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GEOMAGNETIC BULLETIN 24

Magnetic Results 1994

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES

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

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Magnetic results 1994: Lerwick, Eskdalemuir and Hartland observatories

1 INTRODUCTION

This bulletin is a report of the measurements made between 1 January and 31 December 1994 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 1994 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°03′N
Longitude	358°49′E	89°28′E
Height above *msl*	85 m	

Geomagnetic coordinates used in this report are relative to a geomagnetic pole position of 79°16′N, 71°22′W, computed from the 6th generation International Geomagnetic Reference Field (Langel, 1992) at epoch 1994.5.

Eskdalemuir (Dumfries & Galloway, Scotland)

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

Eskdalemuir is a synoptic meteorological station involved in measurement of solar radiation, levels of atmospheric pollution, and in chemical sampling. The observatory operates a US standard seismograph and an International Deployment Accelerometer Program long-period sensor. BGS has a three-component seismometer set installed at the observatory and records data from four remote sites transmitted to the observatory by radio link. The observatory opened in 1908. It was built because of disruption to geomagnetic measurements at Kew Observatory (London) following the advent of electric tramcars at the beginning of the 20th century. BGS took over responsibility for magnetic observations from the Meteorological Office in 1968. There are two members of BGS staff stationed at the observatory. Mr W E Scott and Mrs M Scott were responsible for the general maintenance of the observatory during 1994.

Figure 2 is a site diagram of Eskdalemuir observatory. No major changes were made at the observatory during 1994. Routine building maintenance was carried out on the observatory buildings.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	55°19′N	57°55′N
Longitude	356°48′E	84°04′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 1994.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	51°00′N	54°03′
Longitude	355°31′E	80°23′
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 the BGS VAX 6410 mainframe for processing.

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

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

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

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

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

The number of missing one-minute values during 1994 at each observatory, resulting from failure of the ARGOS and back-up systems during the same periods of time, were as follows:

	No. of missing one-minute values	Date
Lerwick	77	30 Mar
	35	31 Mar
	13	2 Apr
	11	4 Apr
	6	23 Aug
Eskdalemuir	118	12 Oct
Hartland	0	-

5 CORRECTION OF FLUXGATE VARIOMETER DATA TO ABSOLUTE VALUES

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

The zero-field offset corrections allocated for each observatory for 1994 are shown in Figures 5-7. (The results for each observatory are discussed in detail below.) The zero-field offset correction is derived by comparing the fluxgate measurements with absolute measurements taken simultaneously. In each of the figures the top two panels show the comparison between the absolute measurements and the fluxgate measurements for H (plotted in the sense absolute - fluxgate) and the BRMs and the fluxgate measurements for H (plotted as daily average BRM - fluxgate value). The next two panels show the same for D, in which East is represented by positive values, and the next two panels show the same for Z. The bottom panel shows the daily mean temperature in the fluxgate chamber. In the panels showing the absolute - fluxgate comparison, the symbols represent the observed values and the full line shows the adopted correction. At Lerwick and Hartland the adopted correction is derived from polynomial fits to the observed values computed using the method of least squares. In deriving the polynomials the points immediately before the beginning and after the end of the year were used, but are not shown in the plots. This ensures that unrealistic discontinuities are not introduced at the year boundaries. The plots of the polynomial fits are stepped because the values computed from the polynomials have been rounded to the nearest nT or 0.1 min. The adopted correction at Eskdalemuir consists of the daily mean values of the hourly BRMs (with outliers removed). A correction has been applied to refer the BRMs to the observatory absolute standard.

Lerwick (Figure 5)

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

The ranges of the allocated zero-field offset corrections during the year were 3 nT for H, 1.5 minutes of arc for D and 15 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 $\pm 1^{\circ}C$ over the year.

The comparison of BRMs with fluxgate measurements shows a significant drift during May in the D BRMs. It is likely that this drift is related to changes in the outside air temperature causing mechanical deformation of the coils. The base of the coils system was reinforced during the service visit in June, which resulted in a step in the absolute-BRM comparisons. Following this modification the BRMs appeared to be more stable. The step in the D BRMs in November was not explained, but is likely to have been due to a slight rotation of the D bias coils.

The table below lists the root mean squared (*rms*) differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1991-93 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)		D(min)		Z(nT)	
1991	0.82	(19)	0.58	(19)	0.74	(20)
1992	1.70	(26)	0.36	(27)	1.21	(26)
1993	1.69	(31)	0.36	(33)	0.93	(30)
1994	0.87	(21)	0.25	(21)	0.66	(21)

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 BRMs have been used to correct the fluxgate measurements, taking into account the site difference between the BRMs and the absolute standard (determined from the BRM-absolute measurement comparison), and the small drift in this site difference over the year. The step in the baselines on 28 March resulted from an adjustment to the fluxgate sensor band-pass filter.

The ranges in the allocated zero-field offset corrections over the year, discounting the step on 28 March, were 14 nT for H, 6 minutes of arc for D and 7 nT for Z. The temperature variation in the variometer chamber was kept to within $\pm 0.5°C$ over the year.

On 1 January 1994 a new site difference in F between the standard pillar and the position at which F is measured was adopted. Previously measurements of F were corrected by +25 nT to convert them to the standard pillar. After 1 January 1994 measurements in F are corrected by +1 nT to correct them to the standard pillar.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1991-93 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)		D(min)		Z(nT)	
1991	1.67	(42)	0.44	(43)	1.09	(42)
1992	1.43	(36)	0.55	(36)	0.83	(36)
1993	1.44	(40)	0.41	(42)	0.85	(41)
1994	1.56	(28)	0.45	(29)	0.92	(28)

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 11 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 $\pm 1.25°C$ over the year.

The base of the BRM coil system was reinforced on 18 May, after the BRMs were observed to be drifting, but they continued to drift after this modification. The step in the BRMs at the beginning of December was the result of tightening up the locking screws on the coils system.

The table below lists the *rms* differences of the observed zero-field corrections from the allocated values. The *rms* differences for 1991-93 are also listed. The number of observations of each element in each year is given in brackets.

Year	H(nT)	D(min)	Z(nT)
1991	1.03 (48)	0.17 (49)	1.09 (47)
1992	1.11 (48)	0.36 (49)	1.69 (49)
1993	1.16 (43)	0.28 (51)	1.36 (44)
1994	1.20 (56)	0.25 (56)	0.70 (56)

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.

