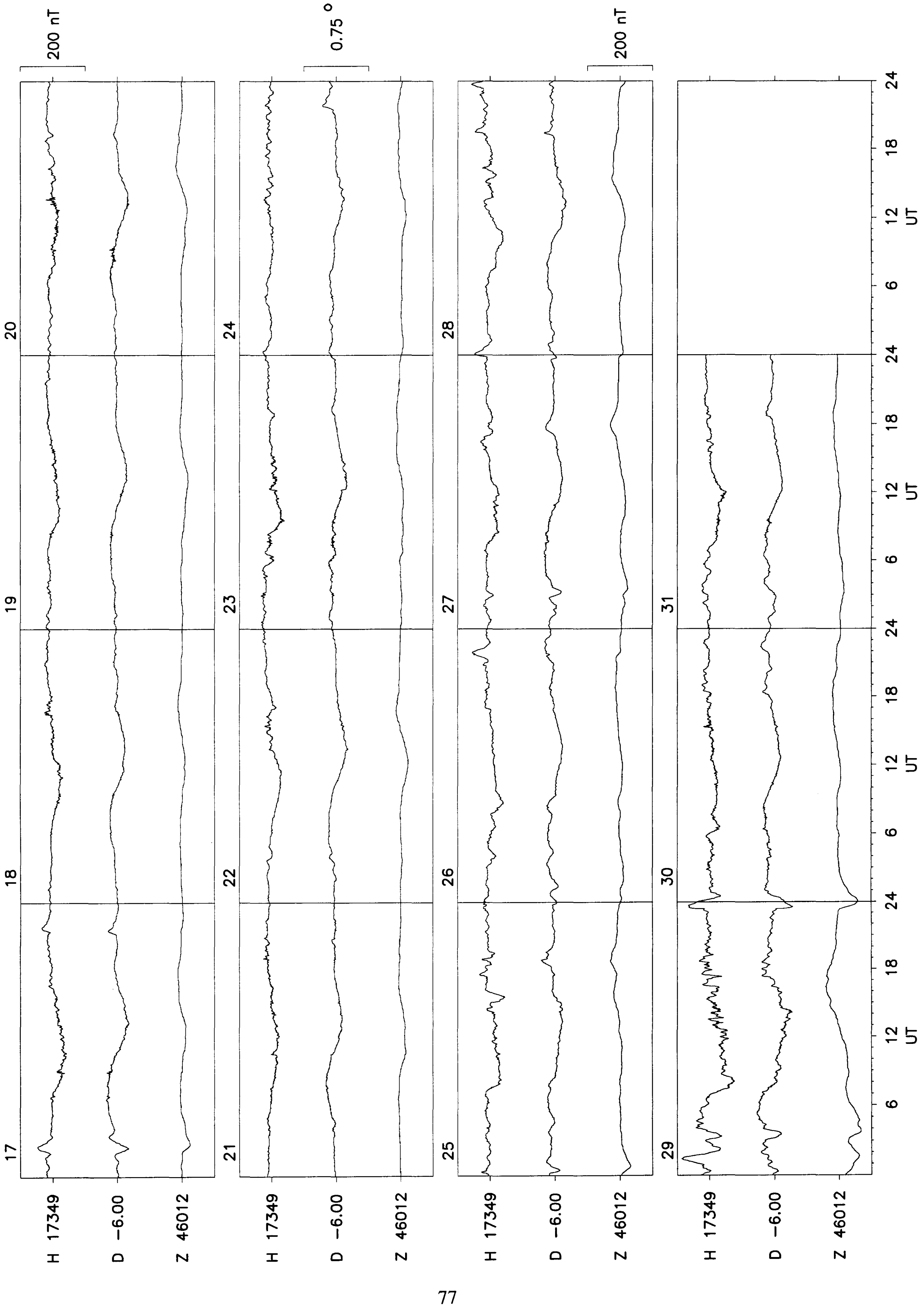
8
9
10
11
12
13
14
15
16
H 17349
D −6.00
Z 46012
6
12
18
24
UT


H 17349
D −6.00
Z 46012
200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
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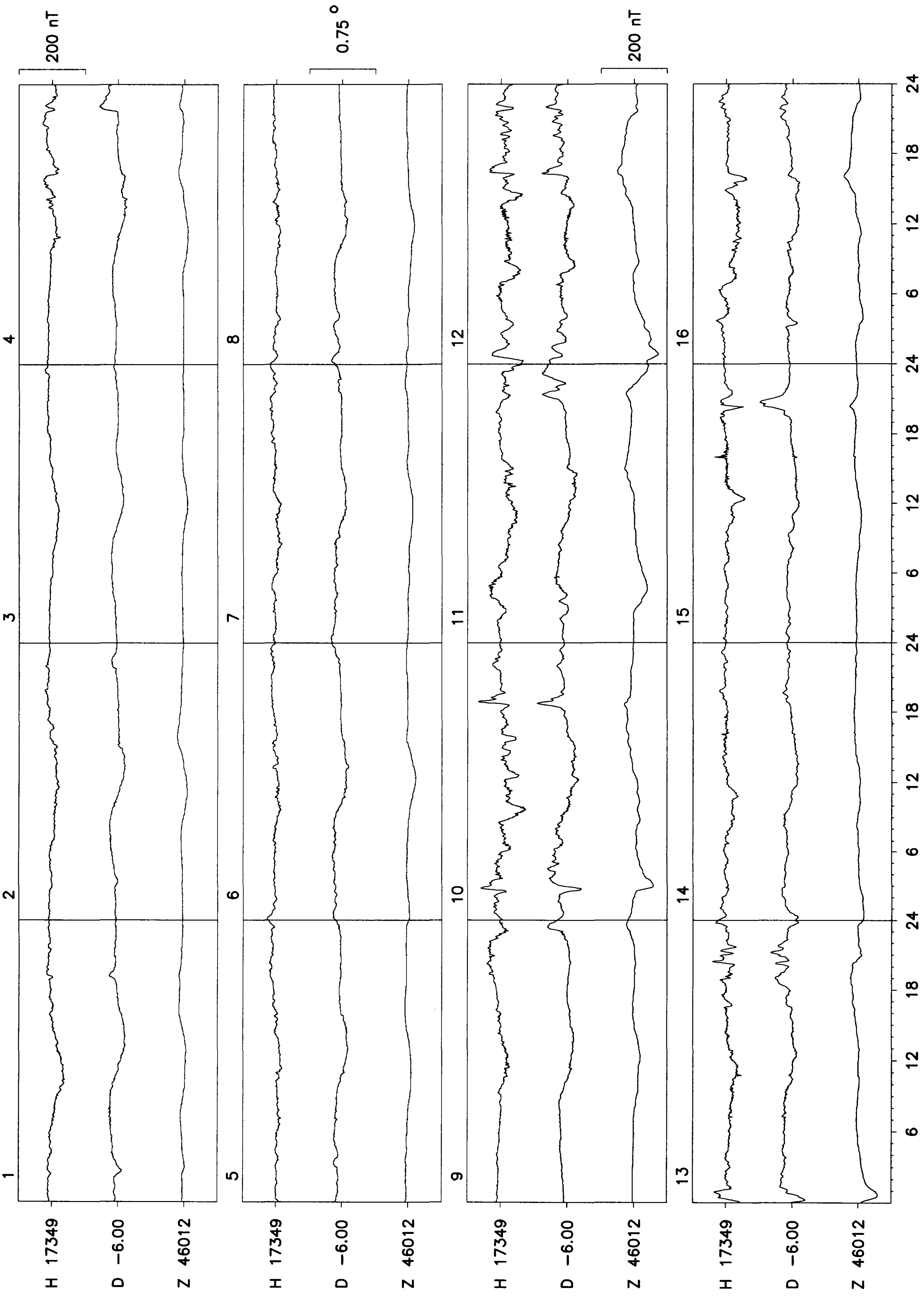
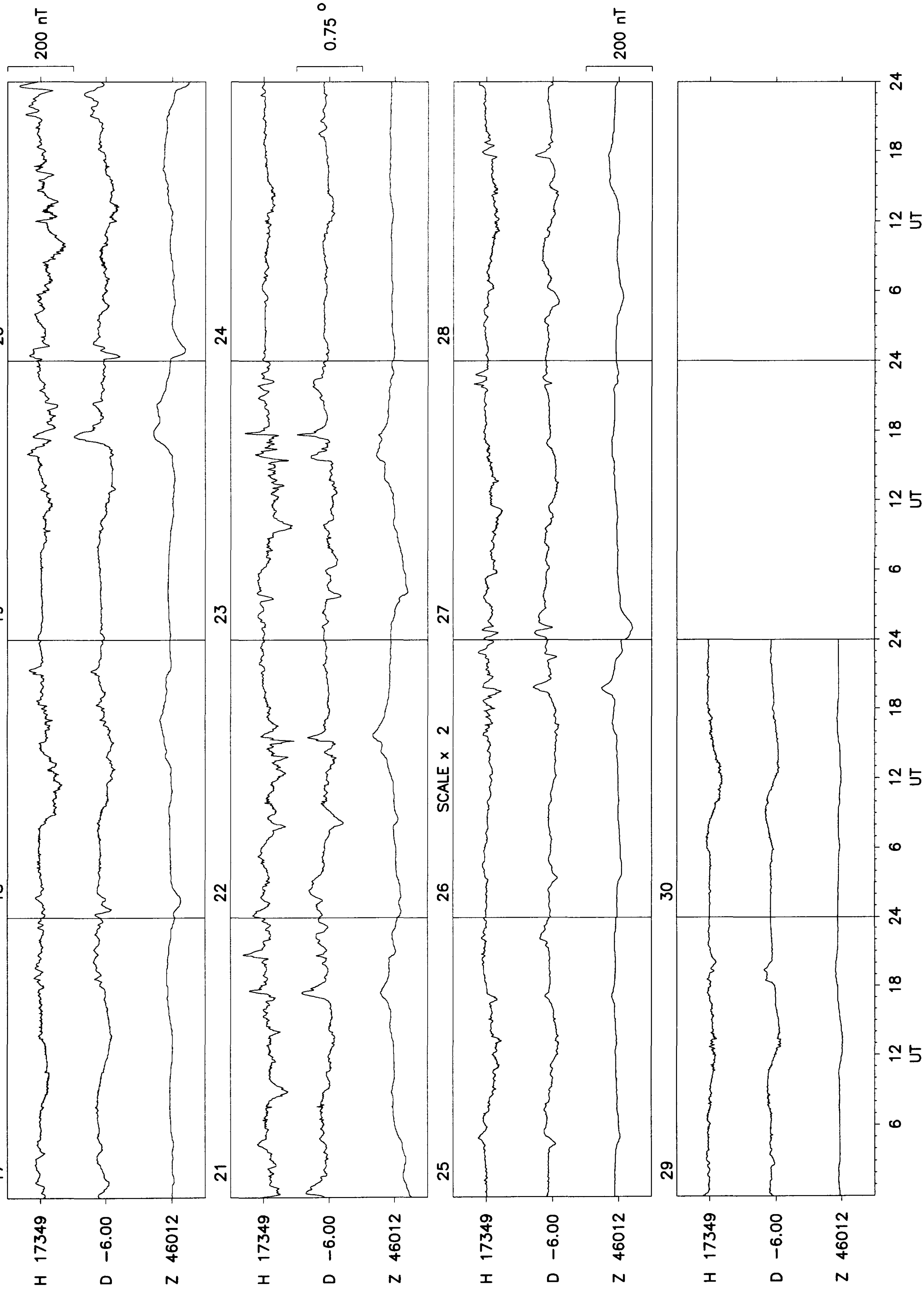
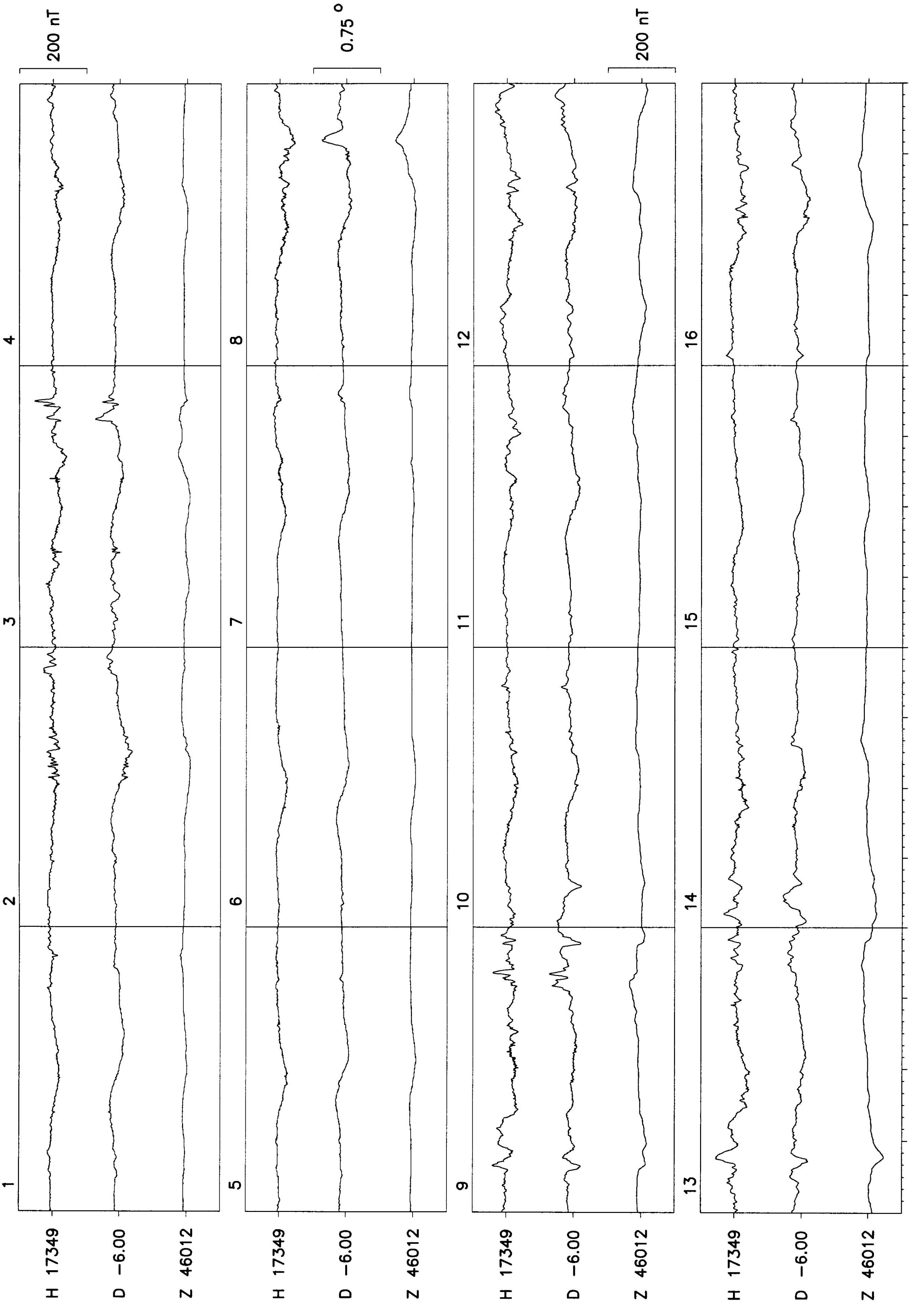
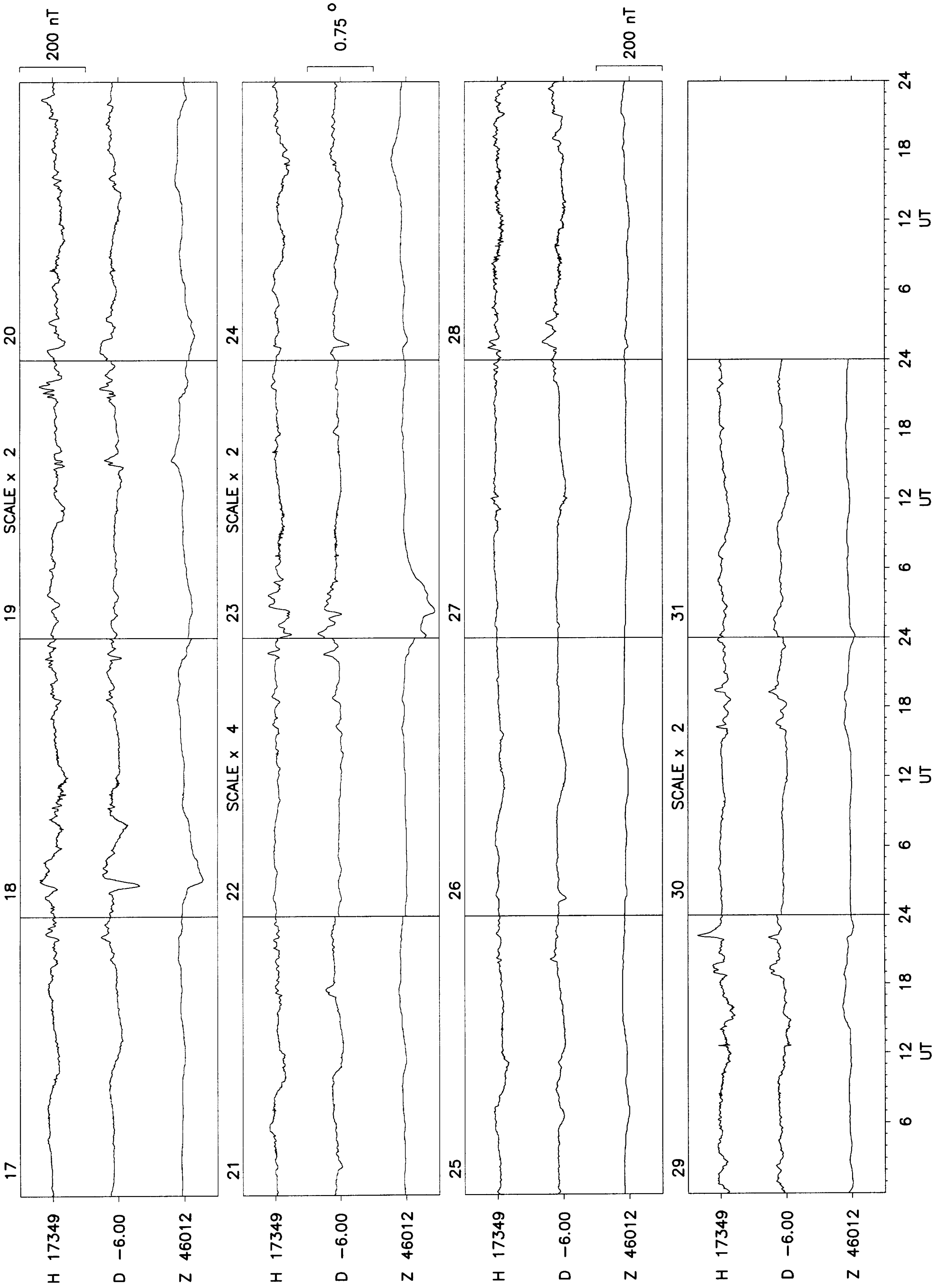
28
29
30
31
UT

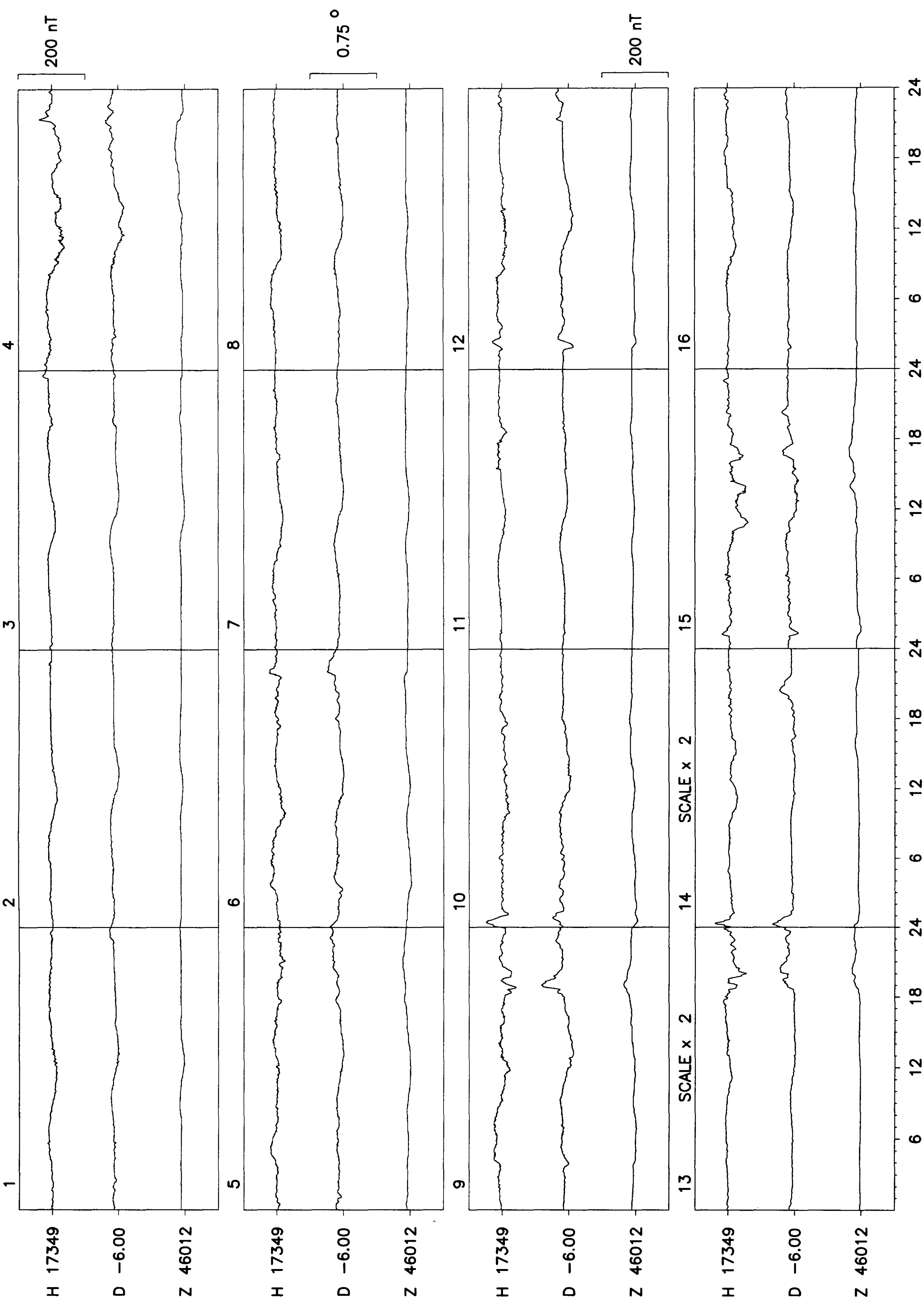

H 17349
D −6.00
Z 46012
200 nT
0.75 °
200 nT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
6
12
18
24
UT

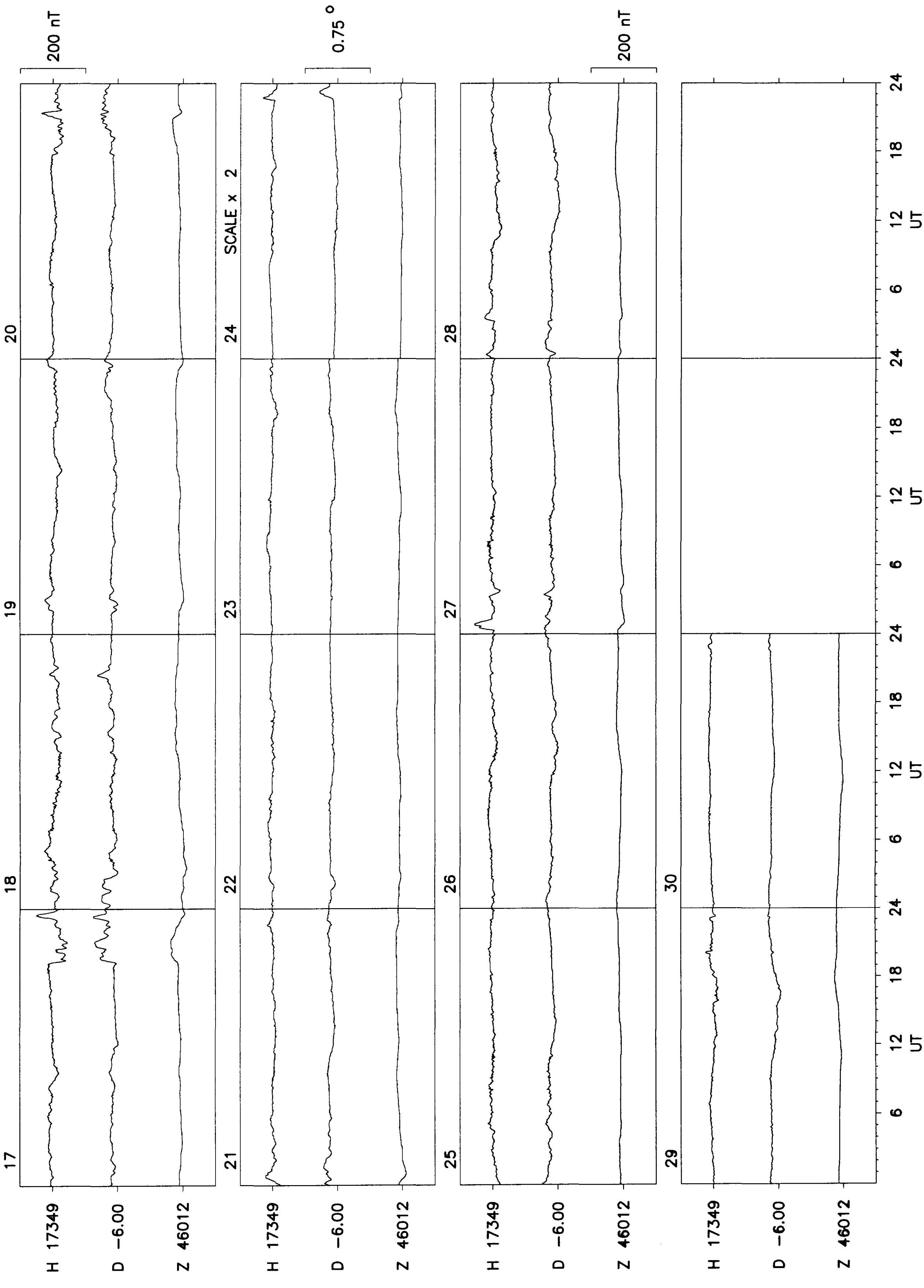

17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 17349
D −6.00
Z 46012
200 nT
0.75 °
SCALE x 2
6
12
18
24
UT