ARGOS data are corrected using BRMs and absolute observations to produce a series of absolute one-minute values of H, D and Z centred on the minute. Hourly mean values, centred on the UT half-hour, are computed from minute values, daily mean values from hourly means, and monthly mean values from daily means. (Hourly means are not computed if there are more than six one-minute values missing; daily means are not computed if there are more than two hourly means missing.) Annual mean values are calculated from the monthly mean values weighted according to the number of days in the month. At each stage of processing the mean values of the remaining geomagnetic elements are calculated from the corresponding mean values of H, D and Z. The monthly mean and annual mean values for all the geomagnetic elements are tabulated. Declination and inclination are expressed in degrees and decimal minutes of arc, the units of all the other elements are nanoteslas. The annual mean values are also calculated using only the five international quiet days (designated "Q days" in the table) and the five international disturbed days ("D 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 1994 is given below, with the number of missing intervals under the column headed "Null".

	K Index										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Null**
LER	416	730	736	599	270	105	36	17	9	2	0
ESK	260	614	718	744	420	136	24	3	0	0	1
HAD	49	672	749	739	503	183	21	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 IAGA Provisional Atlas of Rapid Variations (1961). Occurrences of Solar Flare Effects (SFE), Sudden Impulses (SI) and Storm Sudden Commencements (SSC) are given along with the time, amplitude and quality of the event.

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

7 DATA AVAILABILITY

One-minute mean values of geomagnetic elements at each of the UK observatories from 1983 onwards are available in digital form. Hourly mean values are available in digital form for Lerwick (1926-94), Eskdalemuir (1911-94), Abinger (1926-56) and Hartland (1957-94). K indices from the UK observatories are available in digital form from 1954 onwards. In its role as the World Data Centre C1 for Geomagnetism, the Geomagnetism Group also holds a selection of hourly mean values and annual mean values from observatories worldwide. Digital data can be transferred by electronic mail over JANET, or supplied on IBM compatible 3.5 inch diskettes. For more information contact:

Data Services		
Geomagnetism Group		
British Geological Survey		
Murchison House		
West Mains Road	☎:	0131 667 1000
Edinburgh EH9 3LA	Fax:	0131 668 4368
Scotland UK	Telex:	727343 SEISED G

8 GEOMAGNETISM GROUP STAFF LIST 1994

Edinburgh

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

Eskdalemuir

Craftsman	W E Scott
Cleaner	Mrs M Scott

Hartland

PGS E	C R Pringle

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

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

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.

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

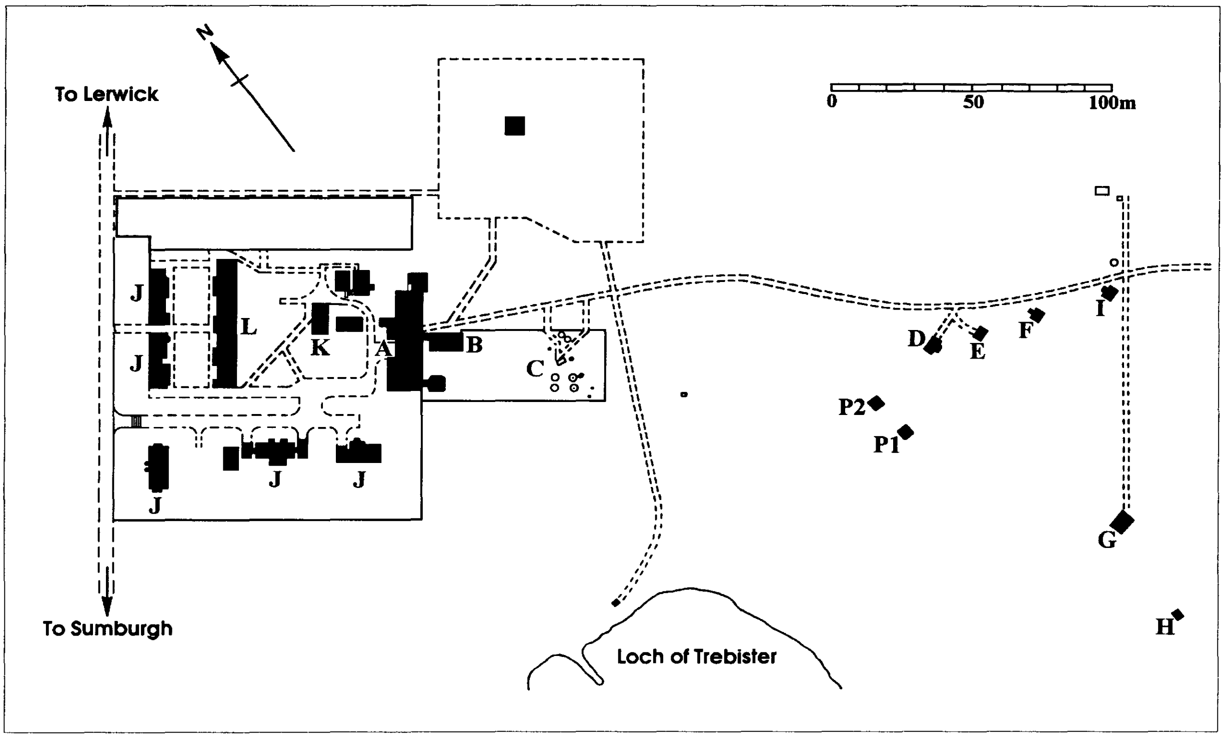
Langel, R A. 1992. International Geomagnetic Reference Field: The sixth generation. *Journal of Geomagnetism and Geoelectricity*, **44**, 679-707.

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

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

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

Lerwick Observatory



Observatory Layout

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

Instrument Deployment

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

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

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

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

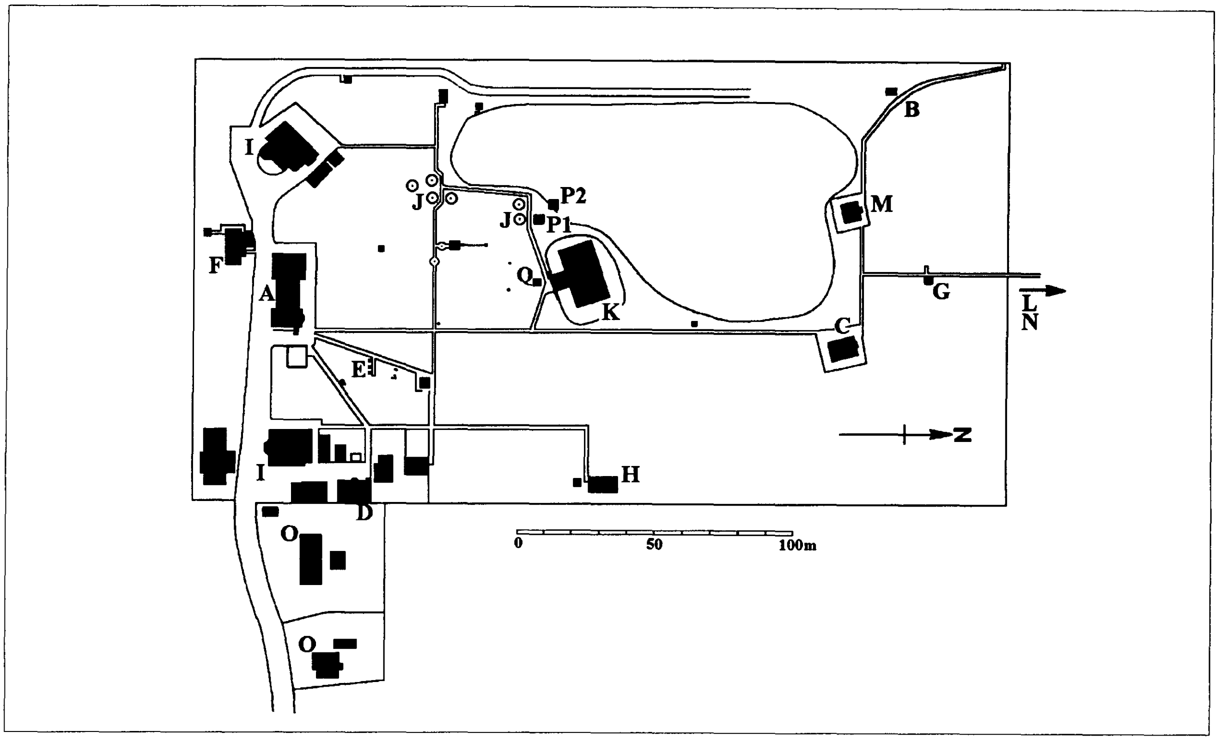
The Variometer House is constructed from non-magnetic concrete and has internal dimensions of 4.9 by 3 metres. The roof is semi-circular in cross section. The temperature of the house is controlled to a diurnal range of ±1°C. The meridian at the time of construction is defined on the north and south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

Previous descriptions

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

Figure 1. Lerwick observatory site diagram

Eskdalemuir Observatory



Observatory Layout

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

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

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

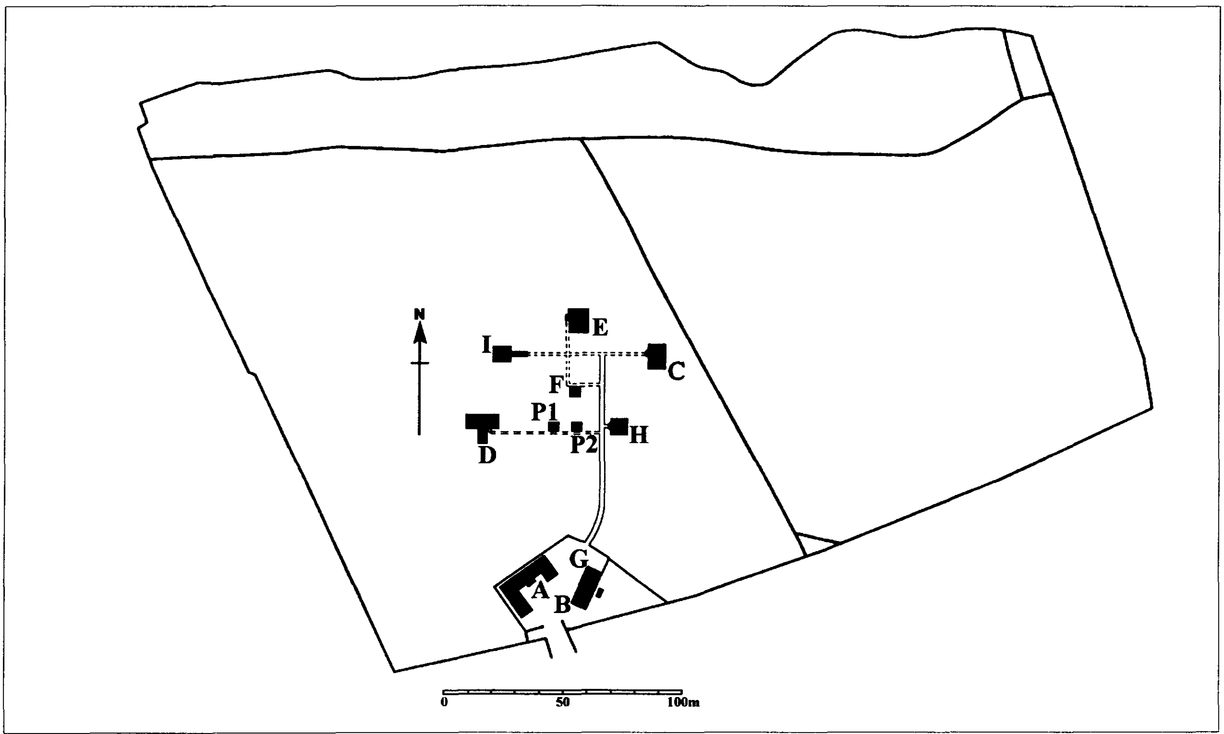
West Absolute Hut
The hut contains three instrument piers. The fixed mark is viewed from the central pillar at a bearing of 4° 36' 08" through a shutter in the south wall of the hut.