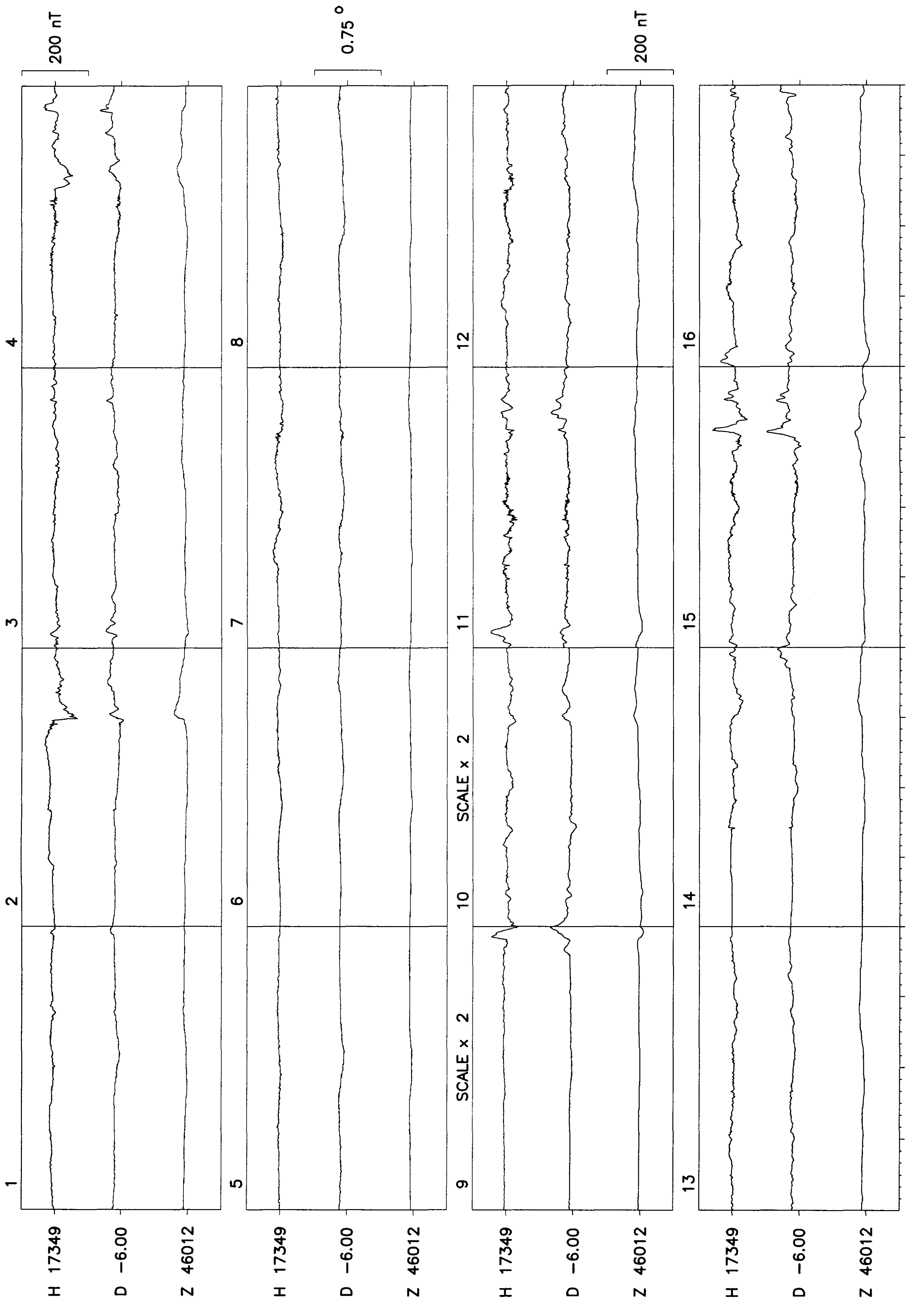

200 nT
0.75 °
200 nT
H 17349
D −6.00
Z 46012
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
UT


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 4
SCALE x 2
SCALE x 2
H 17349
D −6.00
Z 46012
6
12
18
24
UT

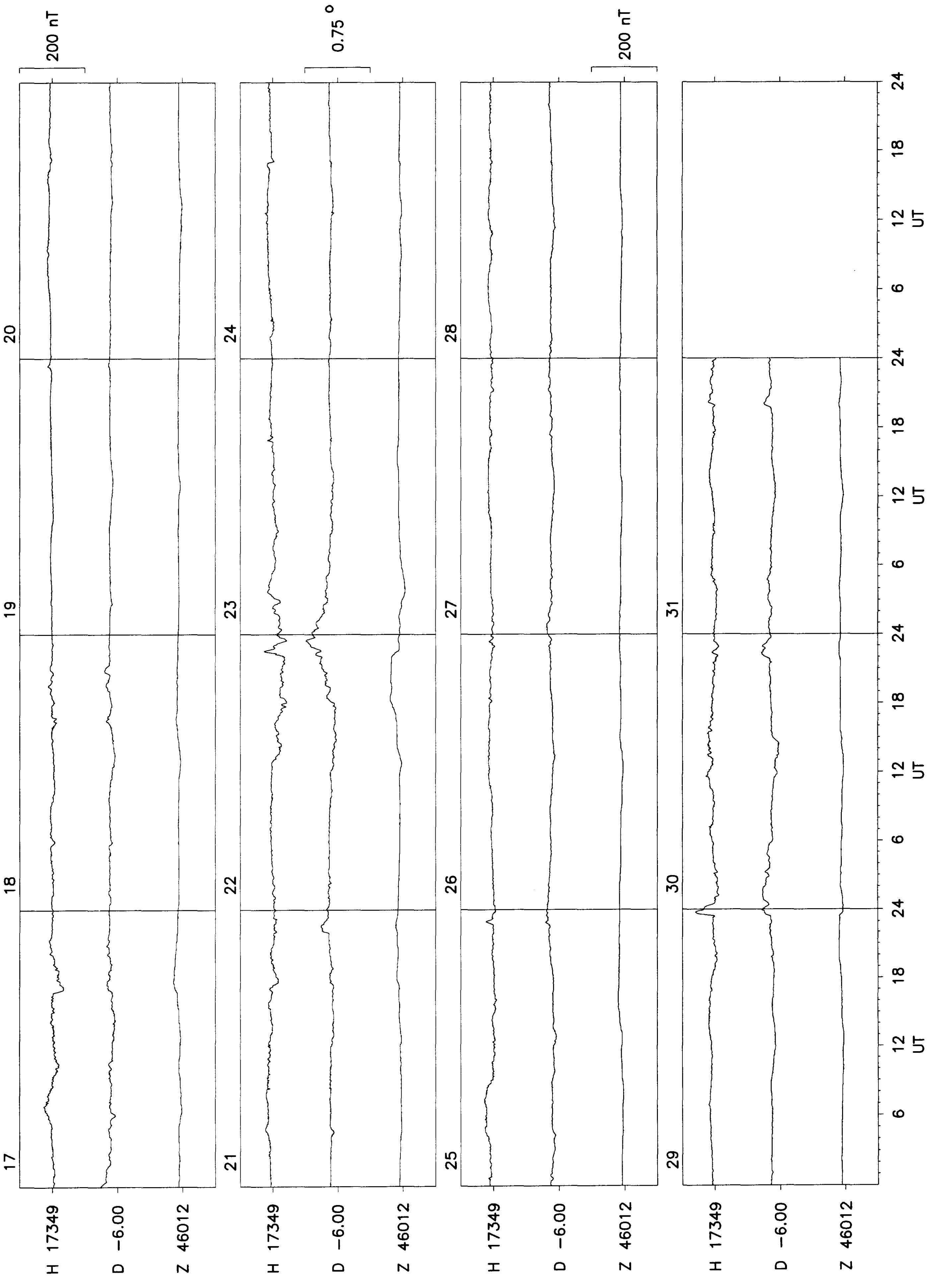
ES 10 96


200 nT
0.75 °
200 nT
SCALE x 2
SCALE x 2
H 17349
D -6.00
Z 46012
UT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

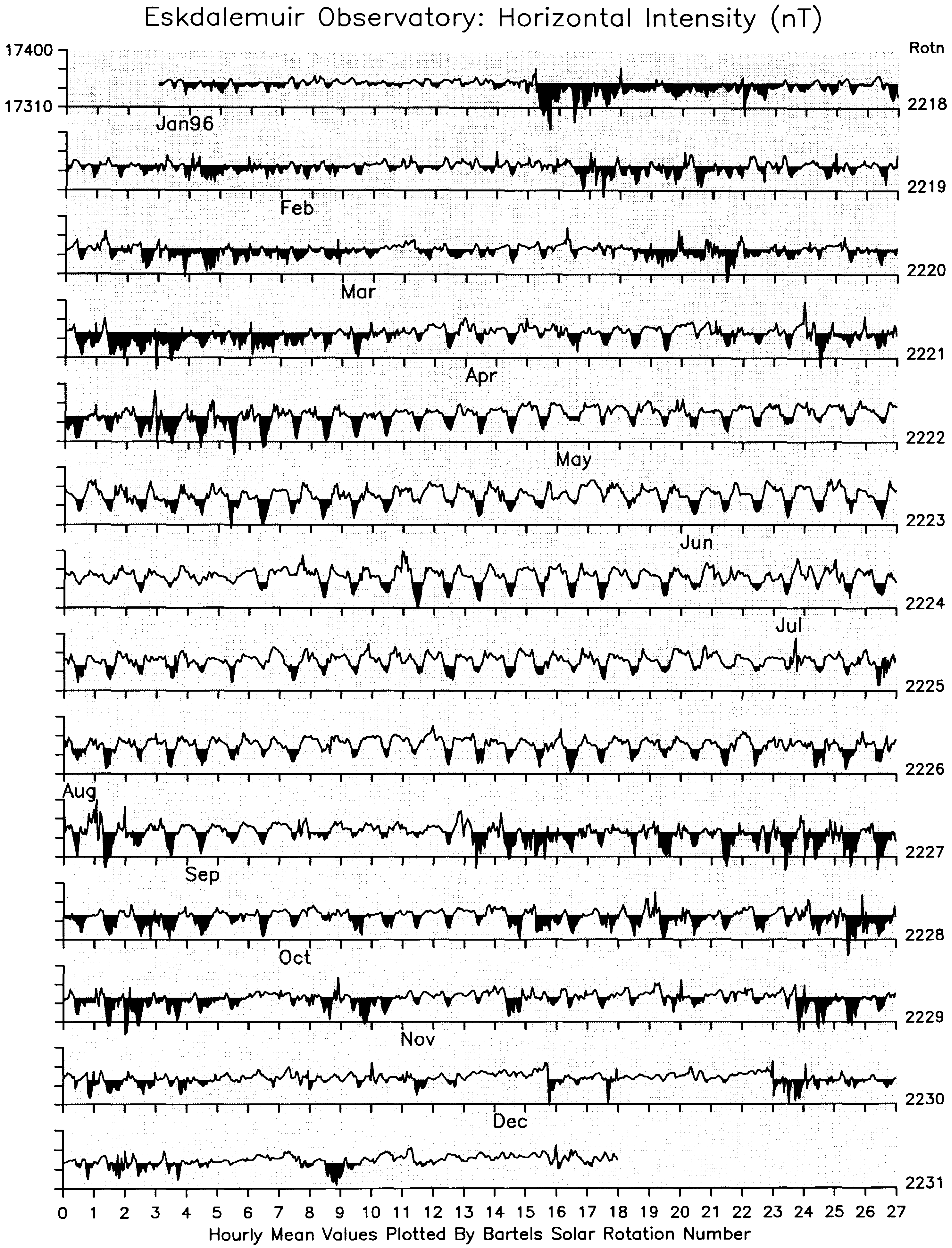

17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 17349
D -6.00
Z 46012
200 nT
0.75 °
SCALE x 2
UT



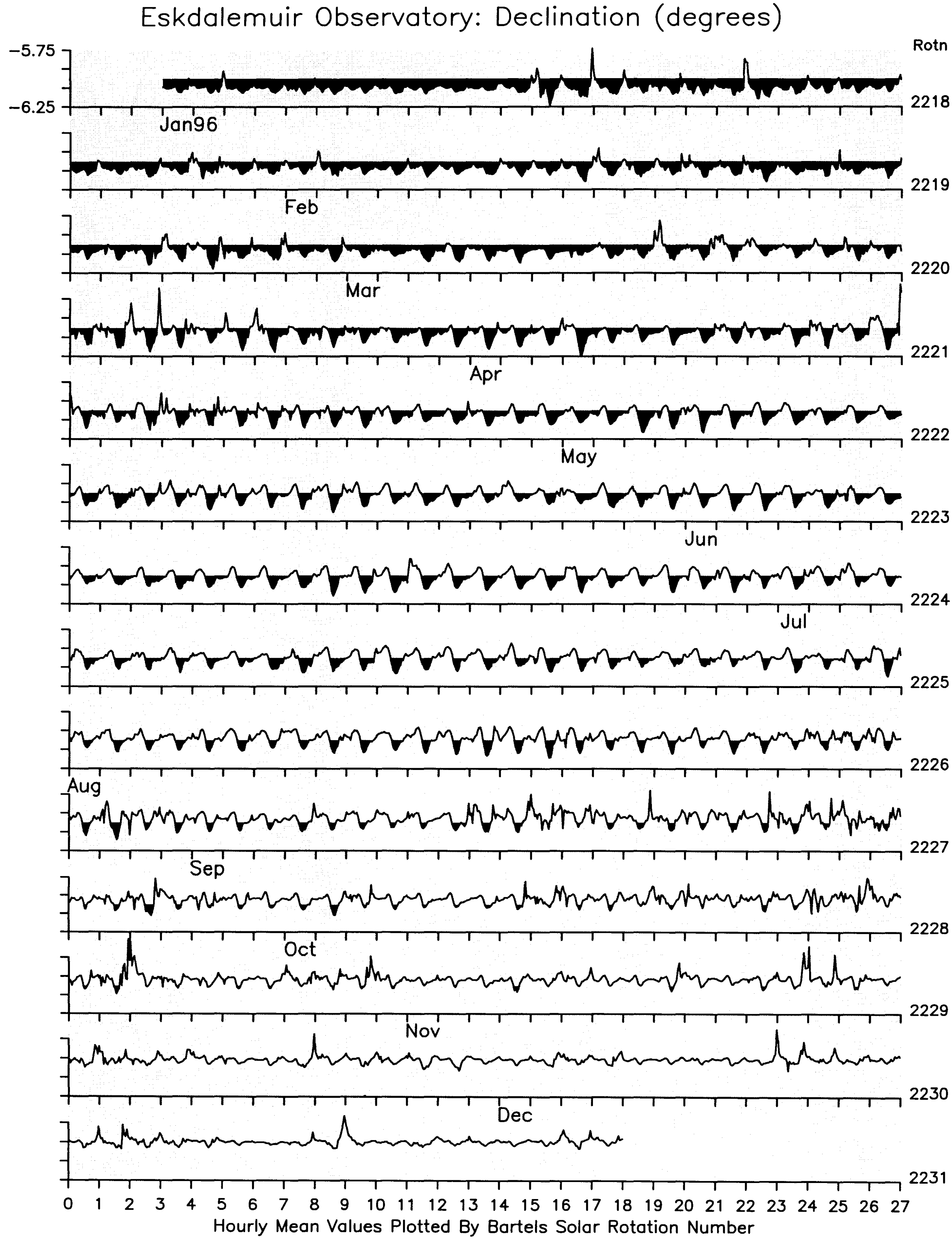
H 17349
D −6.00
Z 46012
200 nT
0.75 °
SCALE x 2
UT

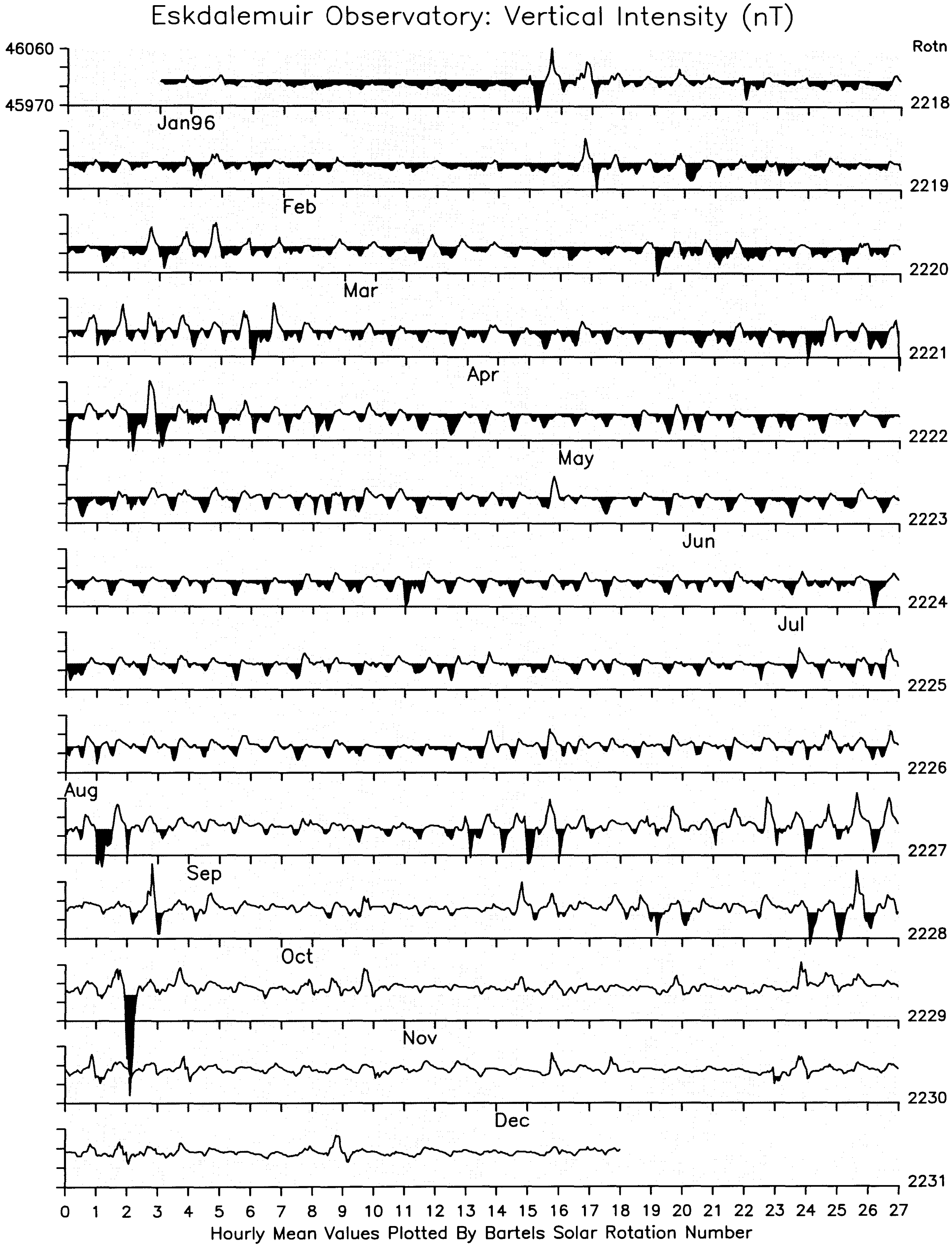

200 nT
0.75 °
200 nT
H 17349
D −6.00
Z 46012
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
6
12
18
24
UT

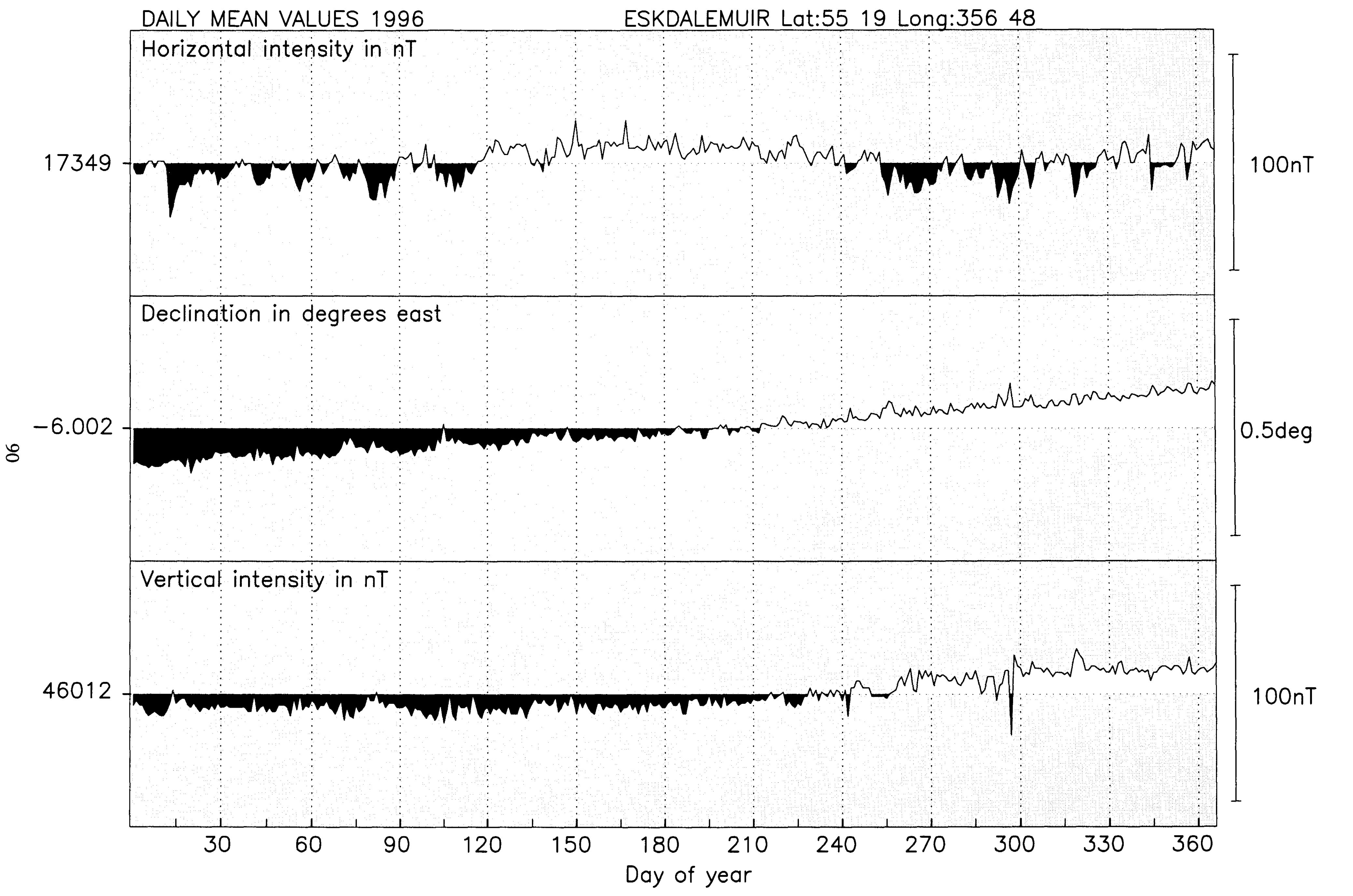
ES 12 96

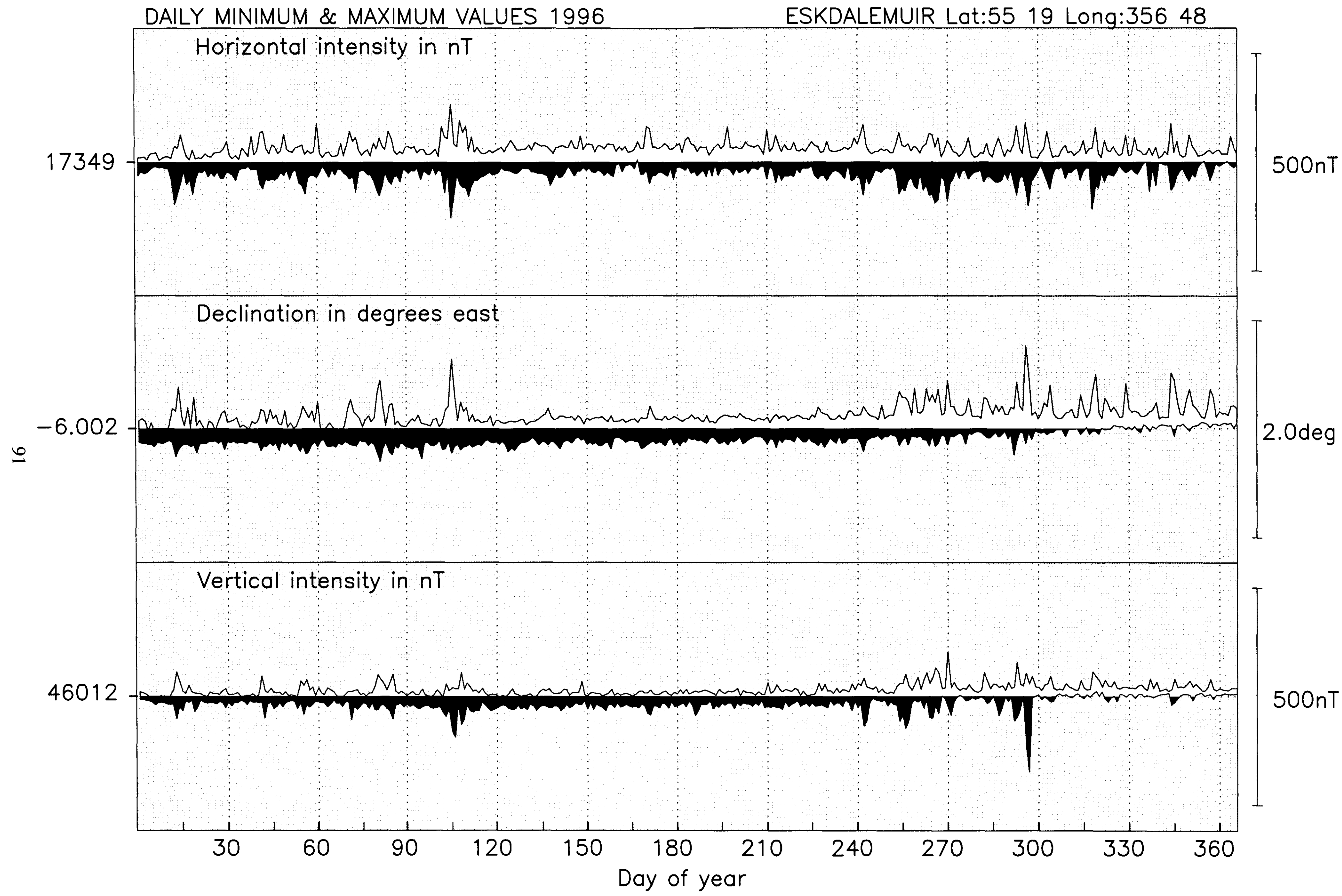


Eskdalemuir Observatory: Horizontal Intensity (nT)
17400
17310
Rotn
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231
Jan96
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number


Eskdalemuir Observatory: Declination (degrees)
-5.75
-6.25
Rotn
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231
Jan96
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)
46060
45970
Rotn
2218
Jan96
2219
Feb
2220
Mar
2221
Apr
2222
May
2223
Jun
2224
Jul
2225
2226
Aug
2227
Sep
2228
Oct
2229
Nov
2230
Dec
2231
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 1996
ESKDALEMUIR Lat:55 19 Long:356 48
Horizontal intensity in nT
17349
100nT
Declination in degrees east
−6.002
0.5deg
Vertical intensity in nT
46012
100nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year


DAILY MINIMUM & MAXIMUM VALUES 1996
ESKDALEMUIR Lat:55 19 Long:356 48
Horizontal intensity in nT
17349
500nT
Declination in degrees east
-6.002
2.0deg
Vertical intensity in nT
46012
500nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Eskdalemuir 1996

Month	D ° '	H nT	I ° '	X nT	Y nT	Z nT	F nT
Based on All Days							
Jan	-6 4.7	17343	69 20.7	17245	-1836	46006	49166
Feb	-6 3.7	17345	69 20.6	17248	-1832	46006	49167
Mar	-6 3.0	17344	69 20.7	17247	-1828	46007	49168
Apr	-6 2.3	17347	69 20.4	17251	-1825	46005	49167
May	-6 1.5	17355	69 19.9	17259	-1822	46006	49171
Jun	-6 1.2	17357	69 19.8	17261	-1820	46007	49172
Jul	-6 0.3	17356	69 19.9	17261	-1816	46008	49173
Aug	-5 59.2	17353	69 20.2	17258	-1810	46011	49175
Sep	-5 57.9	17344	69 20.9	17250	-1802	46017	49177
Oct	-5 56.9	17344	69 21.0	17251	-1797	46019	49179
Nov	-5 56.2	17349	69 20.7	17256	-1794	46024	49185
Dec	-5 55.0	17352	69 20.5	17260	-1789	46023	49185
Annual	**-6 0.1**	**17349**	**69 20.5**	**17254**	**-1814**	**46012**	**49174**
International quiet day means							
Jan	-6 5.2	17349	69 20.2	17251	-1840	46003	49166
Feb	-6 4.0	17349	69 20.3	17252	-1834	46006	49168
Mar	-6 3.8	17349	69 20.3	17252	-1833	46006	49168
Apr	-6 2.6	17351	69 20.1	17255	-1827	46004	49167
May	-6 1.6	17355	69 19.9	17259	-1822	46007	49172
Jun	-6 1.1	17356	69 19.8	17260	-1820	46006	49171
Jul	-6 0.4	17356	69 19.9	17261	-1816	46008	49173
Aug	-5 59.3	17357	69 19.8	17262	-1811	46007	49172
Sep	-5 58.4	17349	69 20.6	17255	-1805	46017	49179
Oct	-5 57.5	17350	69 20.6	17256	-1801	46019	49181
Nov	-5 56.6	17353	69 20.5	17260	-1797	46023	49186
Dec	-5 55.6	17355	69 20.3	17262	-1792	46022	49186
Annual	**-6 0.5**	**17352**	**69 20.2**	**17257**	**-1816**	**46011**	**49174**
International disturbed day means							
Jan	-6 4.7	17333	69 21.4	17236	-1835	46009	49166
Feb	-6 3.3	17340	69 20.9	17243	-1829	46007	49166
Mar	-6 1.8	17338	69 21.0	17242	-1821	46006	49165
Apr	-6 1.1	17341	69 20.7	17245	-1818	46002	49162
May	-6 1.4	17351	69 20.2	17255	-1821	46006	49169
Jun	-6 1.2	17358	69 19.7	17262	-1820	46006	49172
Jul	-6 0.1	17355	69 20.0	17260	-1815	46008	49172
Aug	-5 58.7	17348	69 20.5	17254	-1807	46011	49173
Sep	-5 57.4	17338	69 21.2	17244	-1799	46014	49172
Oct	-5 55.9	17337	69 21.2	17244	-1792	46012	49170
Nov	-5 55.8	17341	69 21.3	17248	-1792	46027	49185
Dec	-5 54.7	17345	69 21.0	17253	-1786	46023	49183
Annual	**-5 59.7**	**17344**	**69 20.8**	**17249**	**-1811**	**46011**	**49171**

Eskdalemuir Observatory K Indices 1996

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0001 1032	3000 1332	2101 1132	3221 2123	1211 2221	1100 1101	2100 2233	3322 3223	3211 1221	1110 1123	1100 1001	0000 1101
2	1010 0223	3211 2321	1000 0102	0101 1213	1111 2201	1110 1221	3201 1223	2132 3211	1111 1212	1111 3323	1000 0001	0101 1443
3	4111 2211	1000 1102	2111 2222	1001 2213	1201 3213	0011 2112	3312 3222	2222 1213	0000 1101	2331 3344	1000 0022	3201 1212
4	1011 2101	0010 2113	2221 1333	3222 3313	3211 3333	2100 1211	2321 1220	0111 2221	0002 2324	1111 2212	2012 2323	1111 2333
5	2212 2223	2200 1111	1211 1221	3011 0212	3221 2101	1111 1223	3322 2220	2211 2221	1212 1112	1101 1110	2210 1222	0000 0000
6	3200 1112	1000 0010	0001 2210	1000 1000	1111 2122	2433 3321	0111 1320	1110 2332	2111 2202	1001 1100	3311 1123	0000 0011
7	0000 0023	2101 1224	0010 1010	0100 1000	2002 2211	0112 2220	2221 3320	0101 1232	1221 2112	0000 1222	1110 0111	0011 0121
8	1000 1110	2110 2222	1332 2100	0000 2213	2211 1110	1111 2132	1132 3322	1101 1211	3201 2111	1112 2342	0110 1110	0001 0111
9	0000 1012	3111 2123	1211 1232	3222 3333	2200 2211	1100 2221	1101 1100	2012 3332	0002 2124	2441 3344	0212 2242	0000 1225
10	2000 1022	1110 1234	1111 3134	3111 1211	1201 1221	1202 2221	0101 1111	1211 1101	4334 3343	3311 2231	4212 1221	5233 3433
11	0000 1032	4433 2333	4432 3244	2211 2314	1211 2220	0110 2221	0010 2211	1010 1222	3322 3324	1111 2333	0000 1220	4223 2233
12	1001 1114	2222 3123	2312 2334	4334 3344	0001 1122	1010 2220	1232 2223	1110 1112	4342 4434	2223 3323	3221 1102	1212 2322
13	3443 2423	2231 1343	4334 3333	1001 2214	2232 3333	0101 1001	2111 3222	3211 2211	4223 2344	3432 1323	1102 2254	1111 1111
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15	4212 3223	3111 1143	2010 2120	5242 2323	0122 2231	0112 3232	1111 3432	2122 2211	2122 4354	1110 1121	3223 3322	2211 3343
16	3211 0232	2211 2313	2301 2211	3121 2323	2221 2243	1211 2221	1112 2211	2113 3333	1333 3423	3222 3321	1101 1111	3122 1223
17	2211 1243	3211 1122	2422 2333	3322 3455	2123 2112	1211 3313	2311 3311	3222 2223	3211 2223	0101 1123	2122 2144	3222 1321
18	2211 1332	1111 1334	3111 2132	4433 3234	0100 0100	1110 2224	2111 2312	1012 2221	3132 3333	5433 2233	3322 2232	1110 1222
19	0111 1334	2211 0033	1232 3434	3323 3543	1012 2332	4222 3322	2102 2211	1111 1111	1012 3532	3434 4445	2211 2113	1000 0001
20	2133 3200	2111 3213	3311 3344	3323 4233	4112 3223	2221 2220	3212 3322	1122 3221	4334 4434	3332 2223	2111 1234	0000 0100
21	1122 1223	2121 0101	4334 4455	4231 3233	2212 2321	2010 2111	1211 2332	0112 2221	4343 3443	2222 1312	3200 0102	0111 1223
22	2000 1222	2321 1121	3122 2442	2311 3222	1011 3123	1000 1211	2211 3231	1200 2311	3343 4422	3323 3456	2111 1200	2000 2224
23	2101 1011	2213 3423	3210 1132	3221 2233	2210 2211	1001 3220	1210 2220	2332 3122	2334 3533	5432 2333	0111 0121	3311 1200
24	0100 1323	4422 2242	4222 2335	1101 1231	2321 3231	3111 2231	0111 1212	3211 3223	1122 2122	4211 2232	0012 2315	1100 1200
25	1100 1022	2112 2443	4332 3421	2210 1110	1201 2322	0011 2112	1112 2331	3232 2432	1312 2313	1112 1022	3222 1111	1111 1103
26	2210 0331	4223 3233	2211 2332	2101 1210	3312 1211	1011 2112	2210 1222	3231 1223	3422 3454	3100 1100	1101 2212	0000 1012
27	2111 2123	2221 2244	3312 3113	2001 2123	0111 2433	1113 2221	0101 1110	3332 2333	4313 2213	1002 2002	4321 1001	1100 0101
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30	2200 1214		1011 1213	1211 2220	2112 1321	2111 1121	2321 2121	4231 2333	0111 1200	1121 1453	0000 0001	3211 2103
31	3211 2232		1011 1223		1112 2322		4123 3423	3322 3221		2211 1112		2200 0121

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
6	2	19	49	SI*	B	8	-0.4	3
10	3	22	58	SI	C	34	5.3	-5
24	3	08	57	SSC*	B	14	2.7	-2
3	4	10	07	SSC*	B	13	-1.1	-2
8	4	13	34	SSC*	A	28	-4.4	-2
13	4	09	08	SI*	C	4	1.1	
6	6	05	10	SSC*	B	+15/-15	4.4	
19	6	02	44	SI*	B	-49	7.2	5
27	6	06	29	SSC*	C	-7	1.2	
17	8	15	25	SSC*	C	8	0.9	
23	8	07	18	SI*	C	-7	2.3	
15	9	15	54	SI*	B	33	3.1	5
17	9	10	34	SSC*	B	14	-1.6	
11	11	15	27	SSC	A	13	-1.1	-2
13	11	12	59	SSC*	B	16	-1.4	-2
24	11	09	25	SSC	C	7	-0.7	
1	12	11	53	SSC*	C	-7	-0.6	
2	12	10	00	SSC	C	4	0.8	
2	12	17	23	SI*	C	-23	-0.9	2
14	12	08	28	SSC*	B	20	+1.8/-2.1	-3
24	12	12	38	SI*	C	-8	1.5	

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				
9	7	09	09	09	12	09	18	10	0.8	

Notes

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

Annual Values of Geomagnetic Elements

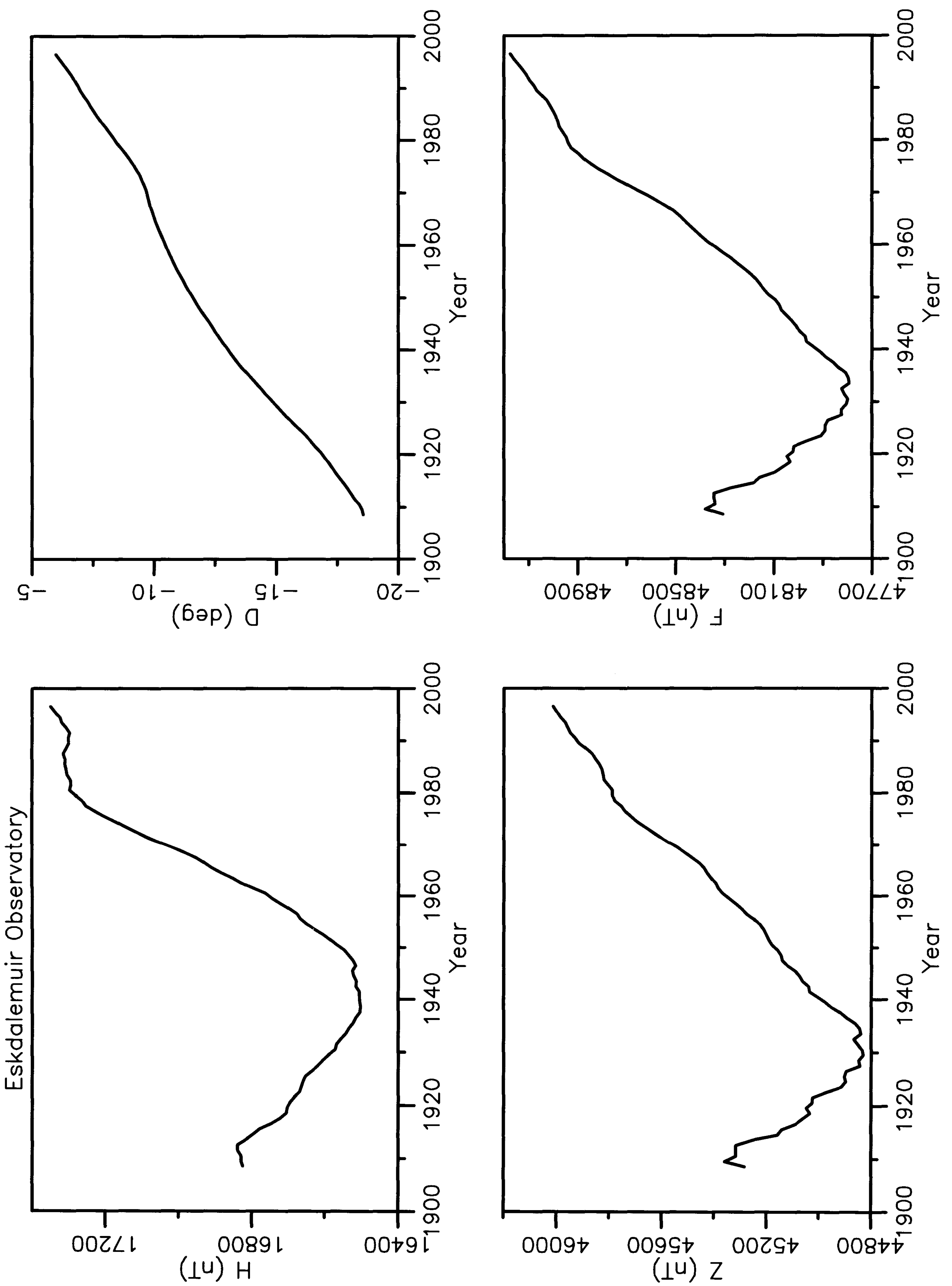
Eskdalemuir

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

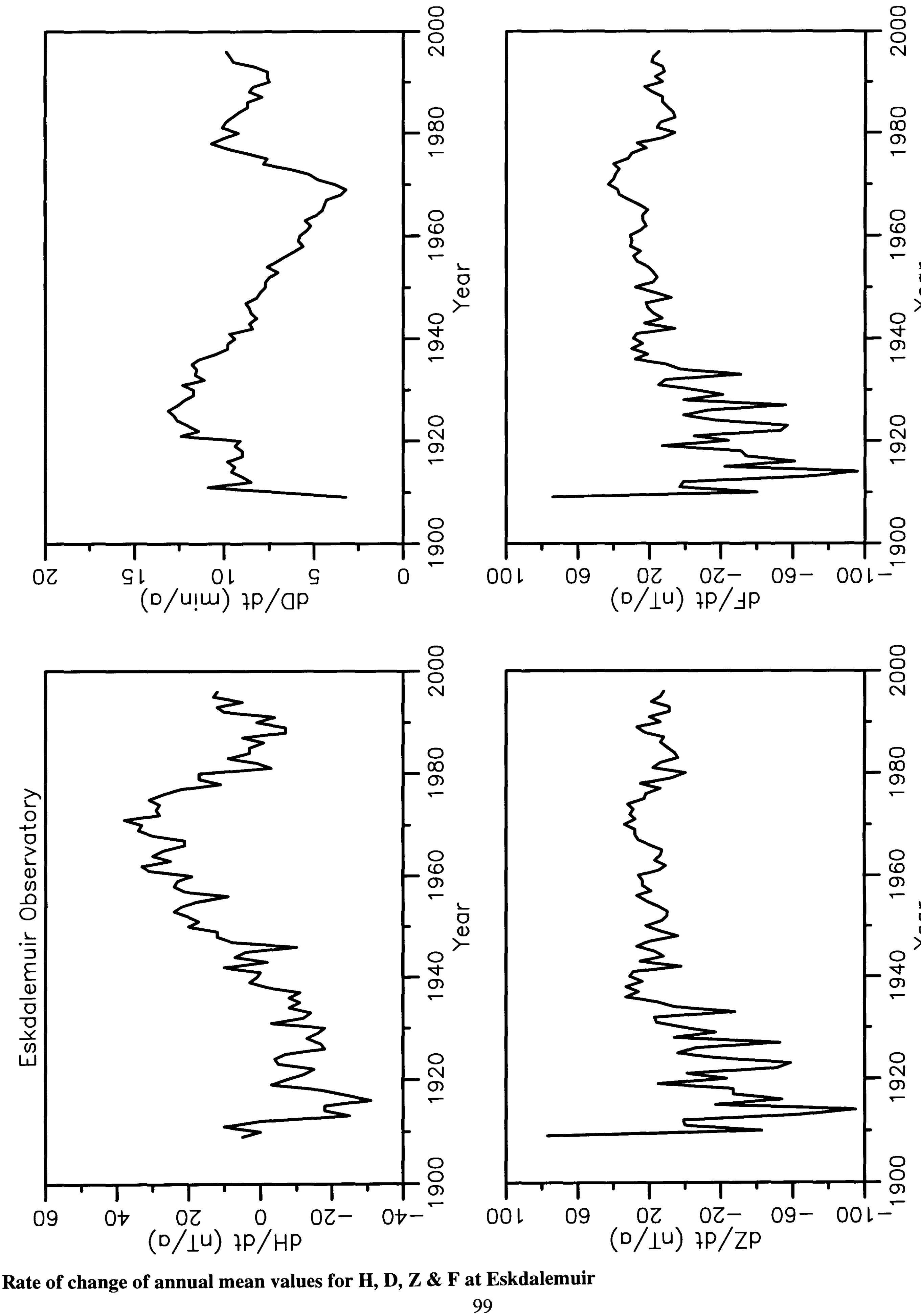
	Year	D		H	I		X	Y	Z	F
	1970.5	-9	41.6	17046	69	29.6	16803	-2870	45576	48659
	1971.5	-9	36.8	17084	69	27.8	16844	-2853	45604	48699
	1972.5	-9	31.5	17112	69	26.7	16876	-2832	45635	48738
	1973.5	-9	25.2	17141	69	25.5	16910	-2805	45664	48775
	1974.5	-9	17.4	17169	69	24.5	16944	-2772	45696	48815
	1975.5	-9	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	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	52.7	17309	69	21.6	17184	-2073	45952	49104
	1991.5	-6	45.1	17305	69	22.3	17185	-2034	45972	49121
	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
Note 2		0	0.0	-8	0	0.0	-8	1	-23	-24
	1994.5	-6	19.7	17324	69	21.4	17218	-1910	45986	49141
	1995.5	-6	10.0	17337	69	20.9	17237	-1862	46000	49159
	1996.5	-6	0.1	17349	69	20.5	17254	-1814	46012	49174