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

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

Figure 2. Eskdalemuir observatory site diagram

Hartland Observatory



Observatory Layout

A	Main observatory building
B	Caretakers house
C	Absolute Hut
D	Non-Magnetic laboratory, Back-up Fluxgate, METEOSAT transmitter
E	Variometer House
F	Instrument Hut
G	Garage
I	Test 1 Hut
P1	ARGOS Proton magnetometer 1
P2	ARGOS Proton magnetometer 2

Instrument Deployment

Absolute Hut
PVM (used for H/Z/F measurements)
D/I Fluxgate Theodolite
The fixed mark (azimuth 11° 27' 54" E of N) is viewed through a window in the north wall of the hut.

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

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

Figure 3. Hartland observatory site diagram

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 positionThe 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.

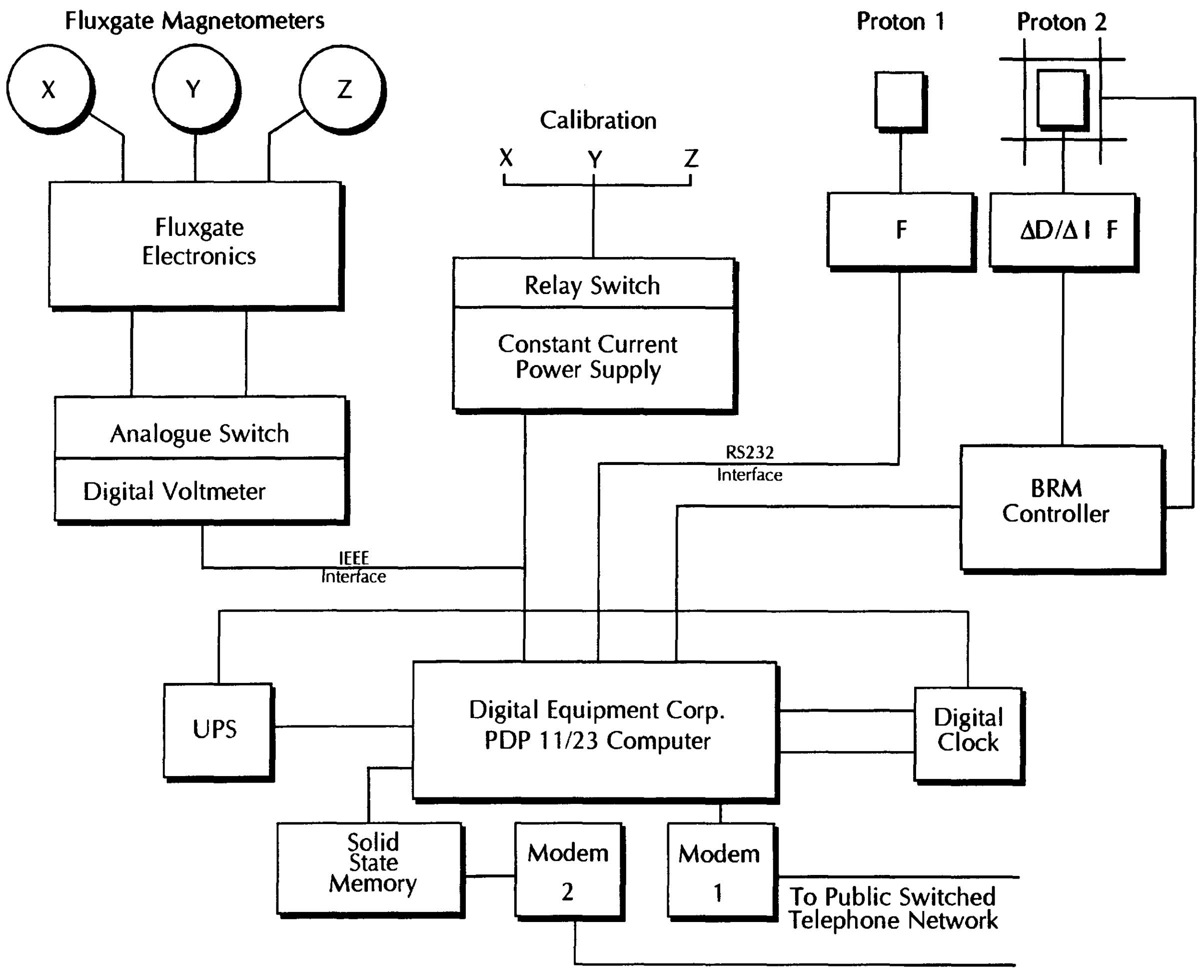


Figure 4a. Block diagram of ARGOS

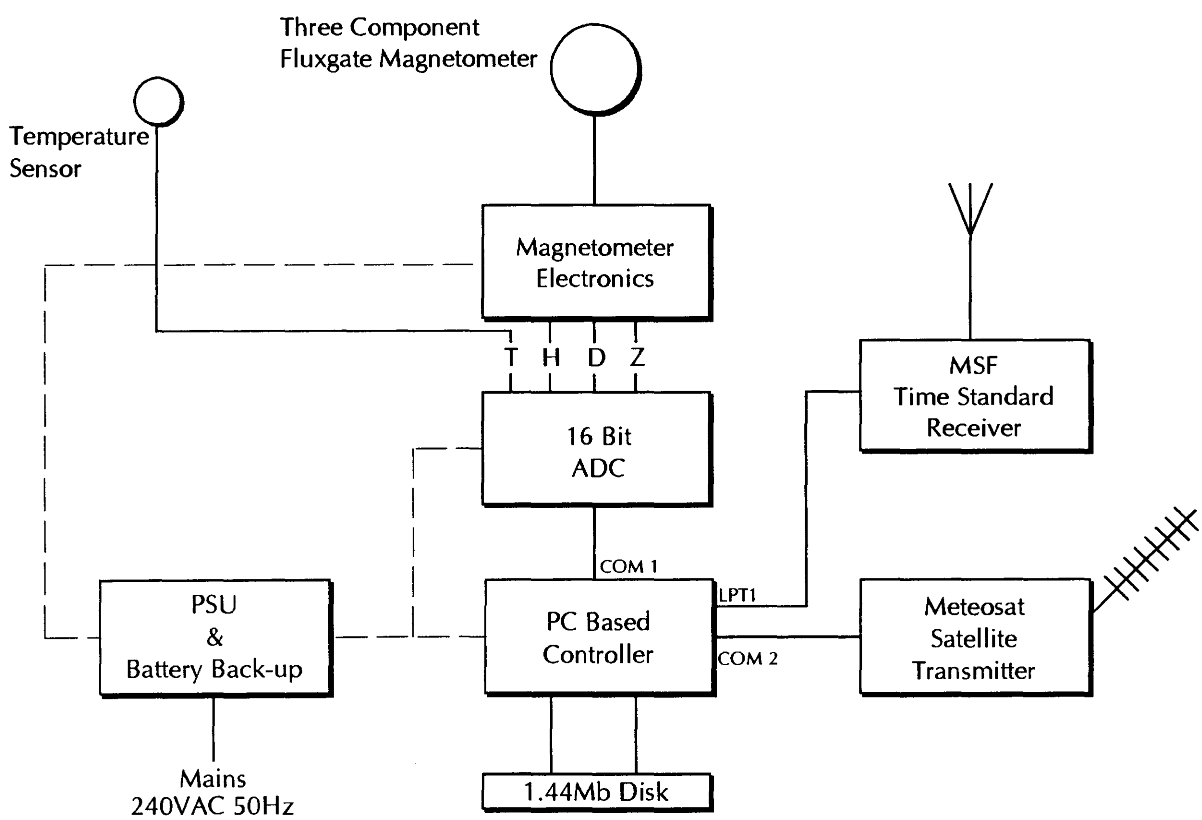