1 Site differences 1 Jan 1990 (new value - old value)
2 Site differences 1 Jan 1994 (new value - old value)

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

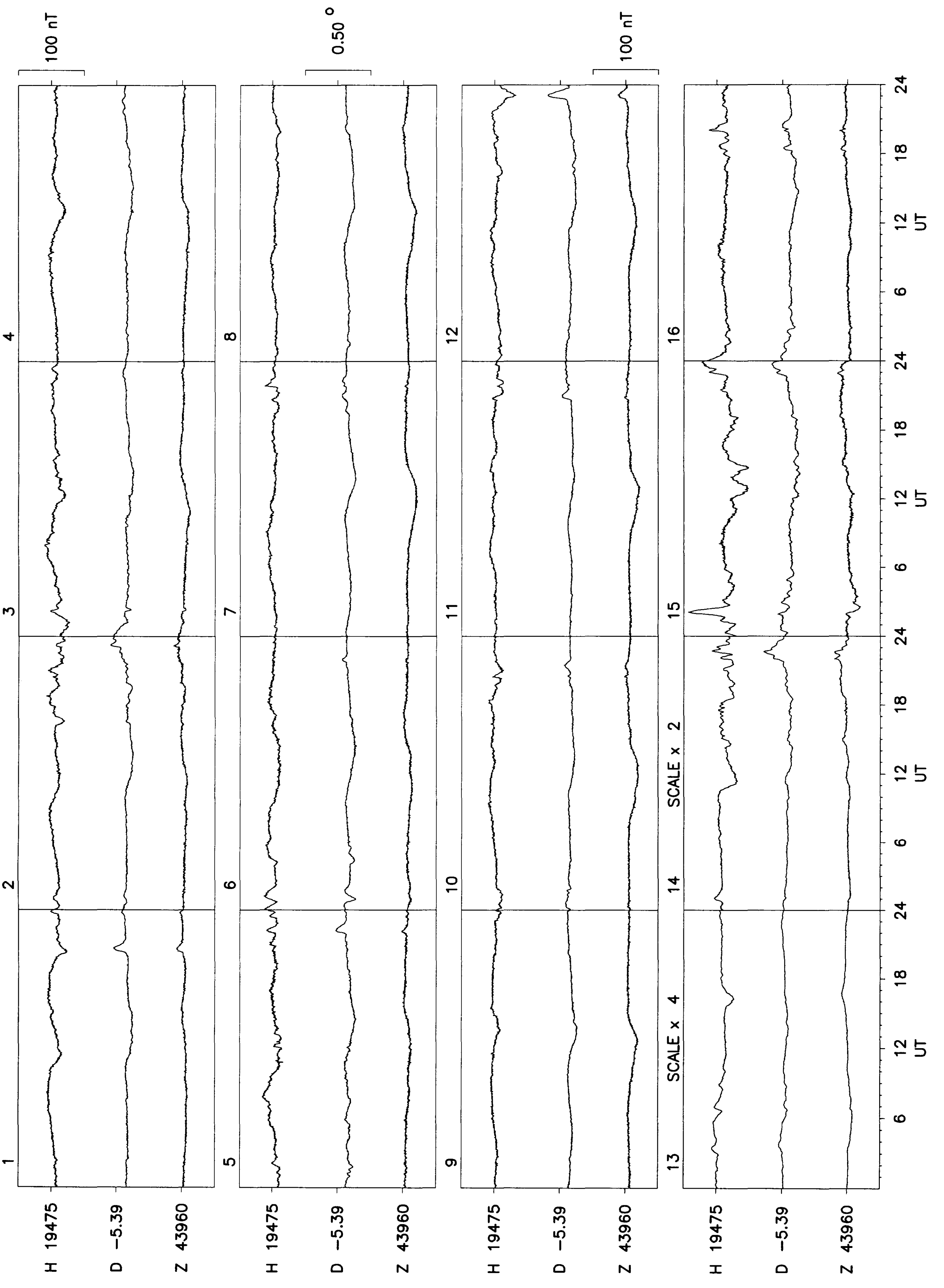


Annual mean values of H, D, Z & F at Eskdalemuir



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

Hartland 1996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Z 43960
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0.50 °
100 nT
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SCALE x 2
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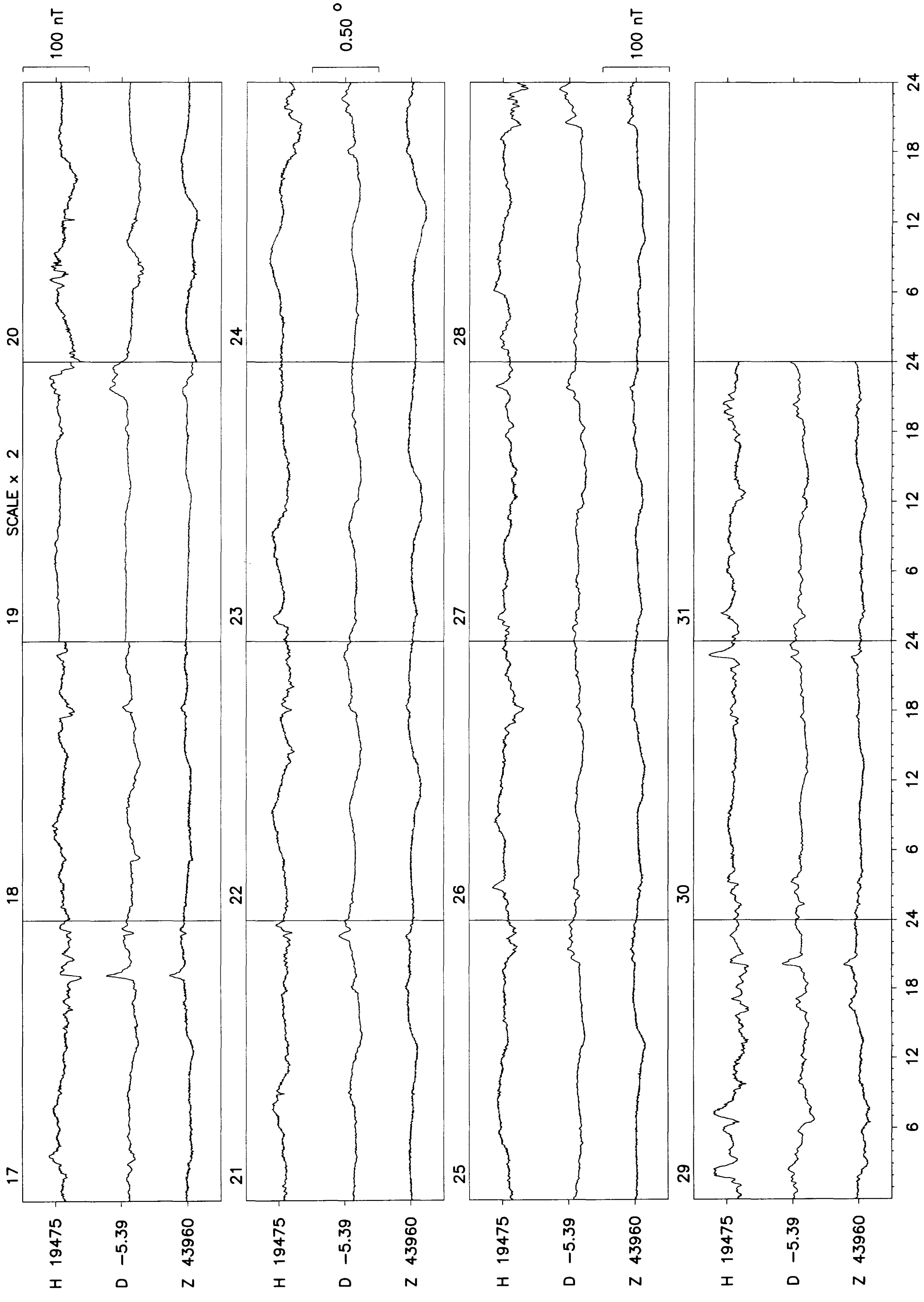
UT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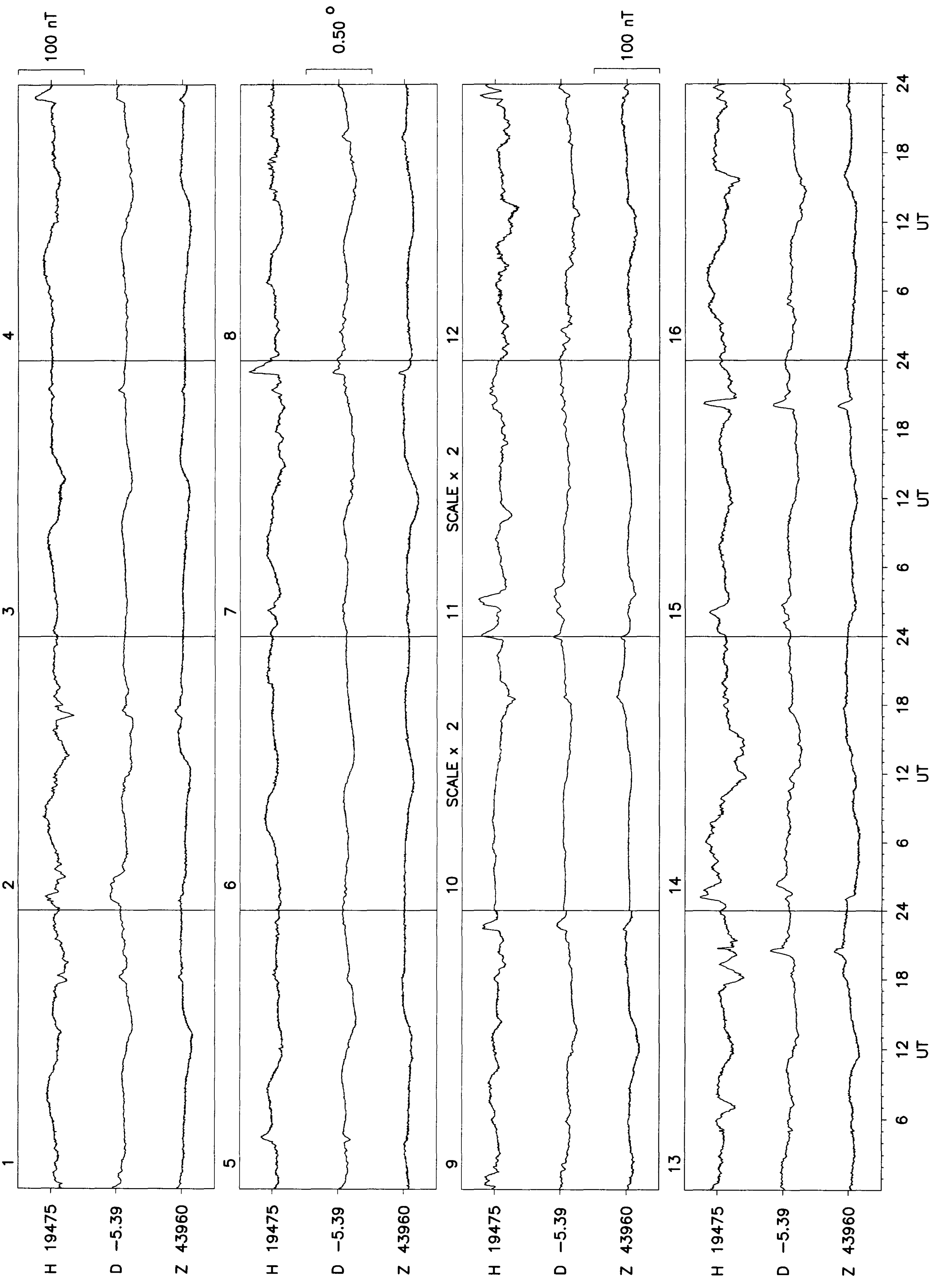
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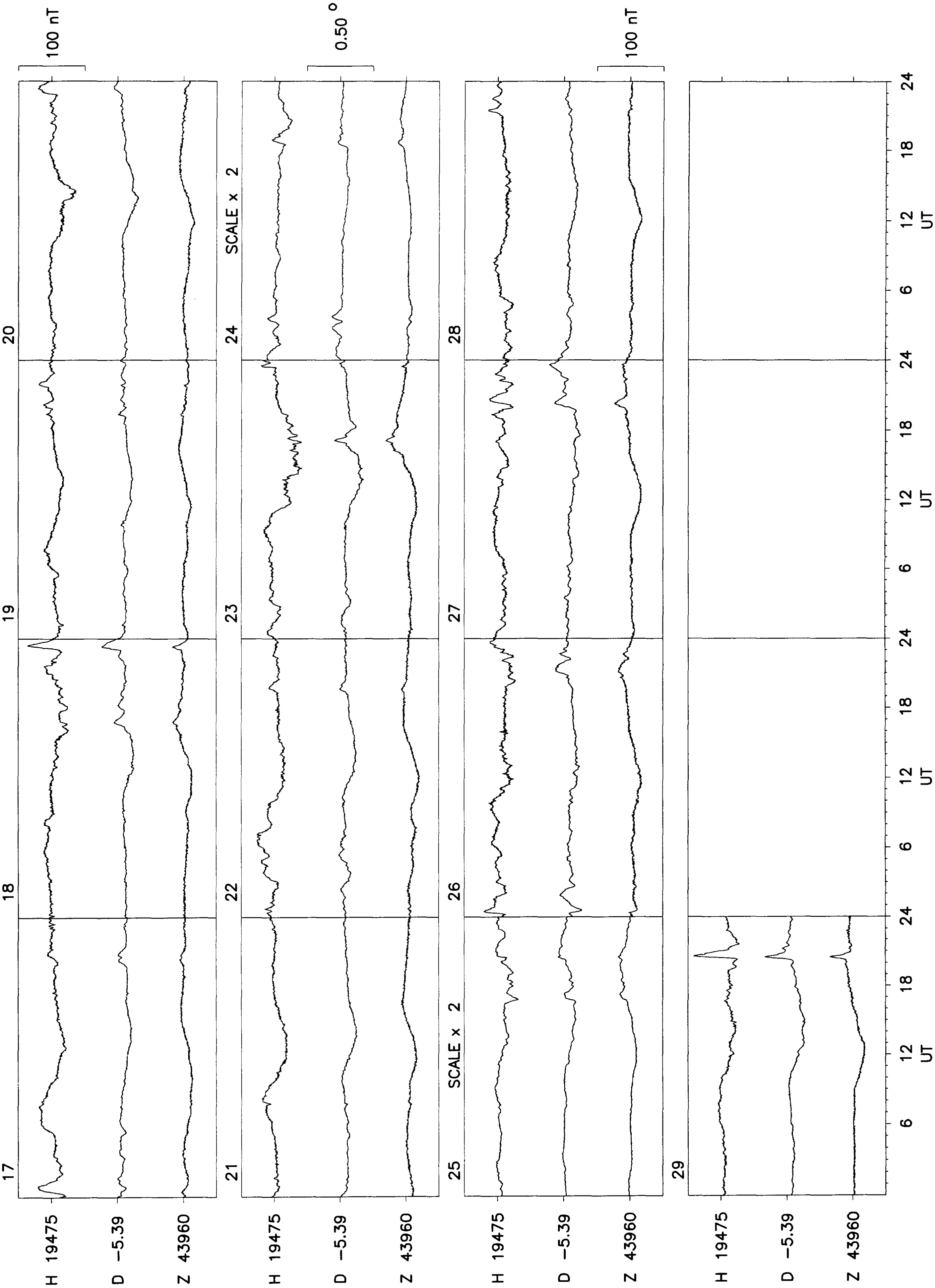
6 12 18 24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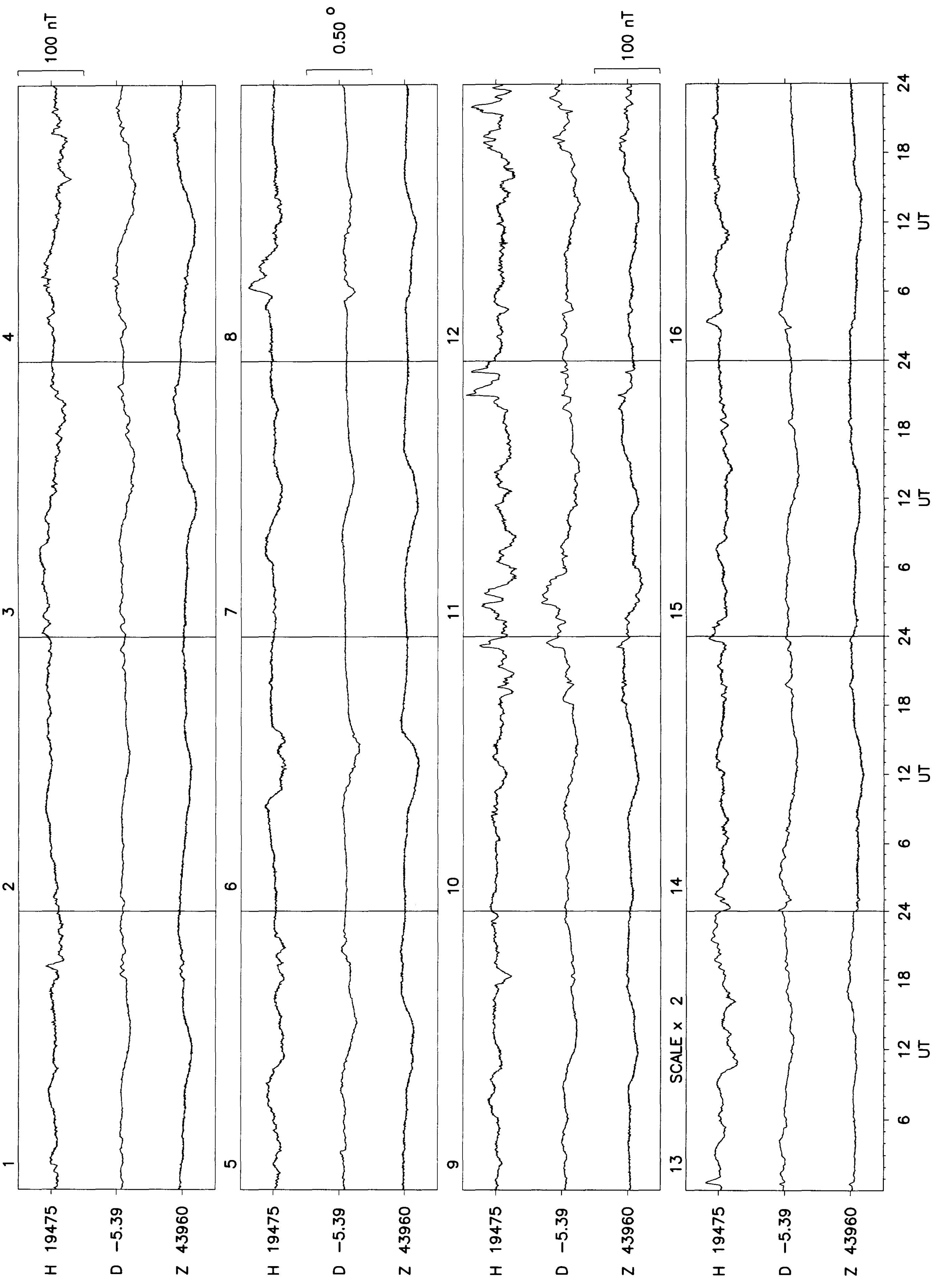
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Z 43960
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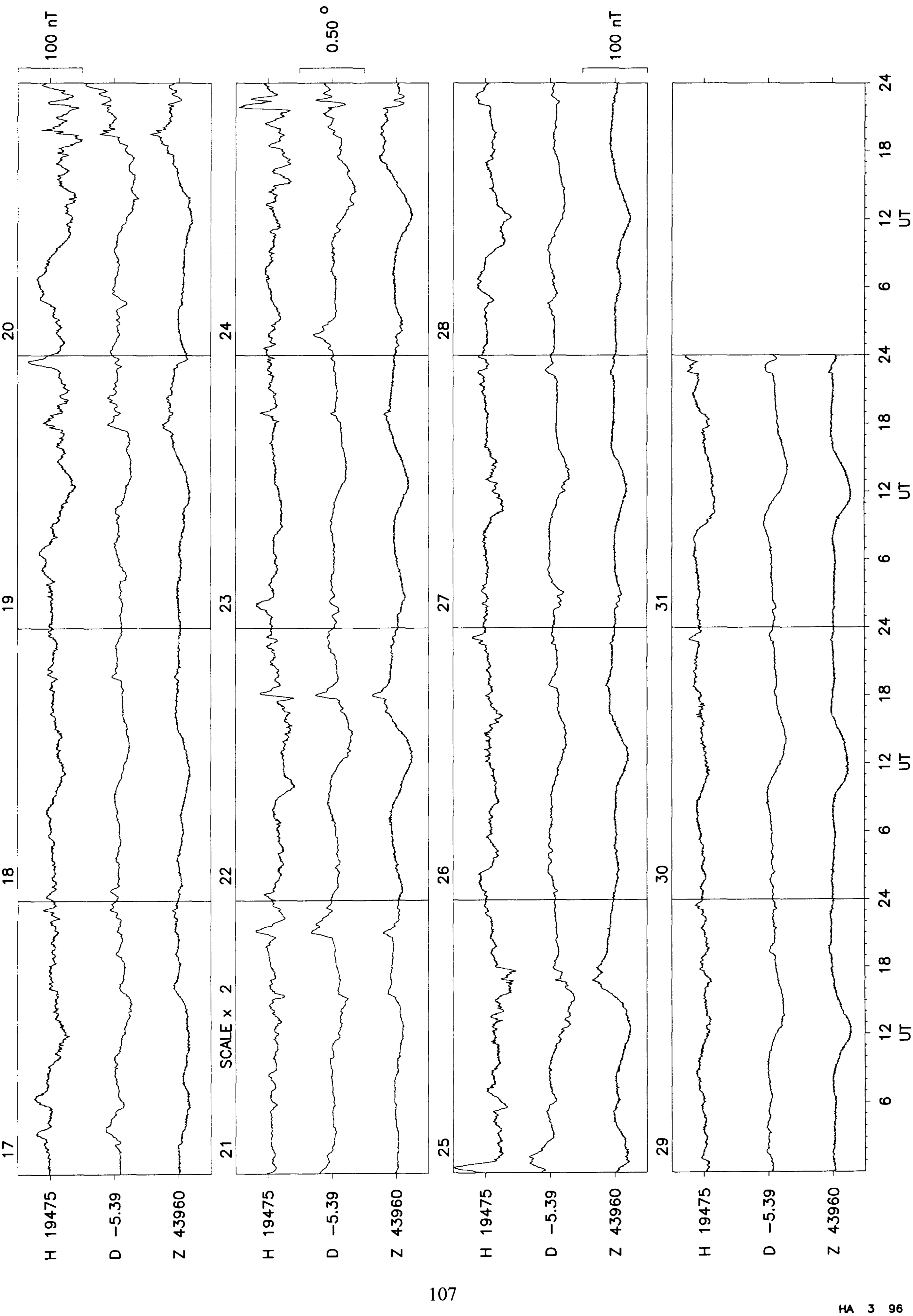
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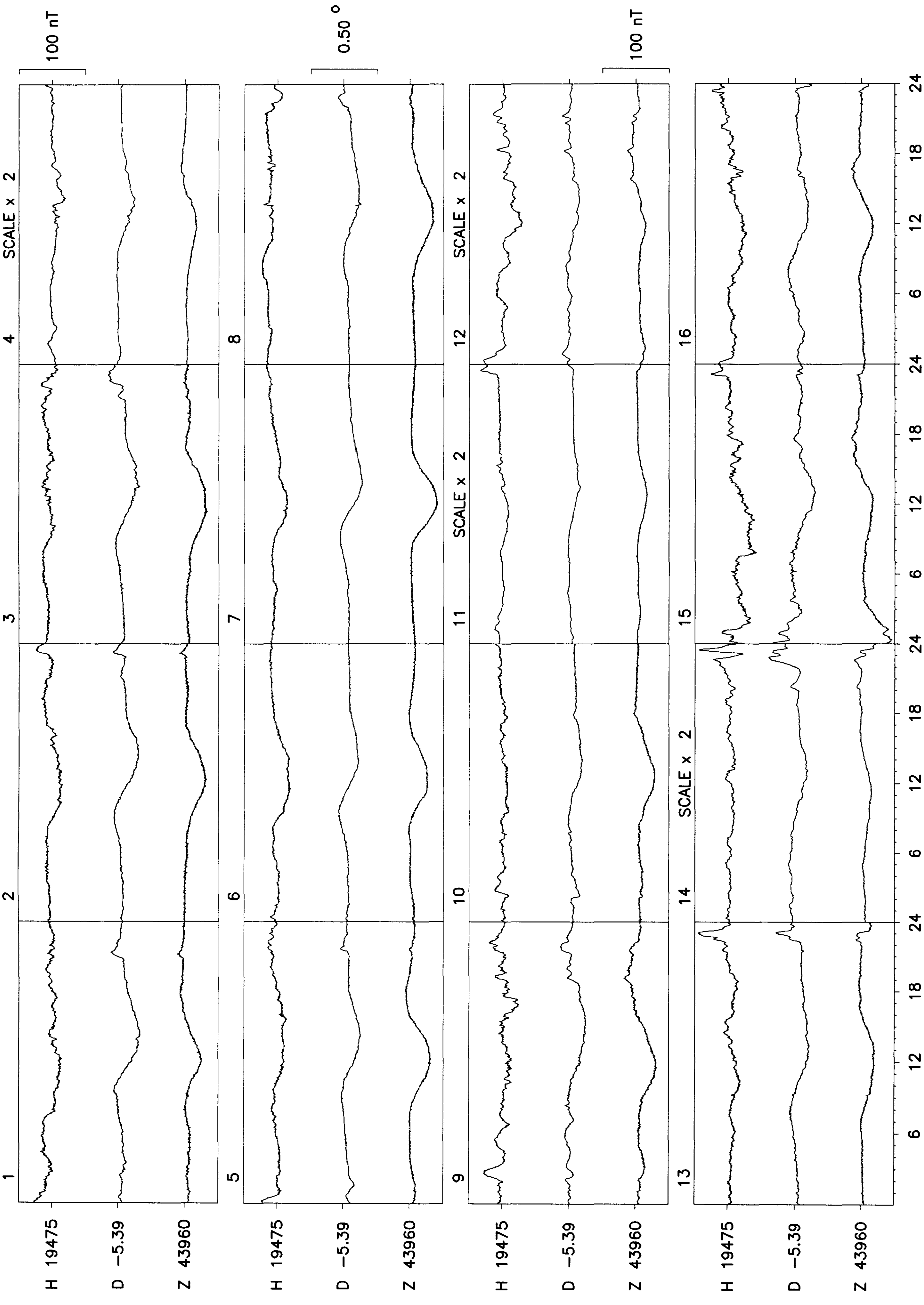
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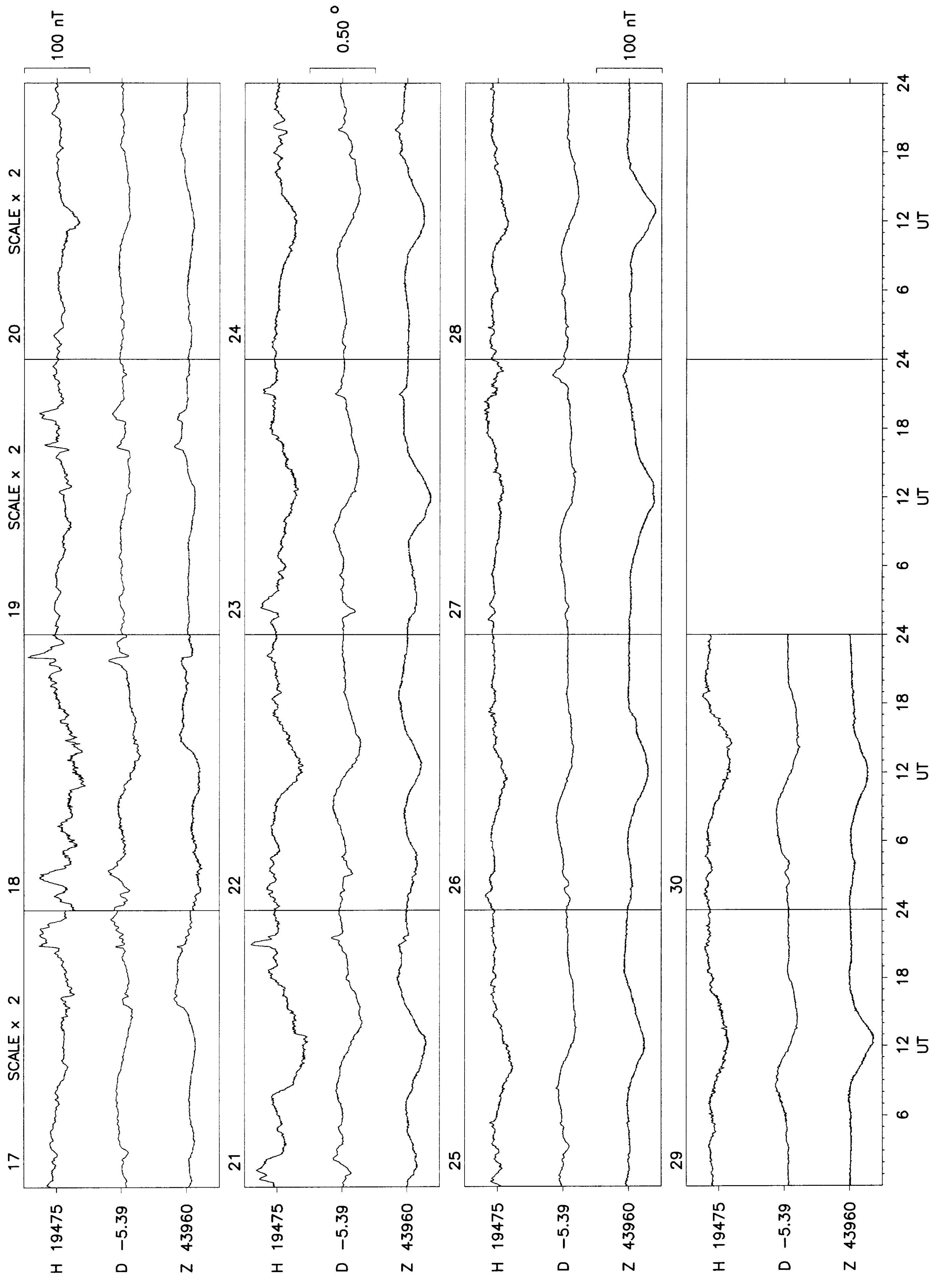

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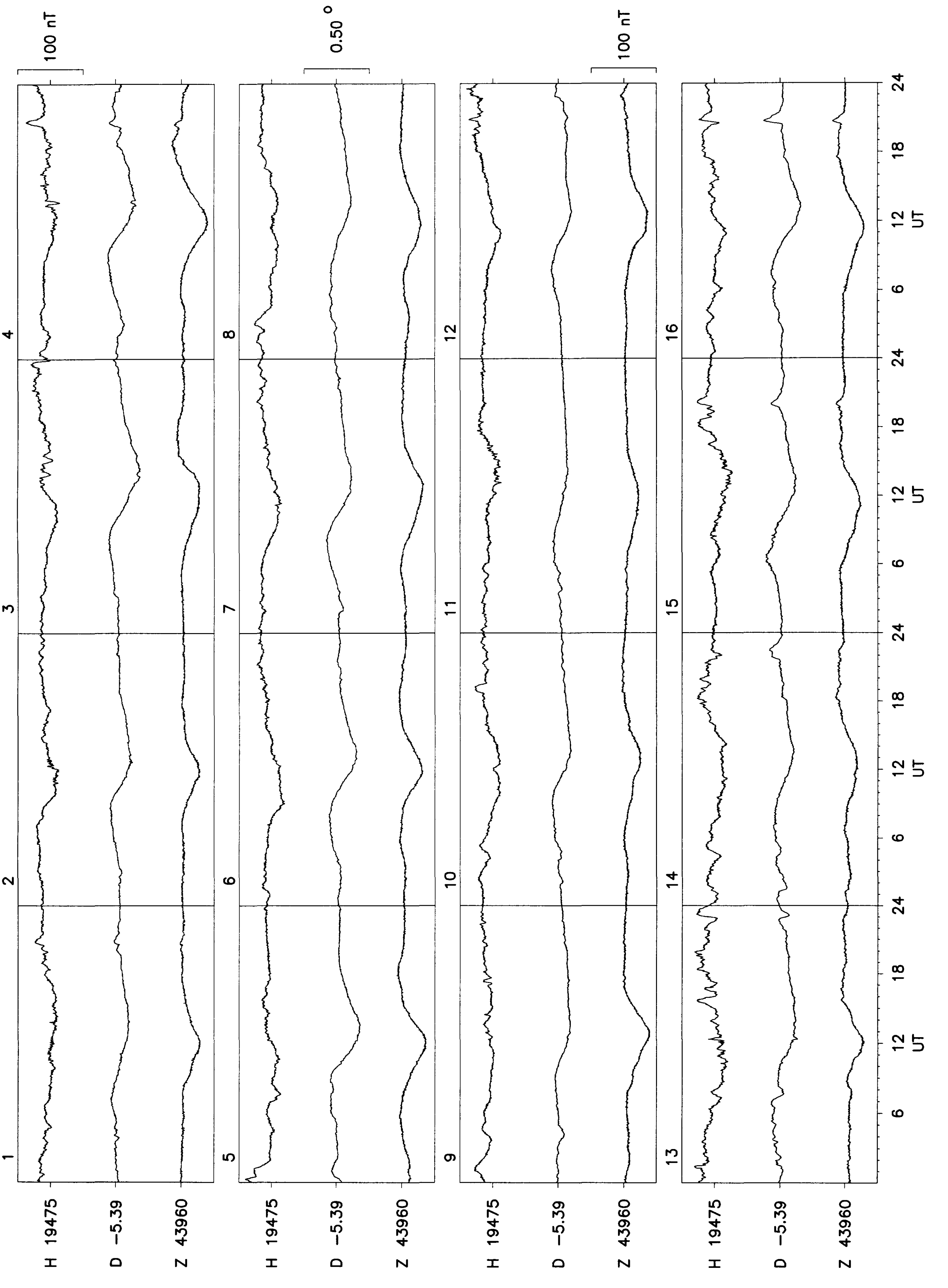

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D −5.39
Z 43960
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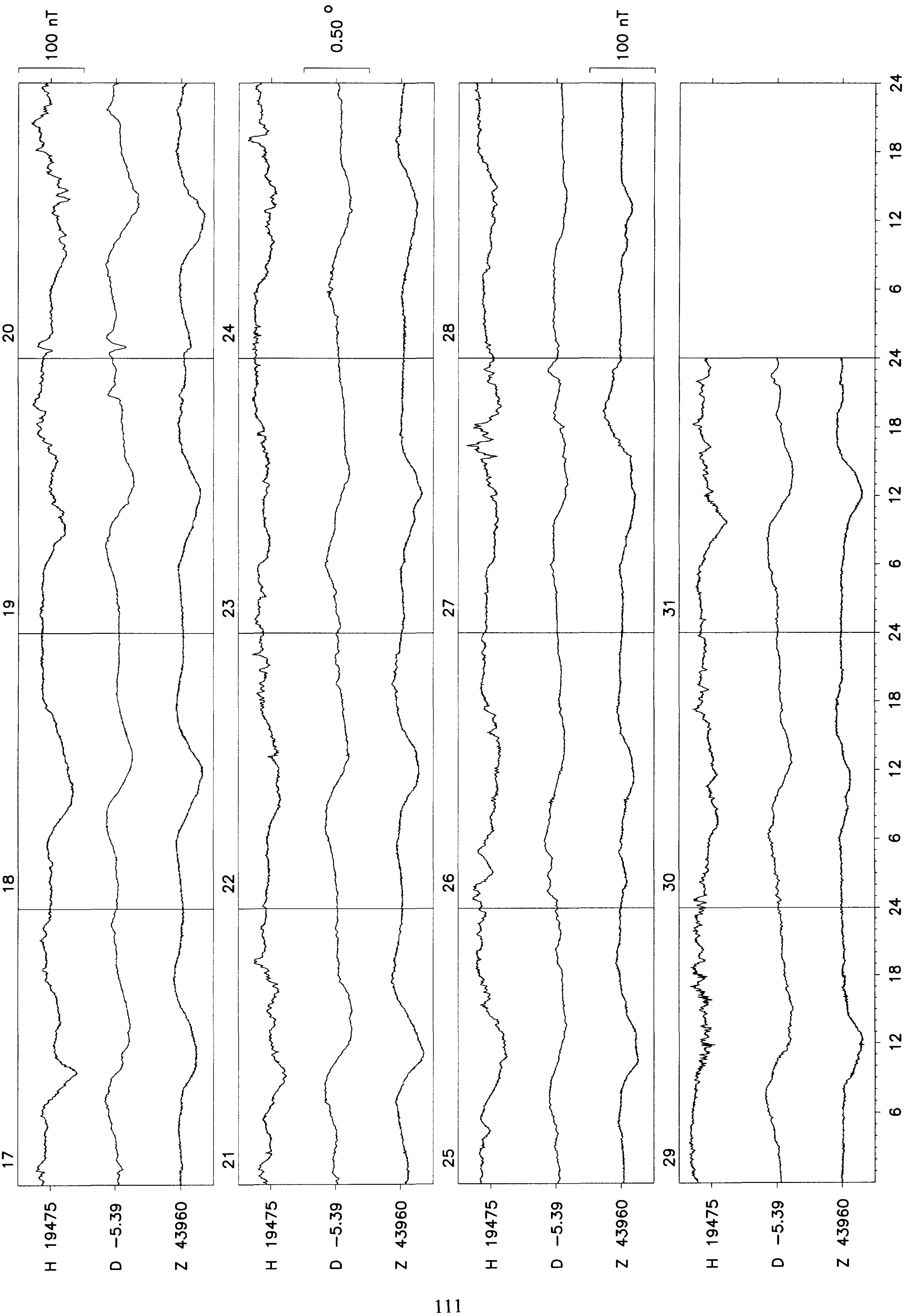

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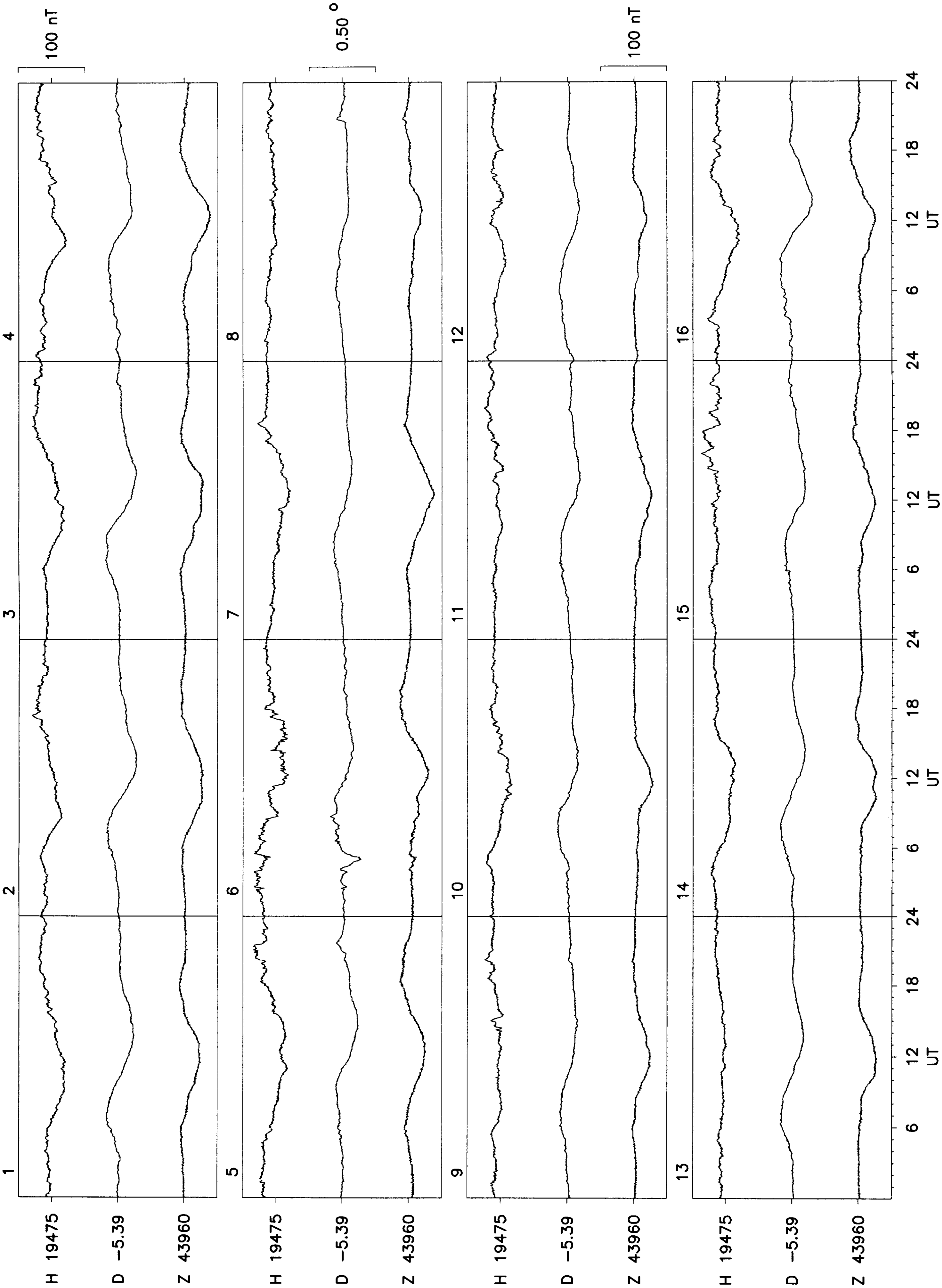

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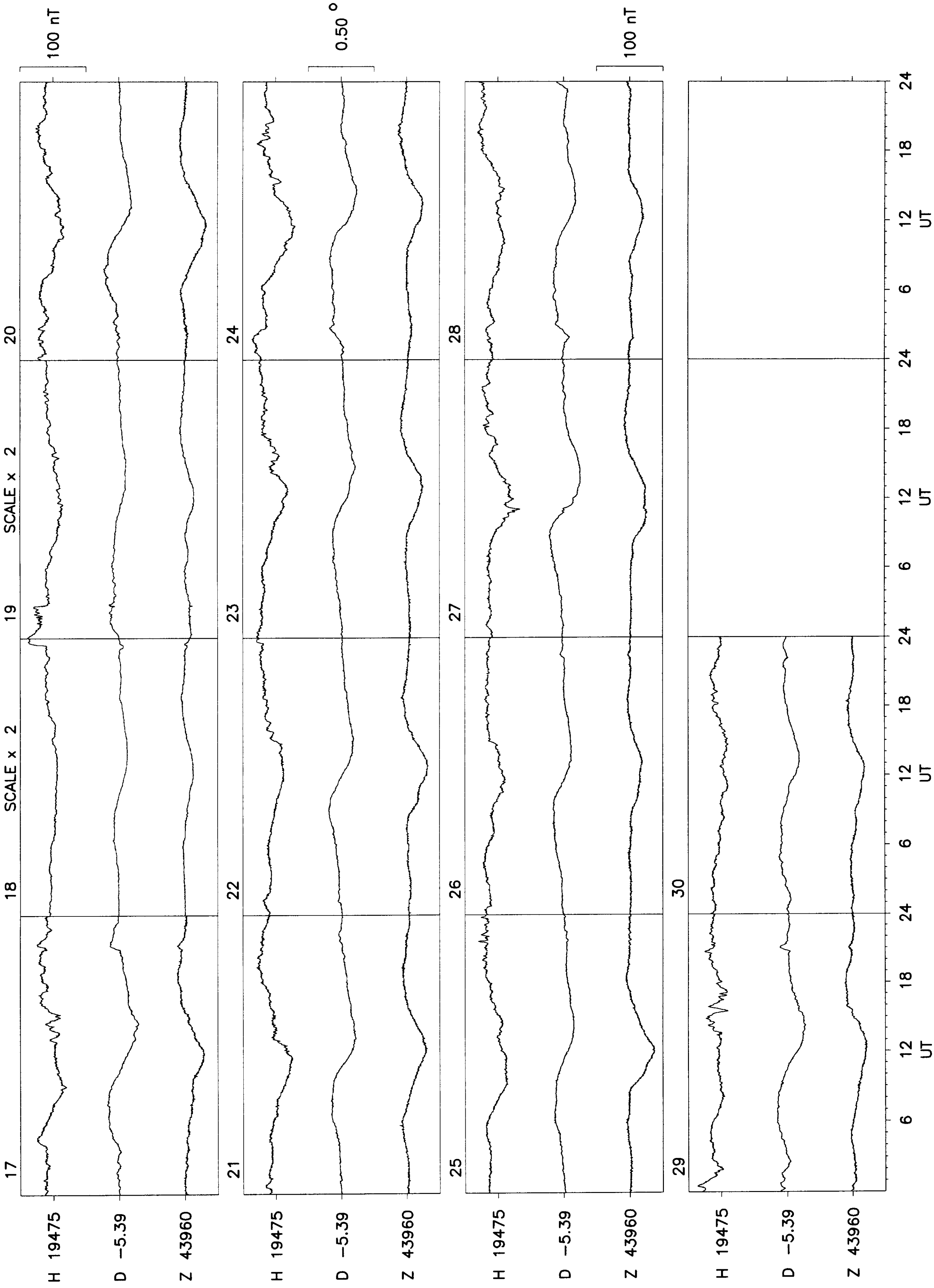

100 nT
0.50 °
100 nT
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SCALE x 2
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H 19475
D −5.39
Z 43960
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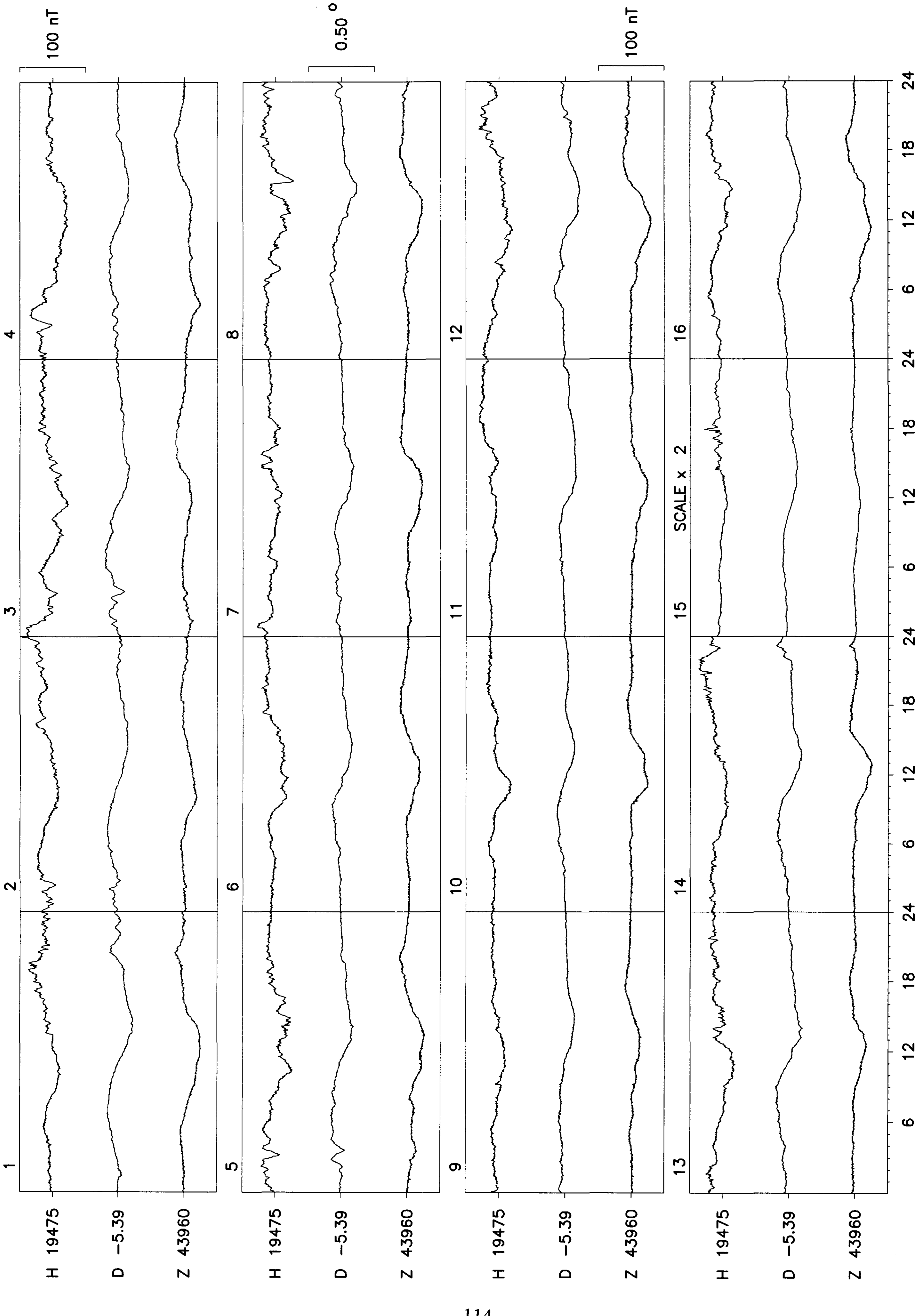
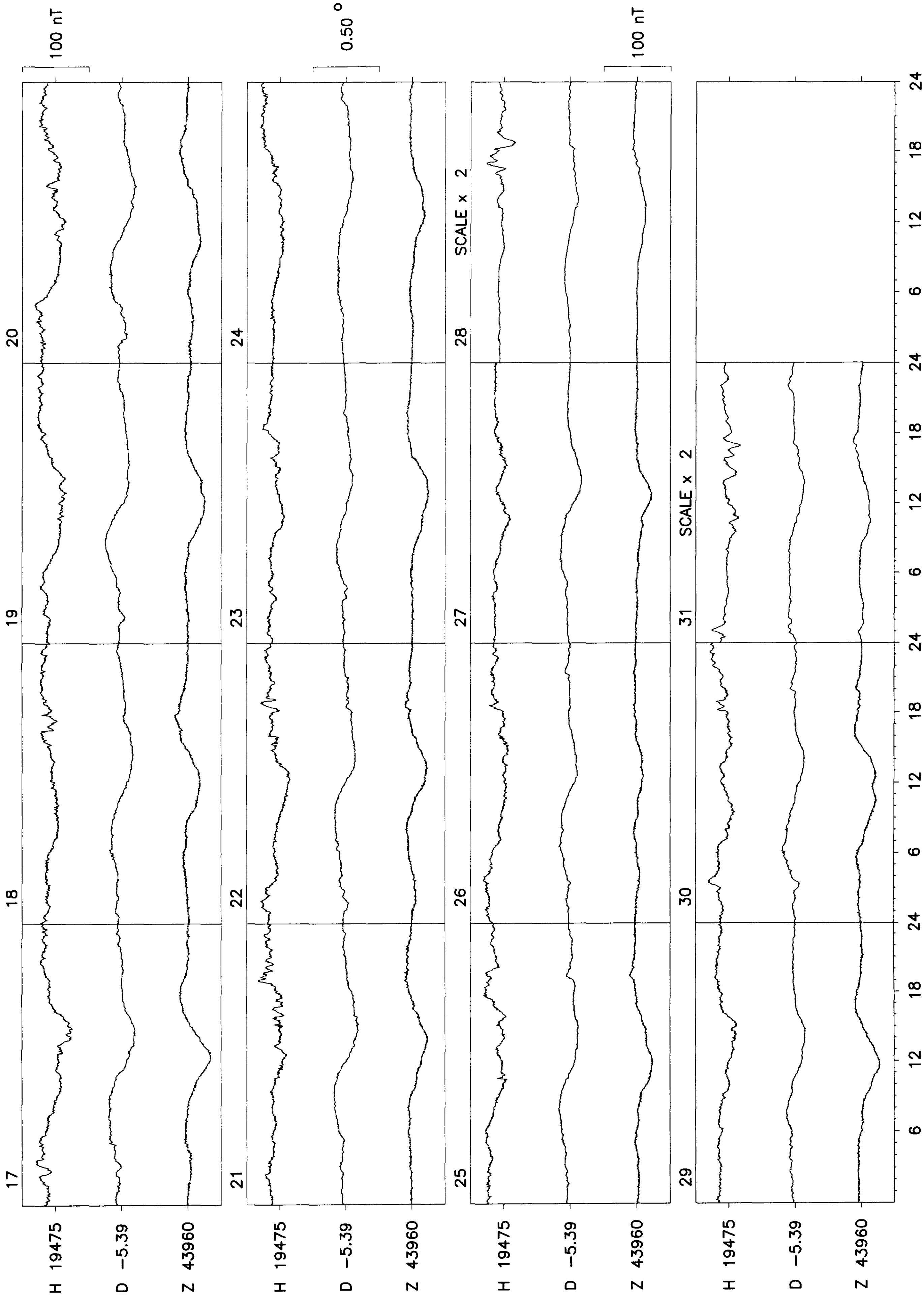
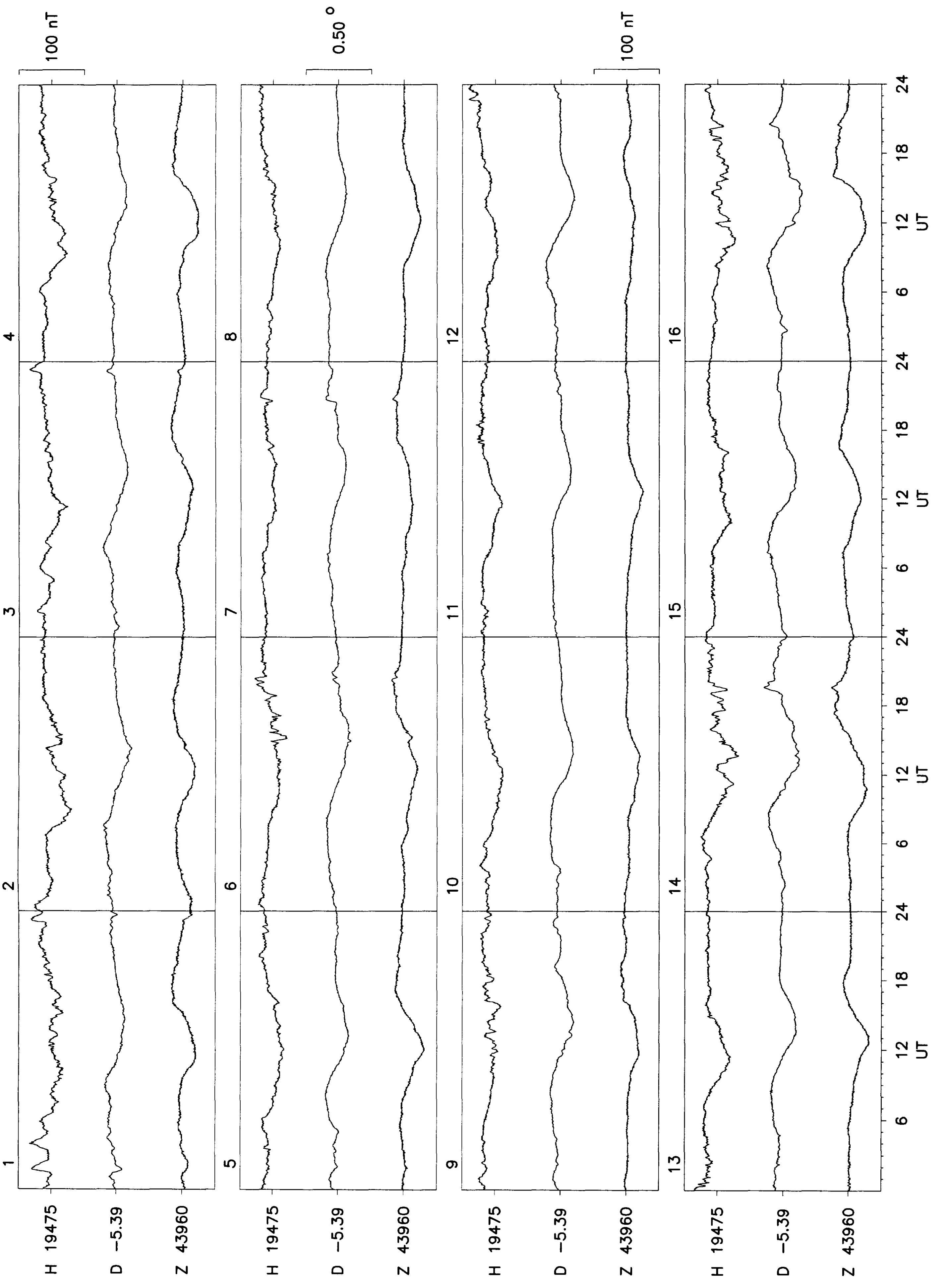
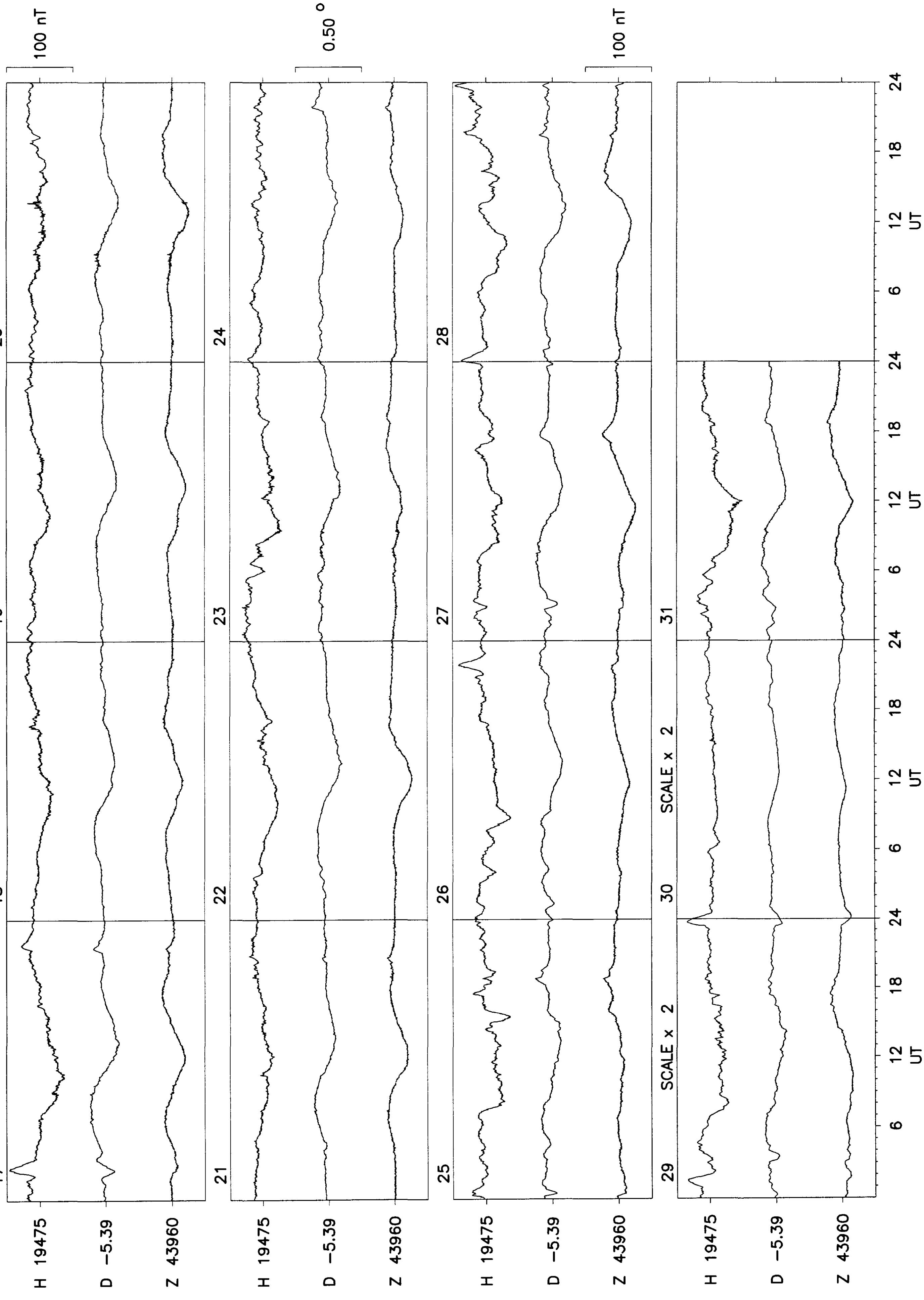
24
UT