Figure 4b. Block diagram of back-up system

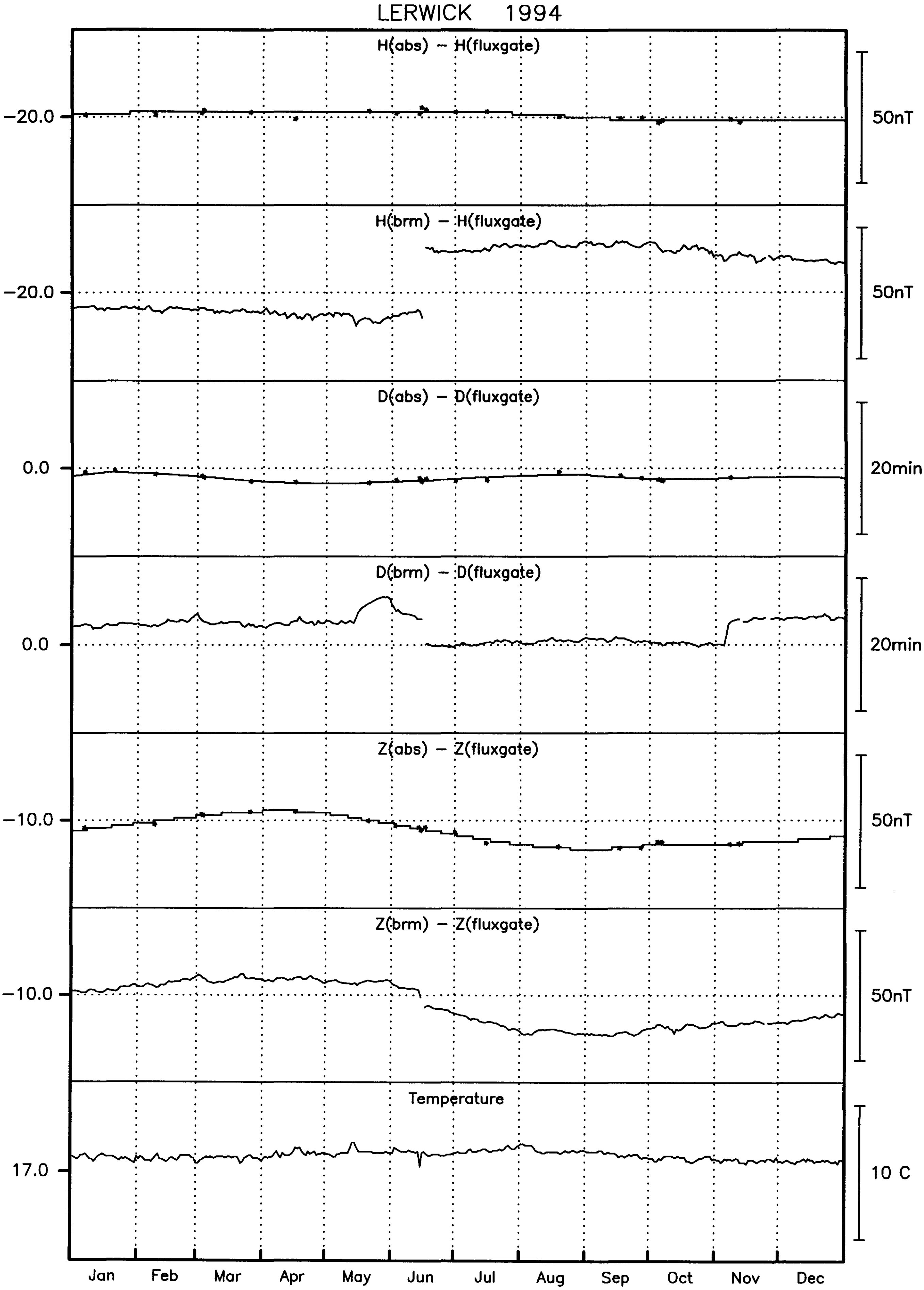


Figure 5. Zero-field corrections and BRMs, Lerwick 1994

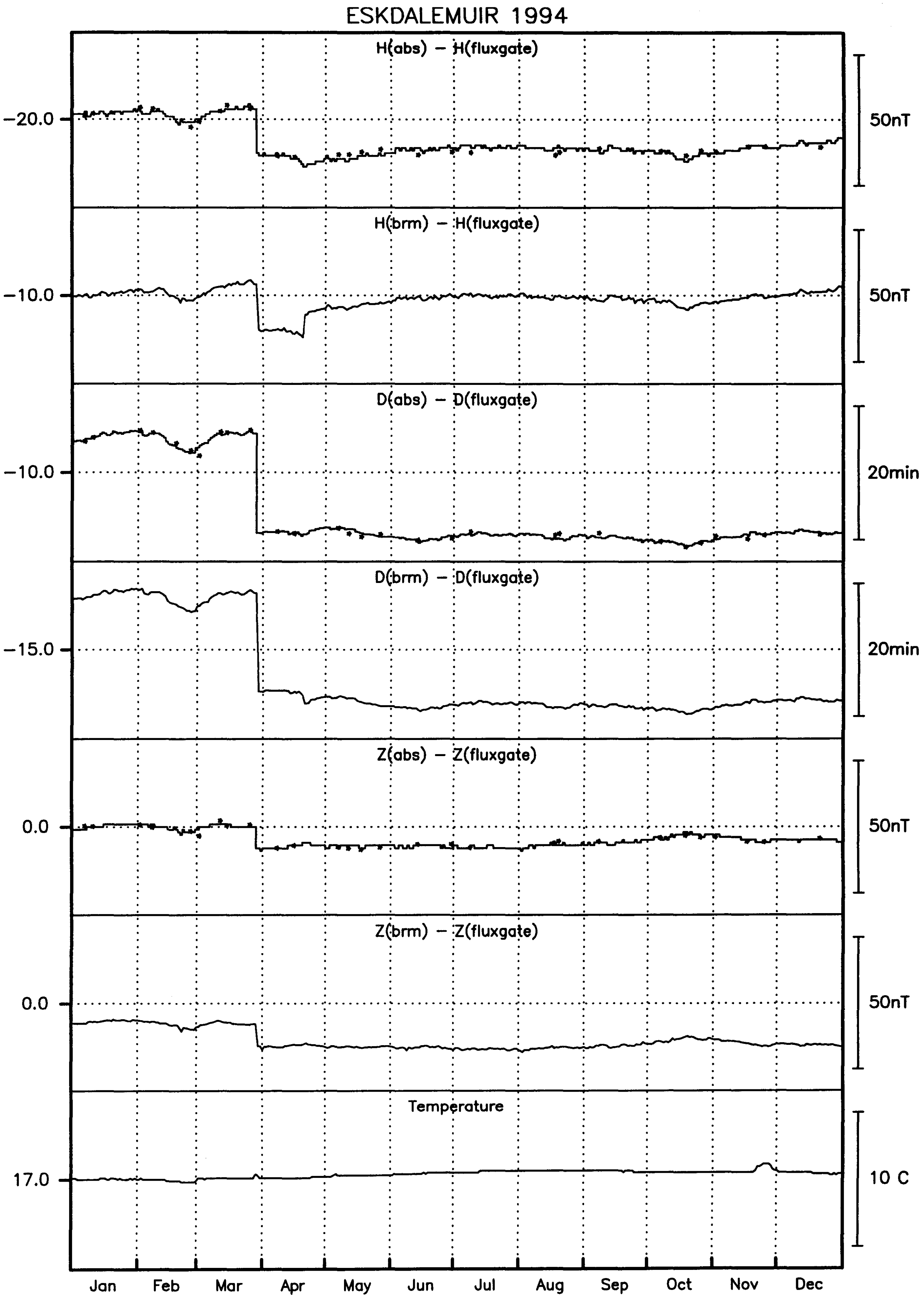


Figure 6. Zero-field corrections and BRMs, Eskdalemuir 1994

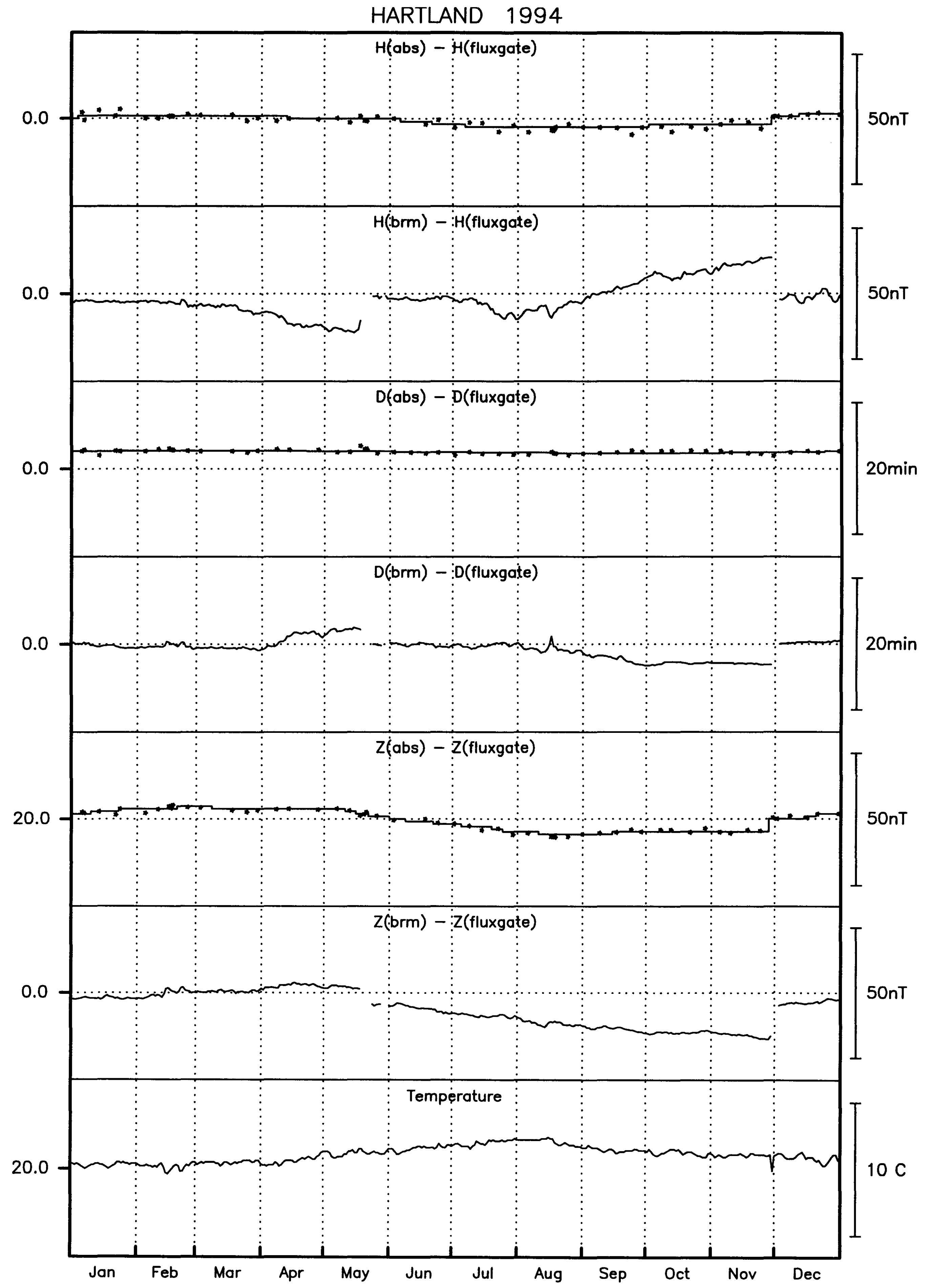
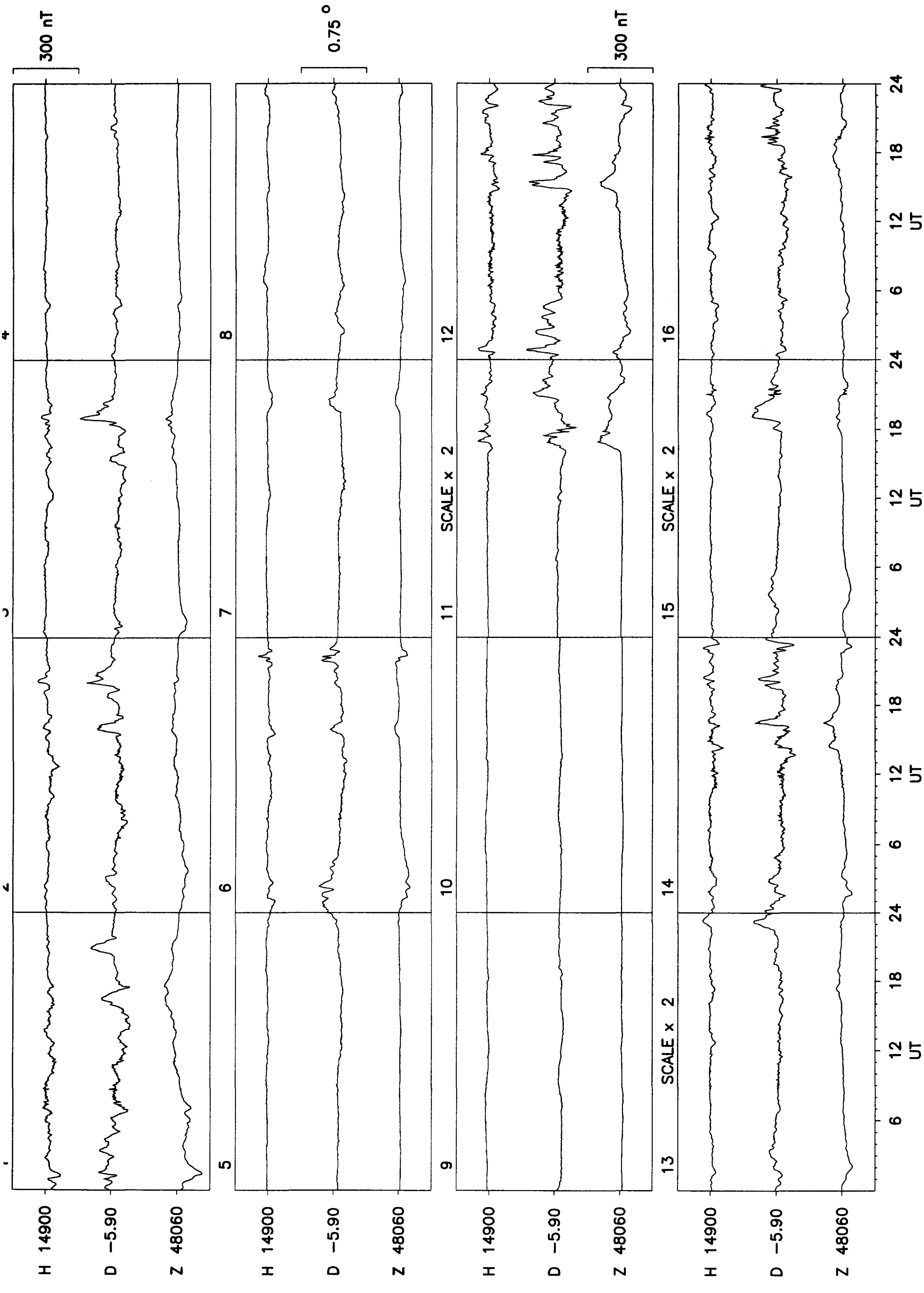
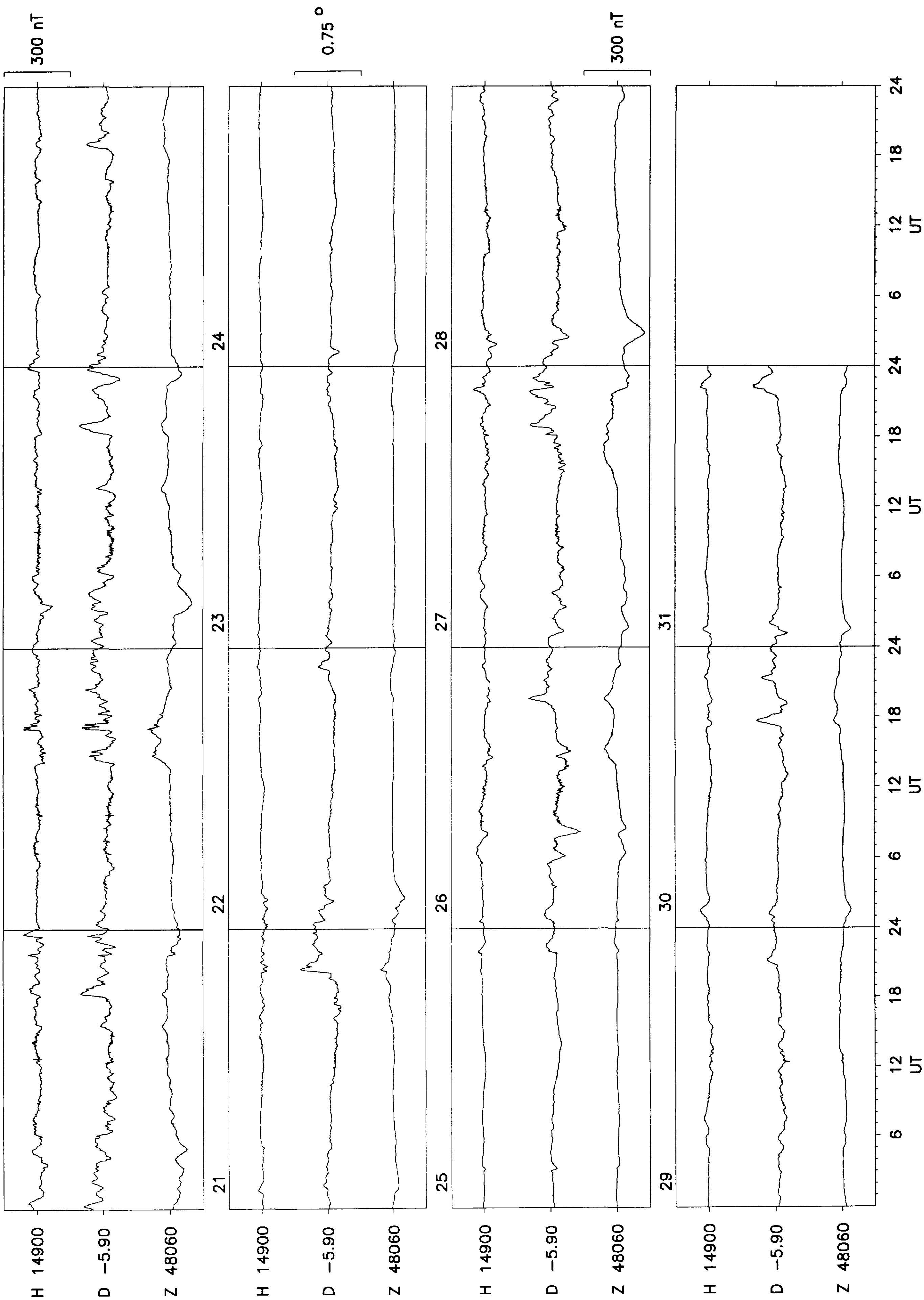