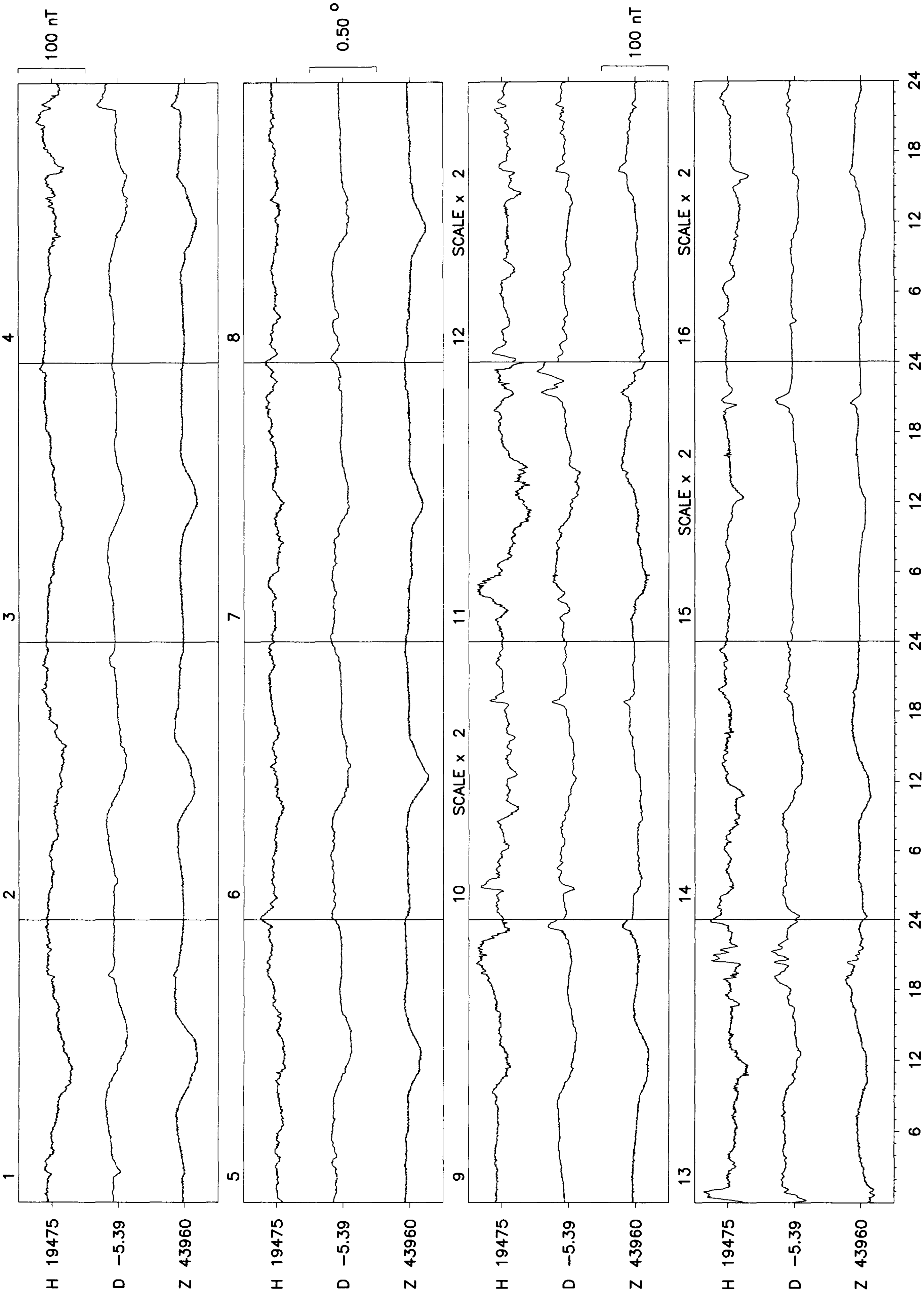

100 nT
0.50 °
100 nT
H 19475
D −5.39
Z 43960
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
6
12
18
24
UT



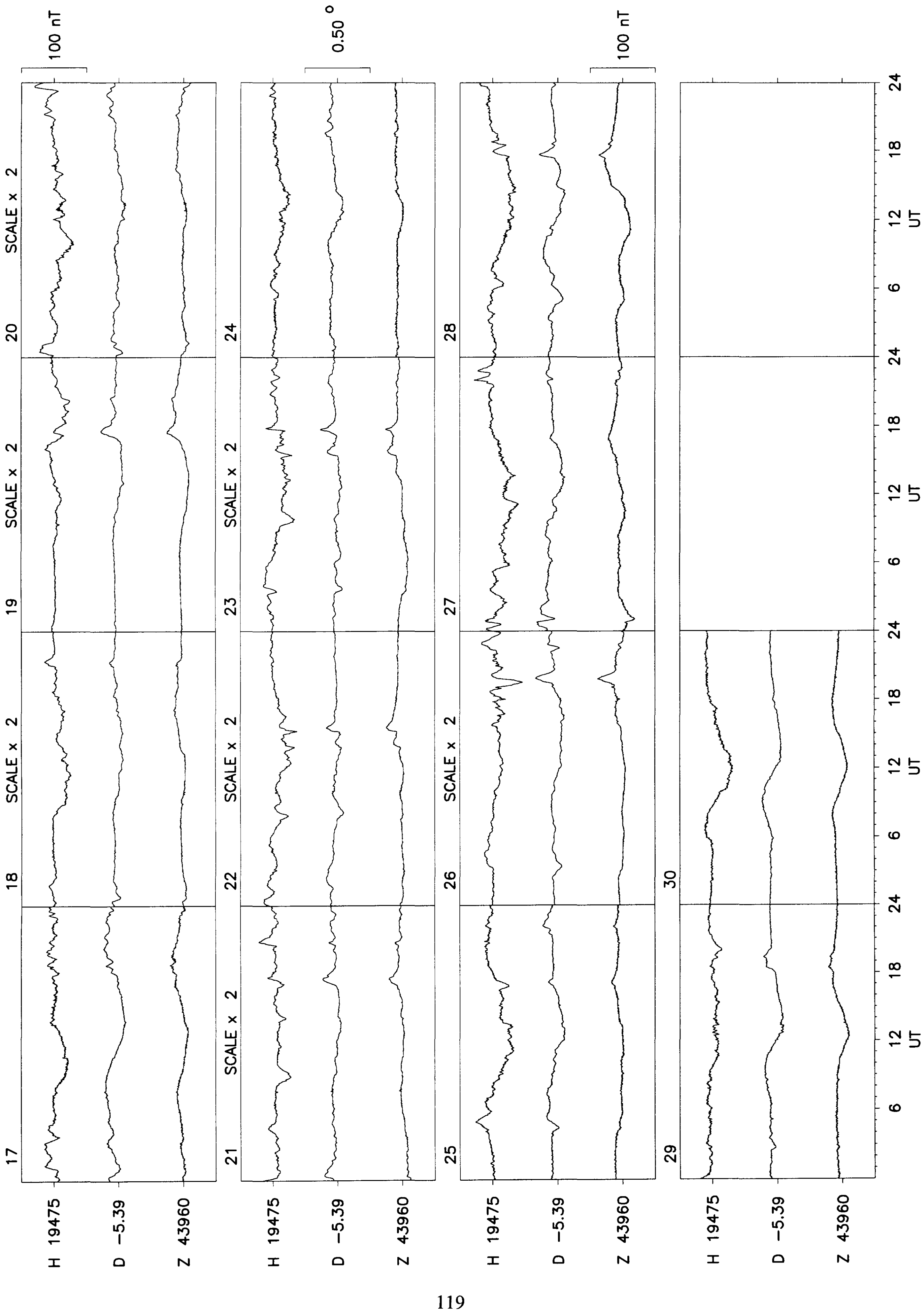
H 19475
D −5.39
Z 43960
100 nT
0.50 °
100 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 2
6
12
18
24
UT


100 nT
0.50 °
100 nT
H 19475
D −5.39
Z 43960
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
6
12
18
24
UT

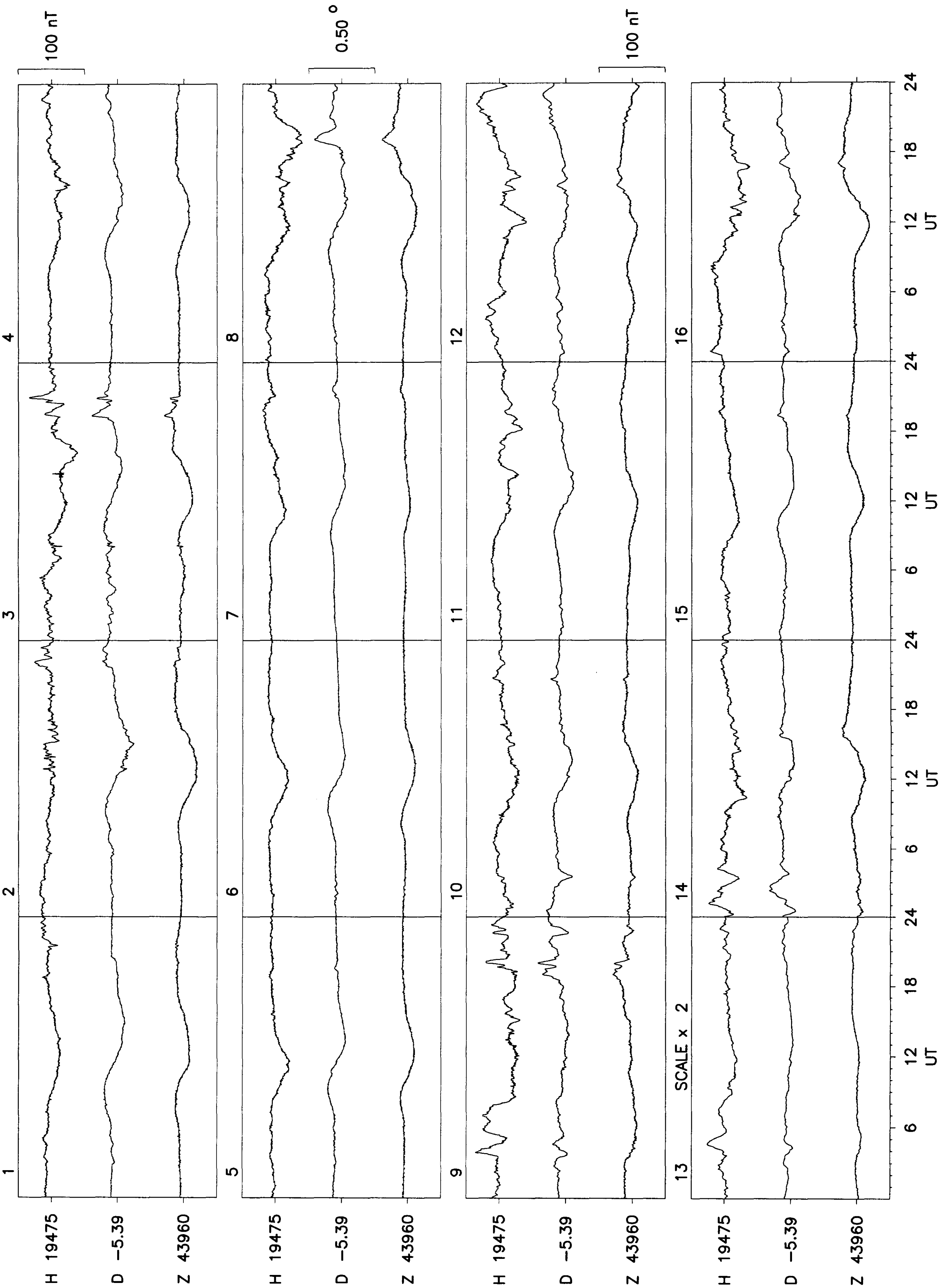

100 nT
0.50 °
100 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 2
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
6 12 18 24
UT

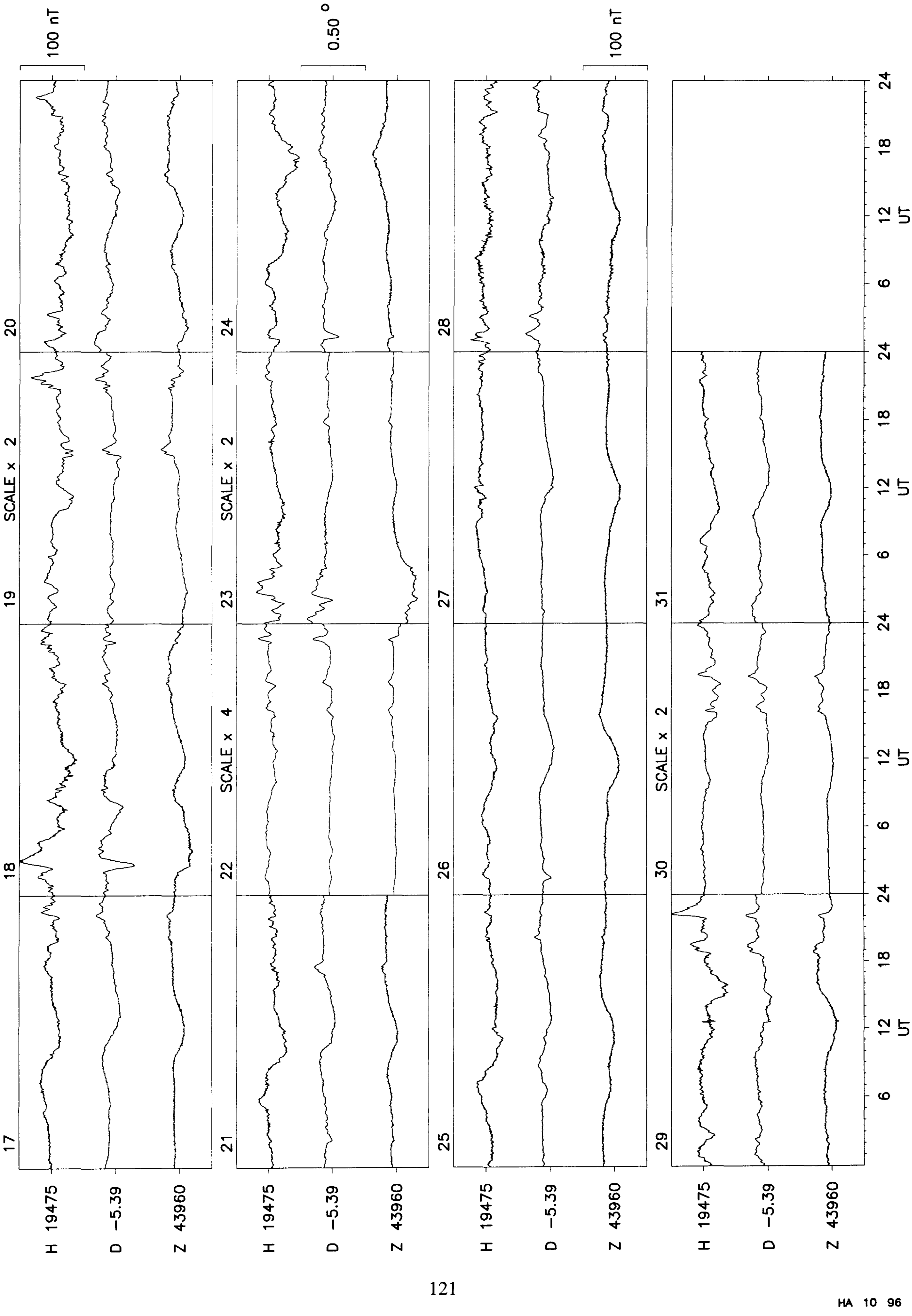


100 nT
0.50 °
100 nT
H 19475
D −5.39
Z 43960
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
6
12
18
24
UT

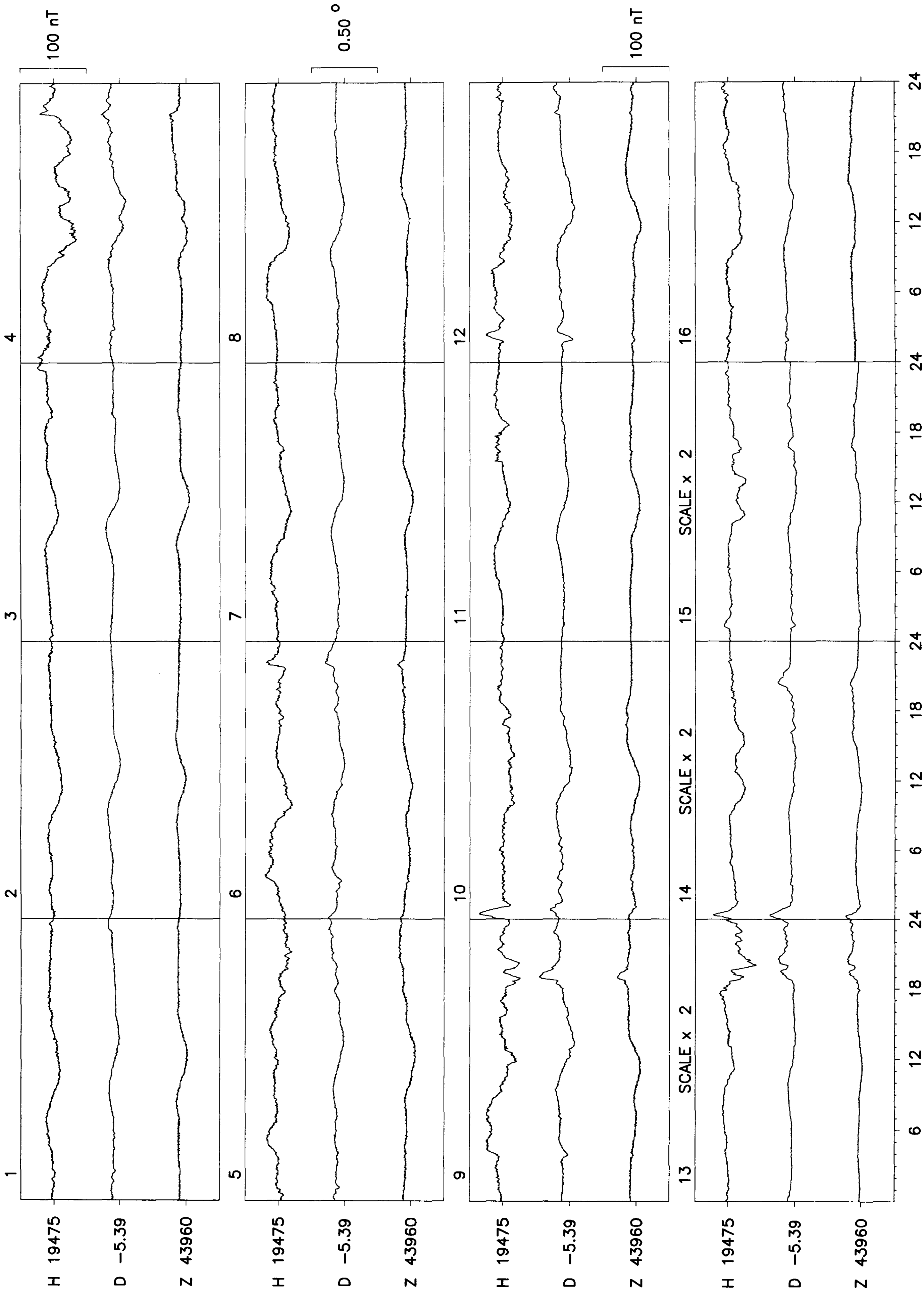


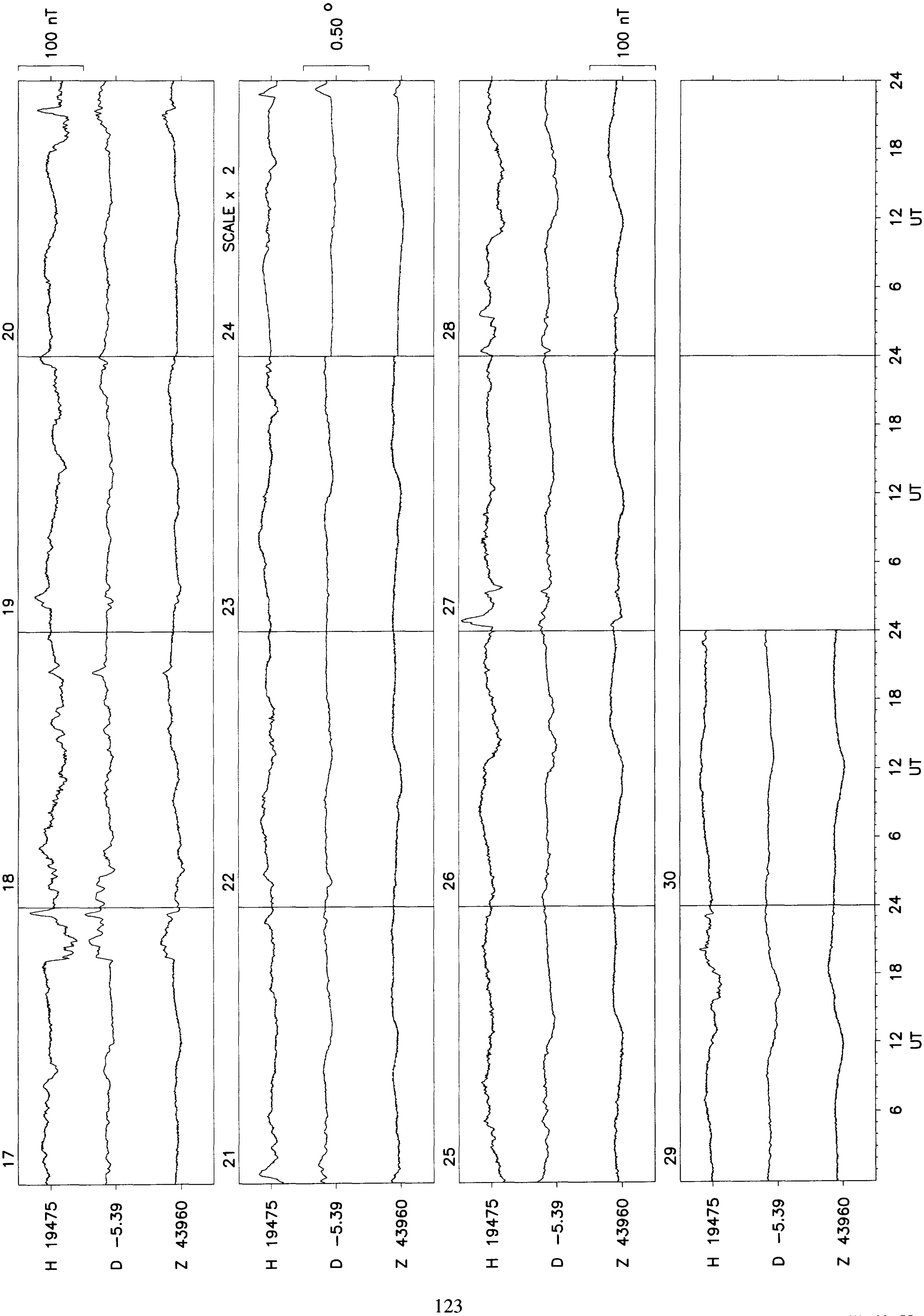
100 nT
0.50 °
100 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
6
12
18
24
UT


100 nT
0.50 °
100 nT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
H 19475
D −5.39
Z 43960
6
12
18
24
UT

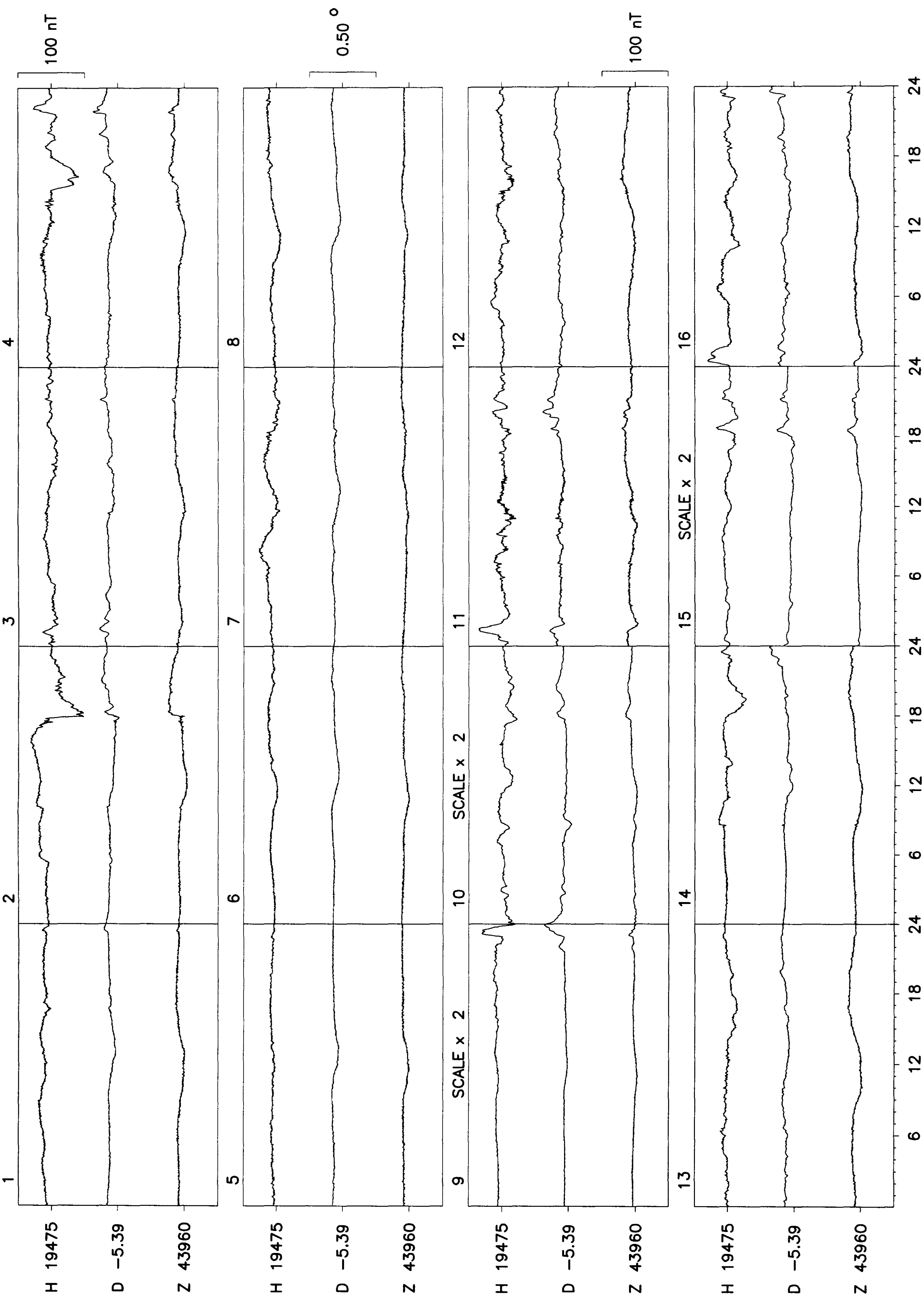


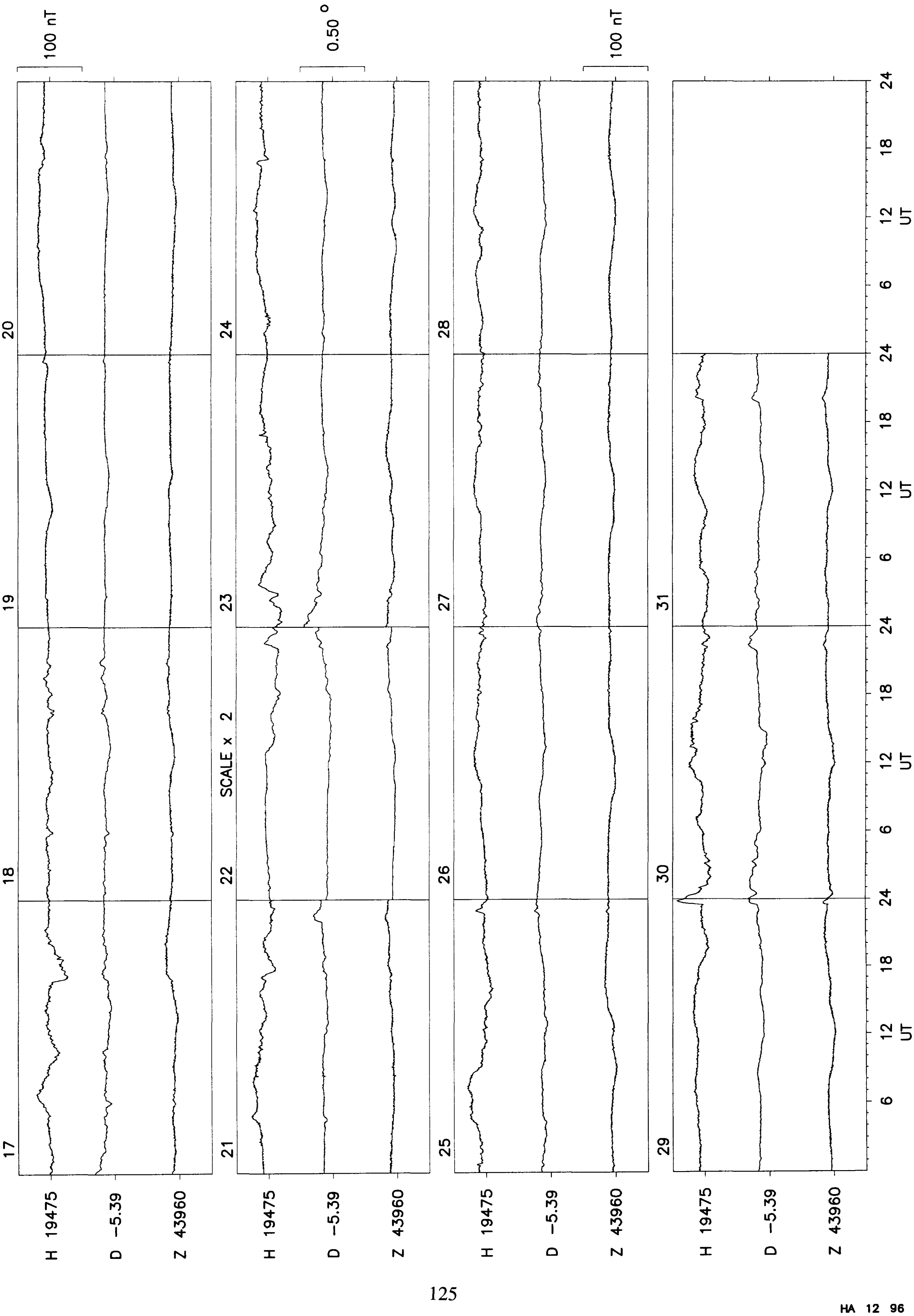
100 nT
0.50 °
100 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 4
SCALE x 2
SCALE x 2
H 19475
D −5.39
Z 43960
6
12
18
24
UT

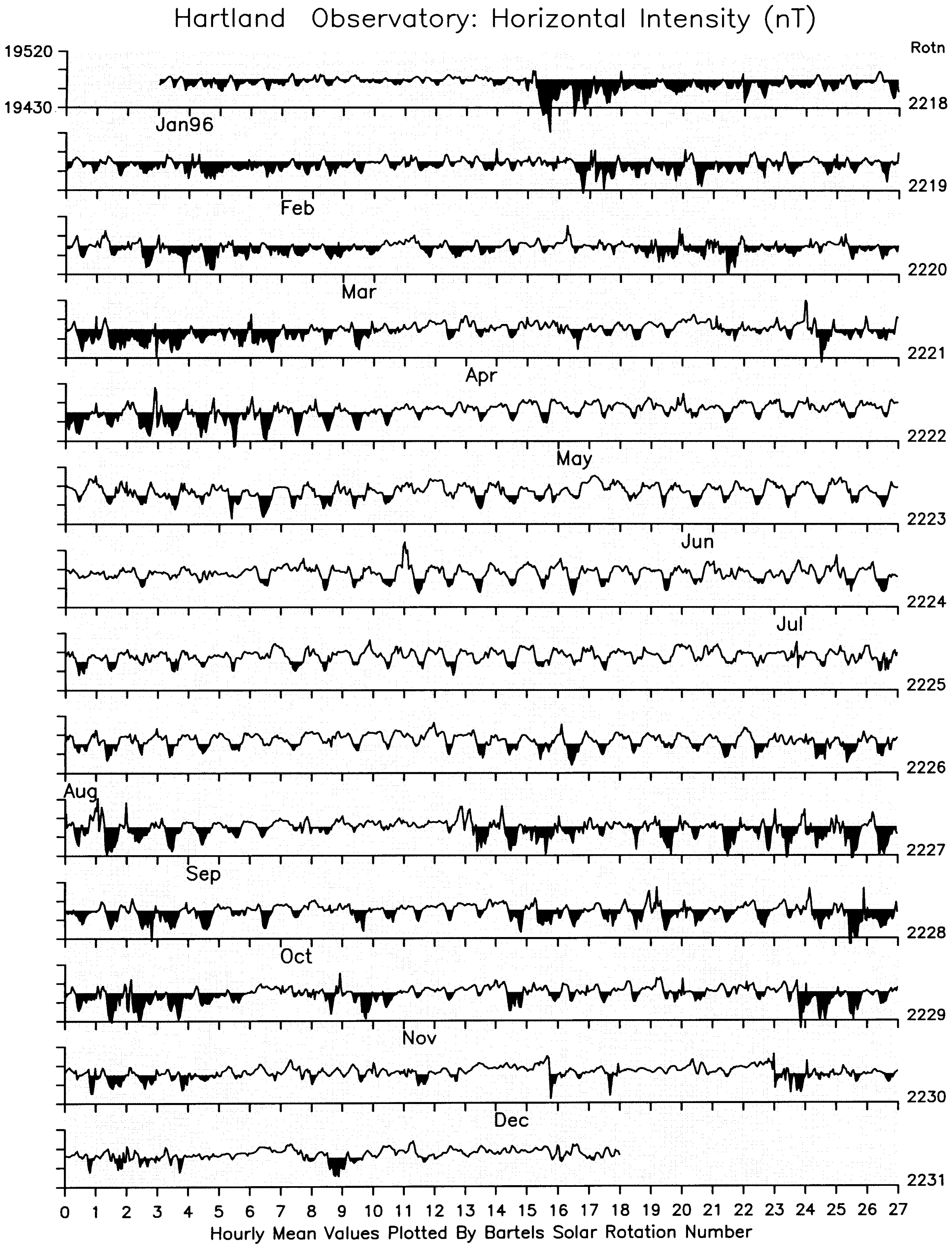

100 nT
0.50 °
100 nT
H 19475
D −5.39
Z 43960
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
SCALE x 2
SCALE x 2
6
12
18
24
UT

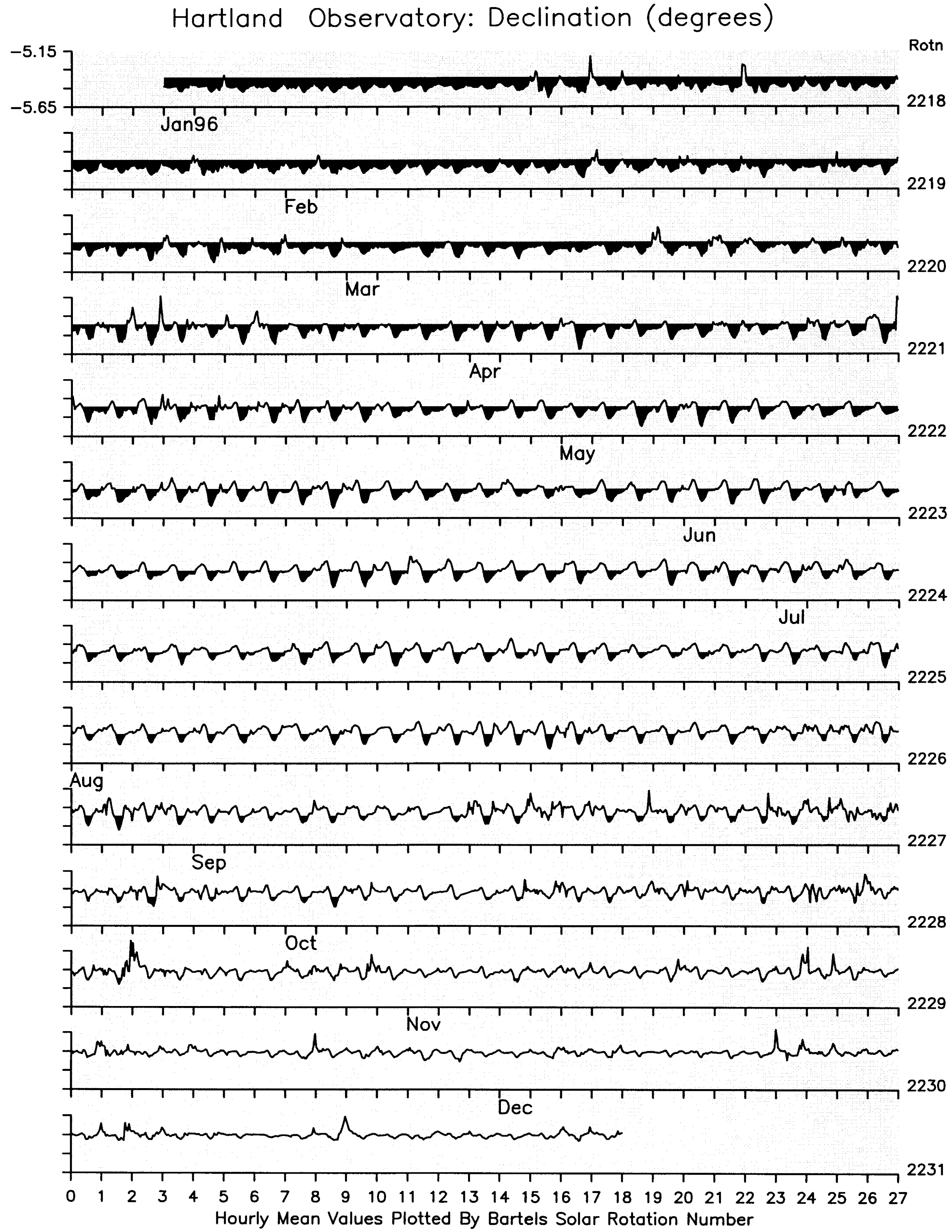

100 nT
0.50 °
100 nT
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
H 19475
D −5.39
Z 43960
6
12
18
24
UT

HA 11 96

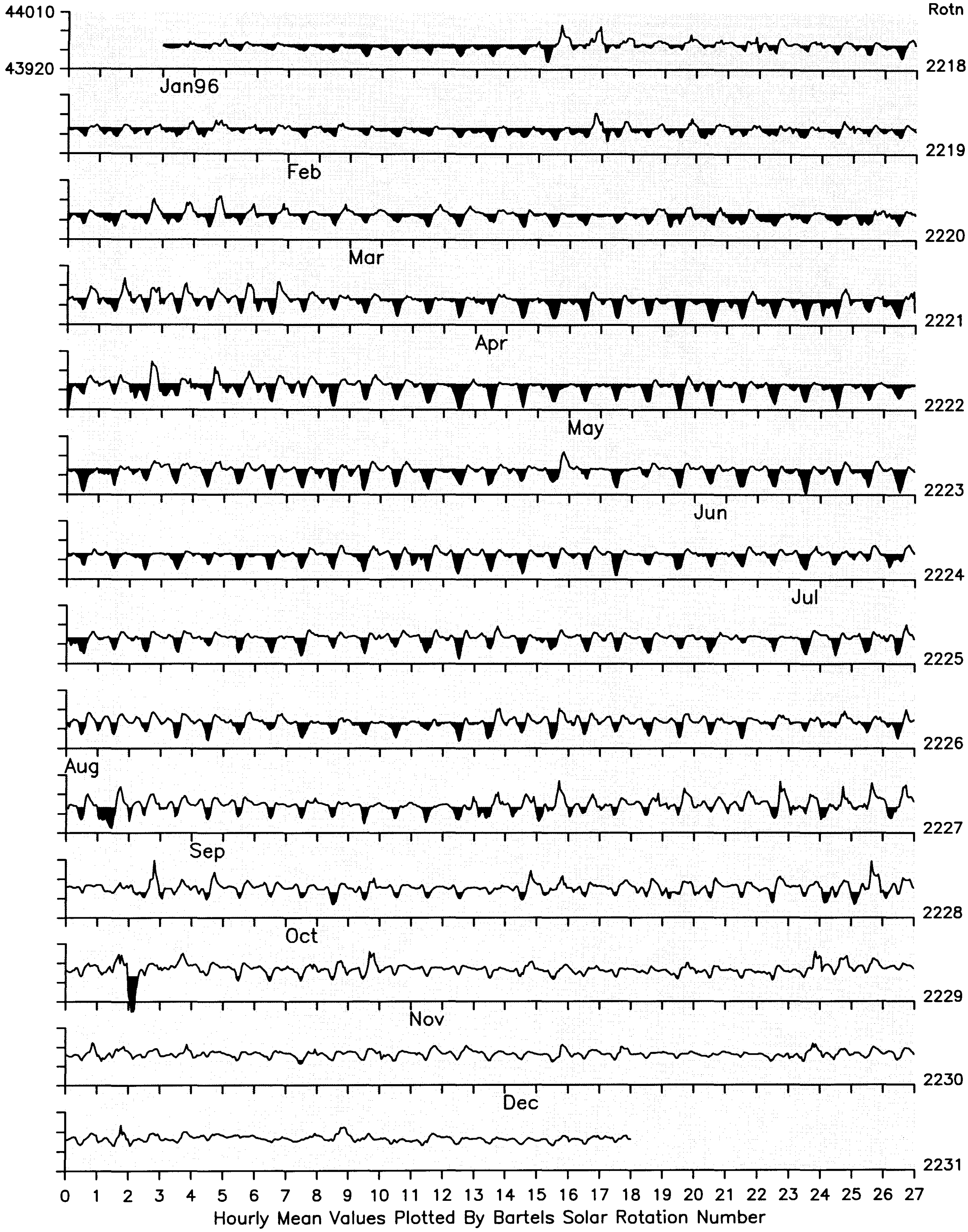

100 nT
0.50 °
100 nT
H 19475
D −5.39
Z 43960
SCALE x 2
UT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

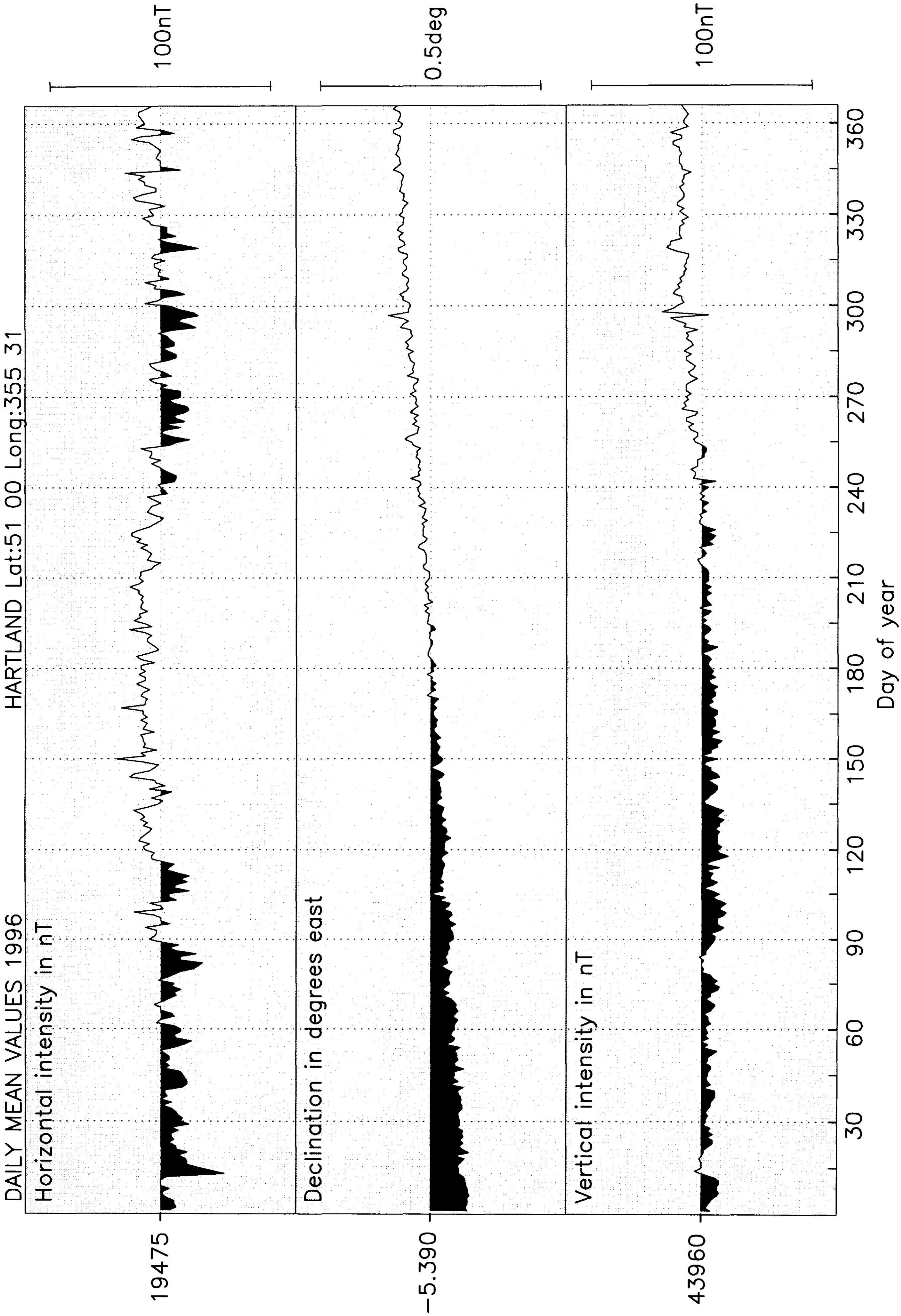

100 nT
0.50 °
100 nT
17
18
19
20
21
22
SCALE x 2
23
24
25
26
27
28
29
30
31
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
H 19475
D −5.39
Z 43960
6
12
UT
18
24
6
12
UT
18
24
6
12
UT
18
24

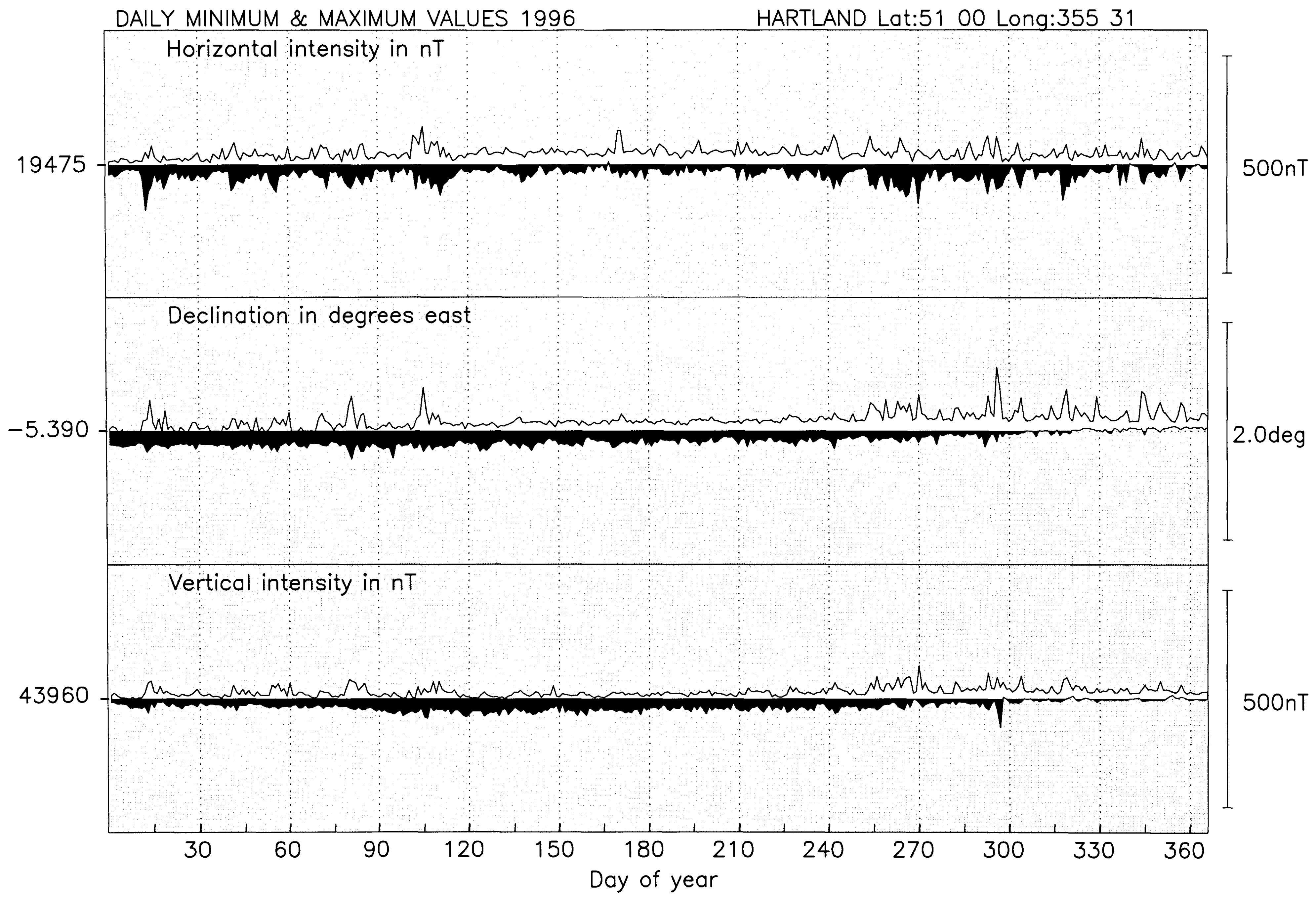

Hartland Observatory: Horizontal Intensity (nT)
19520
19430
Rotn
2218
Jan96
2219
Feb
2220
Mar
2221
Apr
2222
May
2223
Jun
2224
Jul
2225
2226
Aug
2227
Sep
2228
Oct
2229
Nov
2230
Dec
2231
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted By Bartels Solar Rotation Number


Hartland Observatory: Declination (degrees)
-5.15
-5.65
Rotn
2218
Jan96
2219
Feb
2220
Mar
2221
Apr
2222
May
2223
Jun
2224
Jul
2225
2226
Aug
2227
Sep
2228
Oct
2229
Nov
2230
Dec
2231
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: Vertical Intensity (nT)




DAILY MEAN VALUES 1996
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
100nT
19475
Declination in degrees east
0.5deg
-5.390
Vertical intensity in nT
100nT
43960
30
60
90
120
150
180
210
240
270
300
330
360
Day of year


DAILY MINIMUM & MAXIMUM VALUES 1996
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
19475
-5.390
43960
500nT
2.0deg
500nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Hartland 1996

Month	D ° '	H nT	I ° '	X nT	Y nT	Z nT	F nT
Based on All Days							
Jan	-5 27.8	19467	66 6.8	19379	-1853	43957	48075
Feb	-5 27.0	19469	66 6.7	19381	-1849	43957	48076
Mar	-5 26.1	19470	66 6.6	19382	-1844	43957	48076
Apr	-5 25.4	19474	66 6.2	19387	-1841	43953	48074
May	-5 24.8	19481	66 5.8	19394	-1838	43954	48078
Jun	-5 23.9	19483	66 5.7	19397	-1833	43955	48079
Jul	-5 23.1	19483	66 5.7	19397	-1828	43957	48081
Aug	-5 22.3	19478	66 6.1	19392	-1823	43959	48081
Sep	-5 21.3	19471	66 6.7	19386	-1817	43964	48083
Oct	-5 20.3	19471	66 6.8	19387	-1812	43967	48086
Nov	-5 19.7	19475	66 6.6	19391	-1809	43969	48089
Dec	-5 19.1	19480	66 6.3	19396	-1806	43969	48091
Annual	**-5 23.4**	**19475**	**66 6.4**	**19389**	**-1829**	**43960**	**48081**
International quiet day means							
Jan	-5 28.3	19474	66 6.2	19385	-1857	43952	48073
Feb	-5 27.5	19472	66 6.4	19384	-1852	43956	48076
Mar	-5 26.8	19475	66 6.2	19387	-1849	43956	48077
Apr	-5 25.5	19478	66 5.9	19391	-1842	43952	48075
May	-5 25.0	19481	66 5.8	19394	-1839	43954	48078
Jun	-5 23.8	19482	66 5.7	19396	-1832	43954	48078
Jul	-5 23.2	19484	66 5.7	19398	-1829	43957	48082
Aug	-5 22.4	19484	66 5.6	19398	-1825	43956	48081
Sep	-5 21.6	19475	66 6.4	19390	-1819	43963	48083
Oct	-5 20.9	19478	66 6.3	19393	-1816	43966	48087
Nov	-5 20.0	19481	66 6.2	19397	-1811	43970	48092
Dec	-5 19.4	19484	66 6.0	19400	-1808	43969	48093
Annual	**-5 23.7**	**19479**	**66 6.1**	**19393**	**-1831**	**43959**	**48081**
International disturbed day means							
Jan	-5 27.6	19456	66 7.6	19368	-1851	43960	48073
Feb	-5 26.4	19465	66 6.9	19377	-1845	43958	48075
Mar	-5 25.2	19464	66 7.0	19377	-1838	43958	48074
Apr	-5 24.5	19467	66 6.7	19380	-1835	43954	48072
May	-5 24.8	19478	66 6.0	19391	-1838	43955	48077
Jun	-5 23.9	19483	66 5.7	19397	-1833	43955	48079
Jul	-5 23.1	19481	66 5.9	19395	-1828	43957	48080
Aug	-5 21.7	19472	66 6.5	19387	-1820	43959	48079
Sep	-5 20.9	19466	66 7.0	19381	-1814	43963	48080
Oct	-5 19.5	19464	66 7.2	19380	-1806	43966	48082
Nov	-5 19.3	19467	66 7.2	19383	-1806	43972	48088
Dec	-5 18.8	19474	66 6.7	19390	-1803	43969	48089
Annual	**-5 23.0**	**19470**	**66 6.7**	**19384**	**-1827**	**43961**	**48080**

Hartland Observatory K Indices 1996

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1012 1133	3111 2332	2111 1232	3221 2123	2211 2121	1111 1212	2111 2243	3322 3223	3211 1131	1210 1123	2111 1111	0111 1211
2	2011 1324	3222 2321	2100 1112	1111 1223	2112 2211	1211 1222	3211 1223	3232 3221	1211 1212	1221 4423	1111 1111	1211 1543
3	4122 2212	1111 2113	2121 2222	1111 2234	1211 2213	0111 1112	4423 2222	2322 2213	0111 1111	2332 3444	1011 1122	3212 2222
4	1111 2211	1111 2213	2221 2333	3221 3313	3211 3243	2211 1312	3321 1221	1222 2221	0112 2334	1111 2322	3123 3323	2111 2433
5	2222 2223	3311 1221	2211 1232	3111 0223	3231 2101	1211 1223	3323 3321	3321 1221	1212 1212	1111 1110	2221 2222	1001 1001
6	3211 1222	1111 1121	1112 2211	2111 1010	2111 1122	2433 3321	1212 1221	2110 2332	3121 2102	1011 1100	3322 1123	0000 1011
7	1111 1123	2211 2224	1011 1111	0101 1011	2102 1122	1112 1221	3221 3330	1111 1233	1222 2113	0001 1222	1111 1221	0121 1122
8	2111 1121	3221 2232	1332 2101	1111 2213	2311 1121	1111 2132	2132 3323	1101 1211	3211 2121	2112 2352	1111 1111	1111 1111
9	1101 2111	3222 2123	1222 1232	3232 2333	2211 2211	1111 2221	2112 2111	2112 2332	0112 2124	2442 3344	1322 3243	0001 1225
10	2111 1123	1221 1344	1122 3134	3221 1211	2211 2132	1212 2221	0111 1111	1211 1111	5433 3353	3411 2232	4222 2221	5244 3443
11	1111 2133	4534 2343	4433 3244	2211 2214	1211 2321	1111 2222	1111 2212	2111 1222	3322 3334	2101 3333	1011 1221	4223 2243
12	2111 1224	3333 3133	2322 3344	4344 3444	1111 1123	2101 2221	2332 1233	1221 1112	4342 4434	2323 3324	4222 2113	2222 2322
13	3443 3523	2232 2343	4334 3433	1111 2224	3232 3333	1111 1111	2211 3222	3211 2111	4222 2344	3442 2233	2212 2354	1221 1221
14	3124 3345	4323 2321	3221 2123	3222 3246	3322 2233	1111 1111	1221 2124	2212 3343	4223 2222	4323 3312	5223 3354	0022 2133
15	5322 3324	3211 1143	2121 2121	5332 2323	1221 2341	1211 2232	1221 3433	2122 1321	2122 4354	2211 1231	3224 4432	3212 3344
16	3211 1232	3321 2423	2311 1111	3221 2324	2221 2343	2221 2221	1212 2222	3213 3442	2333 3423	3222 3422	1111 1122	3223 2233
17	2321 2253	4211 1132	2432 2333	3423 3455	2223 1112	2212 3323	2311 3321	3322 1223	3311 2233	1111 1233	2222 2245	3222 1332
18	2322 2332	1121 2434	3211 2132	4433 3234	1110 1110	1121 2224	2221 1322	1112 2221	4132 3333	5543 2233	3322 2342	1221 1222
19	1111 2335	3222 1133	2332 3444	3333 3553	1122 1343	4322 2322	2211 2222	2211 1112	1122 3532	3434 4545	3321 2223	1000 0001
20	3233 2311	2211 3223	3322 3355	3324 4233	4112 3223	2322 2221	3222 3322	2222 3221	4334 3335	3322 3333	2111 1233	0100 0110
21	1122 1223	2121 1111	5334 4455	4331 2344	3222 2331	2111 2111	1211 2232	1212 2121	4344 3544	2222 1422	3211 1112	0211 1333
22	2111 2223	3322 2132	3223 2543	2311 2222	1111 2123	2010 1212	2211 2232	1211 2311	3343 4512	3433 4456	2111 2211	2001 3334
23	3111 1111	3223 3423	3221 1232	3321 2243	2221 2212	1111 3221	1211 2221	2333 3122	2434 3533	6532 2333	1111 1121	3321 1210
24	1111 1333	4422 2243	4222 2445	2101 1232	2321 2232	3121 2232	1111 1212	3211 2223	2122 3232	4222 2332	1112 2325	2101 1211
25	1111 1132	2222 3454	5332 3431	2211 1111	1211 2322	1111 1212	1112 2331	3342 3432	1322 2313	1232 1122	3222 1121	2221 2112
26	3221 1332	4223 3234	3321 2333	2101 1210	3312 1211	1111 2112	2221 2232	3332 1224	3432 3464	3111 1110	2212 2212	0101 1112
27	2212 1223	2221 2344	3412 3113	2111 2124	0211 2443	1113 1222	1111 2210	3432 2433	4323 3313	1112 2112	4322 1111	2101 1111
28	2221 1144	3321 1213	1312 3223	2211 1111	2111 2211	3211 2113	2111 3442	4222 3334	1332 3432	3322 2233	3312 2221	1111 1111
29	4333 2342	1111 2253	2211 1222	1221 1211	1213 2332	3111 3333	1111 1211	5543 3435	2211 2231	3222 3344	1111 2232	1011 1114
30	3310 1224		2111 1222	2211 2221	3222 1322	2111 2122	3421 1132	4231 2233	0211 1211	2222 2454	1110 1101	4222 2213
31	3222 2233		2121 1223		2113 2223		4223 4423	3323 3221		3221 1122		2211 1132

DAILY aa INDICES

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14	16	12	19	13	8	14	24	12	10	8	8
2	18	23	6	11	11	8	12	23	11	20	7	25
3	17	9	16	16	12	8	24	17	6	31	7	19
4	10	11	18	24	21	10	16	12	19	13	24	25
5	18	13	12	13	14	11	22	14	14	7	12	7
6	13	9	13	7	8	31	12	15	11	6	16	5
7	10	17	7	4	8	8	16	15	16	8	8	13
8	9	19	15	12	10	10	22	7	12	23	9	9
9	7	18	15	22	10	7	7	15	15	38	22	22
10	11	23	24	13	11	10	5	9	56	22	18	44
11	13	42	44	15	9	7	8	10	29	20	8	27
12	19	28	28	50	8	7	20	9	47	28	17	16
13	45	24	40	17	24	5	17	11	31	35	32	14
14	42	28	17	42	24	6	13	21	17	24	39	15
15	32	17	13	29	18	11	20	12	31	10	31	27
16	15	24	13	22	21	12	10	26	31	25	9	20
17	26	16	27	51	14	15	18	19	16	14	25	22
18	22	22	19	41	6	13	13	10	32	41	25	12
19	23	18	32	44	15	23	10	10	25	51	17	3
20	24	17	41	34	21	15	19	16	51	26	14	5
21	15	9	62	29	19	9	13	10	50	19	11	17
22	17	16	33	15	10	8	12	10	49	65	10	18
23	10	28	16	19	10	9	10	22	41	45	9	15
24	15	30	37	11	14	13	8	17	17	21	25	13
25	12	34	35	10	13	7	12	35	25	14	15	16
26	15	28	22	6	13	7	13	20	48	9	16	9
27	14	26	19	11	20	13	8	29	27	11	20	10
28	19	16	21	9	8	12	21	29	30	24	15	10
29	39	22	11	9	16	18	9	67	13	27	14	11
30	17		11	11	16	9	16	27	8	31	5	23
31	21		12		14		32	22		14		13
Monthly Mean Value	18.8	20.7	22.3	20.5	14.0	11.0	14.6	18.7	26.3	23.5	16.3	15.9

Annual mean Value for 1996 = 18.5

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
6	2	19	49	SI*	B	6		3
10	3	22	58	SI	C	23	3.8	11
24	3	08	56	SSC*	C	7	1.6	
3	4	10	07	SSC*	C	6	-0.5	
8	4	13	34	SSC*	A	14	-2.6	-2
13	4	09	08	SI*	C	5	0.8	3
6	6	05	10	SSC*	C	11	2.3	9
19	6	02	44	SI*	B	-34	4.1	-10/+9
23	8	07	18	SI*	C	-9	1.2	5
15	9	15	55	SI*	C	-24	1.3	-6
17	9	10	24	SSC*	C	8	-0.8	
11	11	15	29	SSC	B	11	-0.7	3
13	11	12	59	SSC*	B	8	-1.3	3
24	11	09	26	SSC*	C	8	-0.6	3
1	12	11	55	SSC*	C	-5	-0.6	-3
2	12	10	02	SSC	C	4	0.4	
14	12	08	32	SSC*	B	11	+1.2/-1.2	-4

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				
9	7	09	09	09	11	09	16	9	0.6	4

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

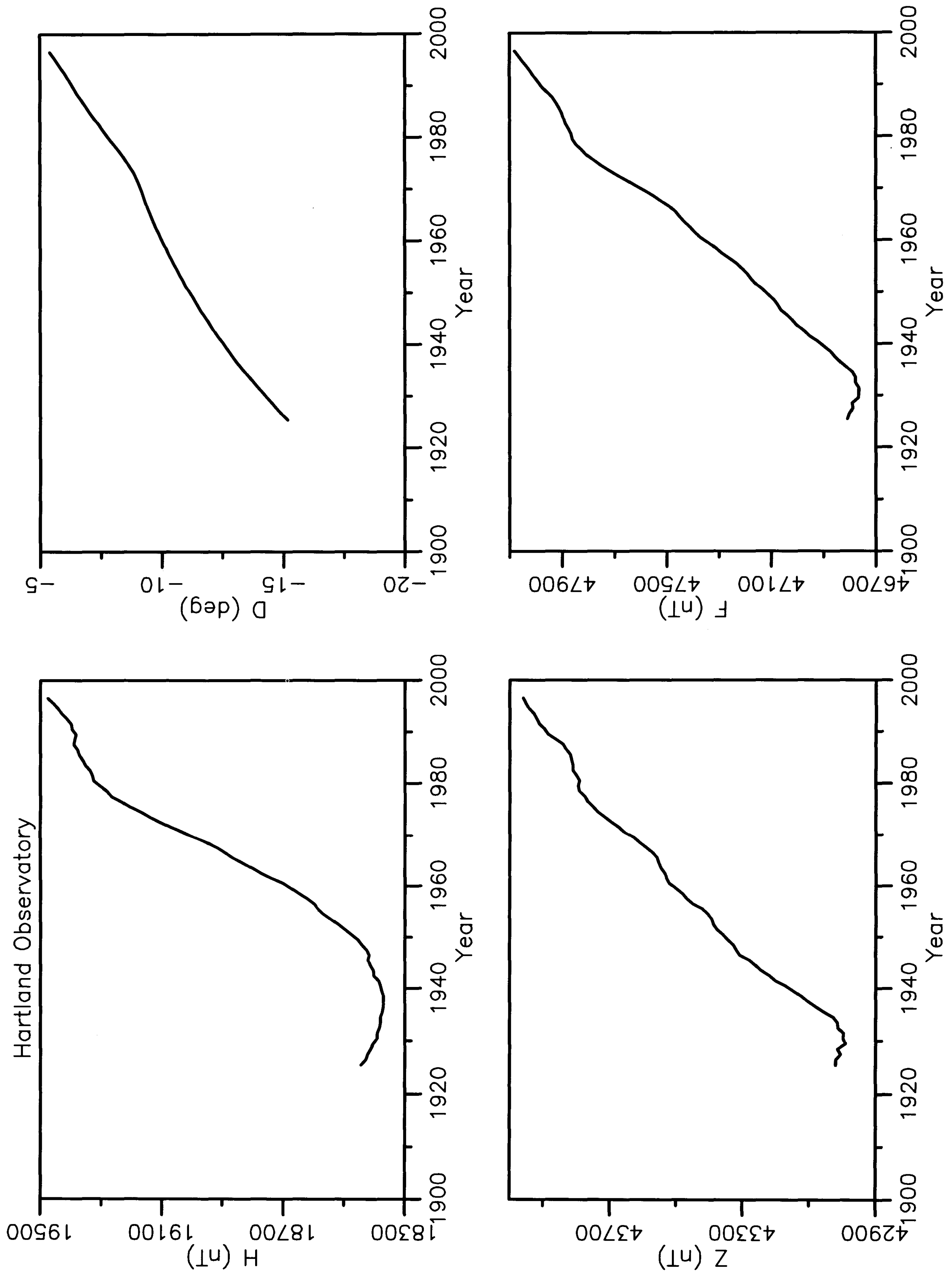
Hartland

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

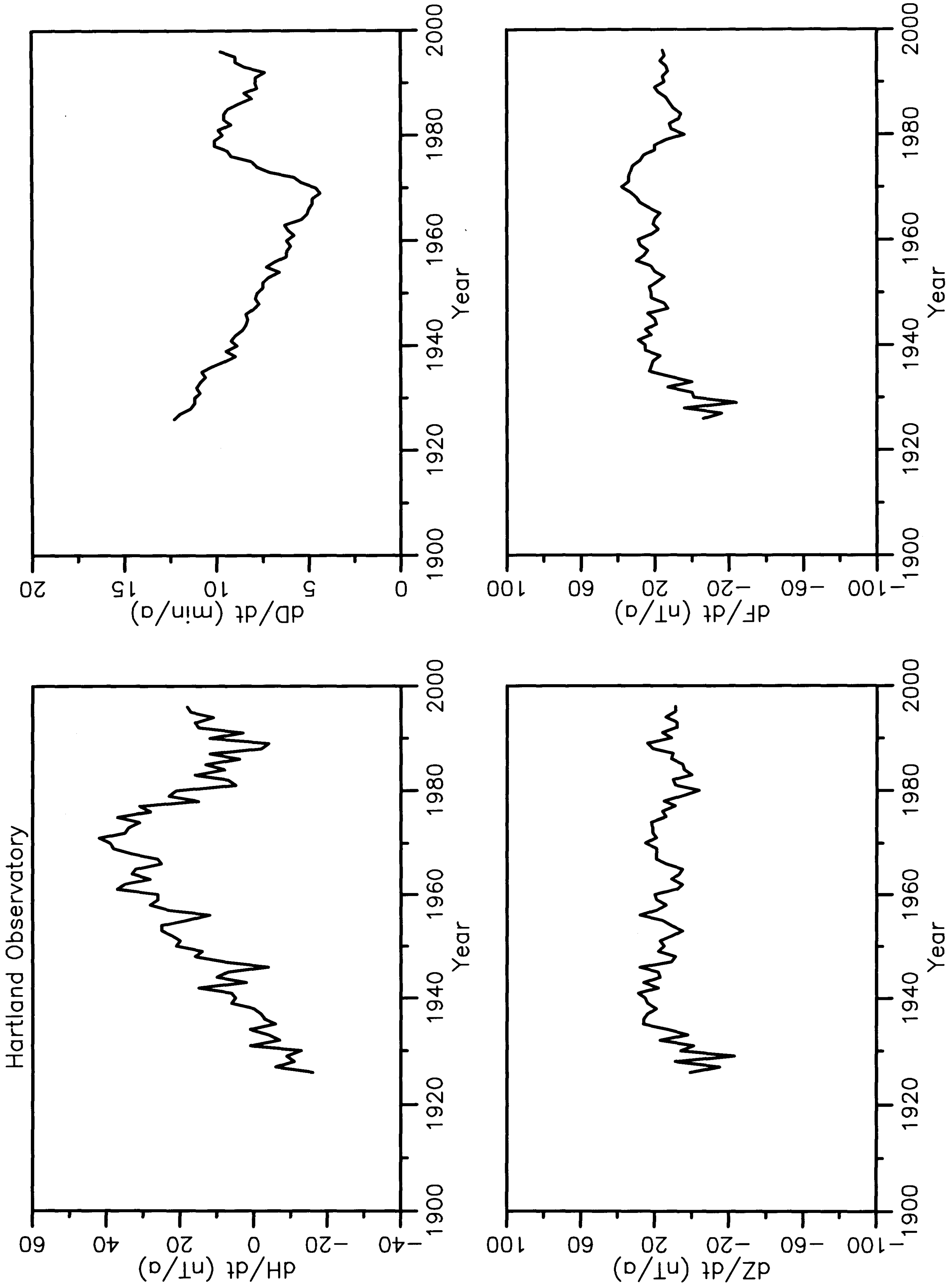
	Year	D		H	I		X	Y	Z	F
	1981.5	-7	33.9	19335	66	10.2	19167	-2546	43777	47857
	1982.5	-7	24.7	19342	66	10.1	19180	-2495	43787	47869
	1983.5	-7	15.1	19358	66	9.0	19203	-2443	43787	47876
	1984.5	-7	5.5	19366	66	8.6	19218	-2391	43791	47882
	1985.5	-6	56.1	19379	66	7.9	19237	-2340	43796	47892
	1986.5	-6	47.3	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
	1994.5	-5	42.2	19440	66	8.1	19344	-1932	43942	48050
	1995.5	-5	33.2	19457	66	7.3	19366	-1883	43951	48065
	1996.5	-5	23.4	19475	66	6.4	19389	-1829	43960	48081

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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Hartland Observatory

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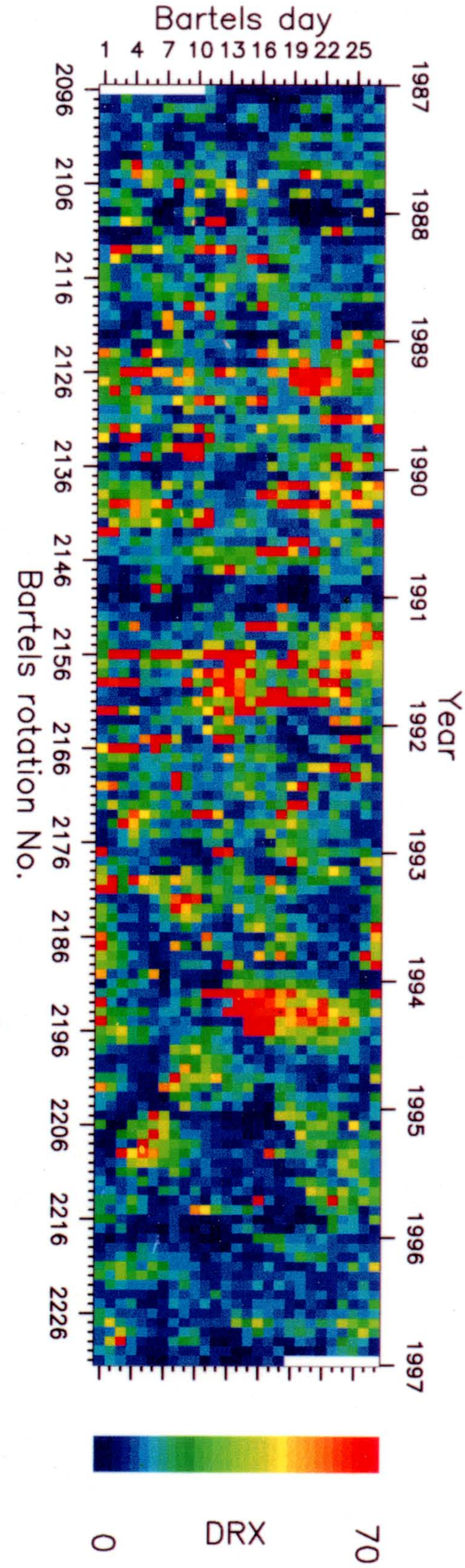
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1987–97



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