Figure 7. Zero-field corrections and BRMs, Hartland 1994

Lerwick 1994



Lerwick January 1994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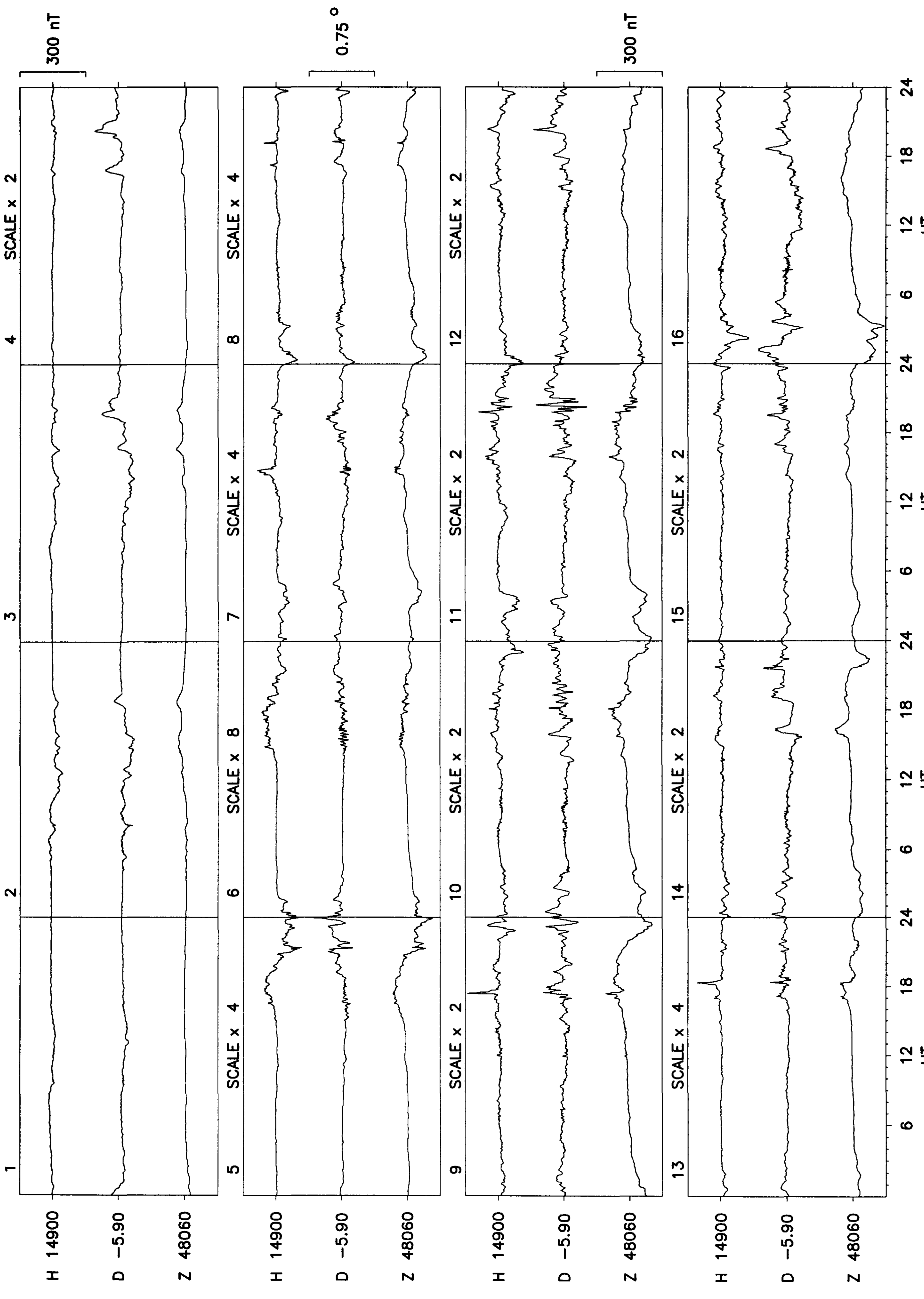

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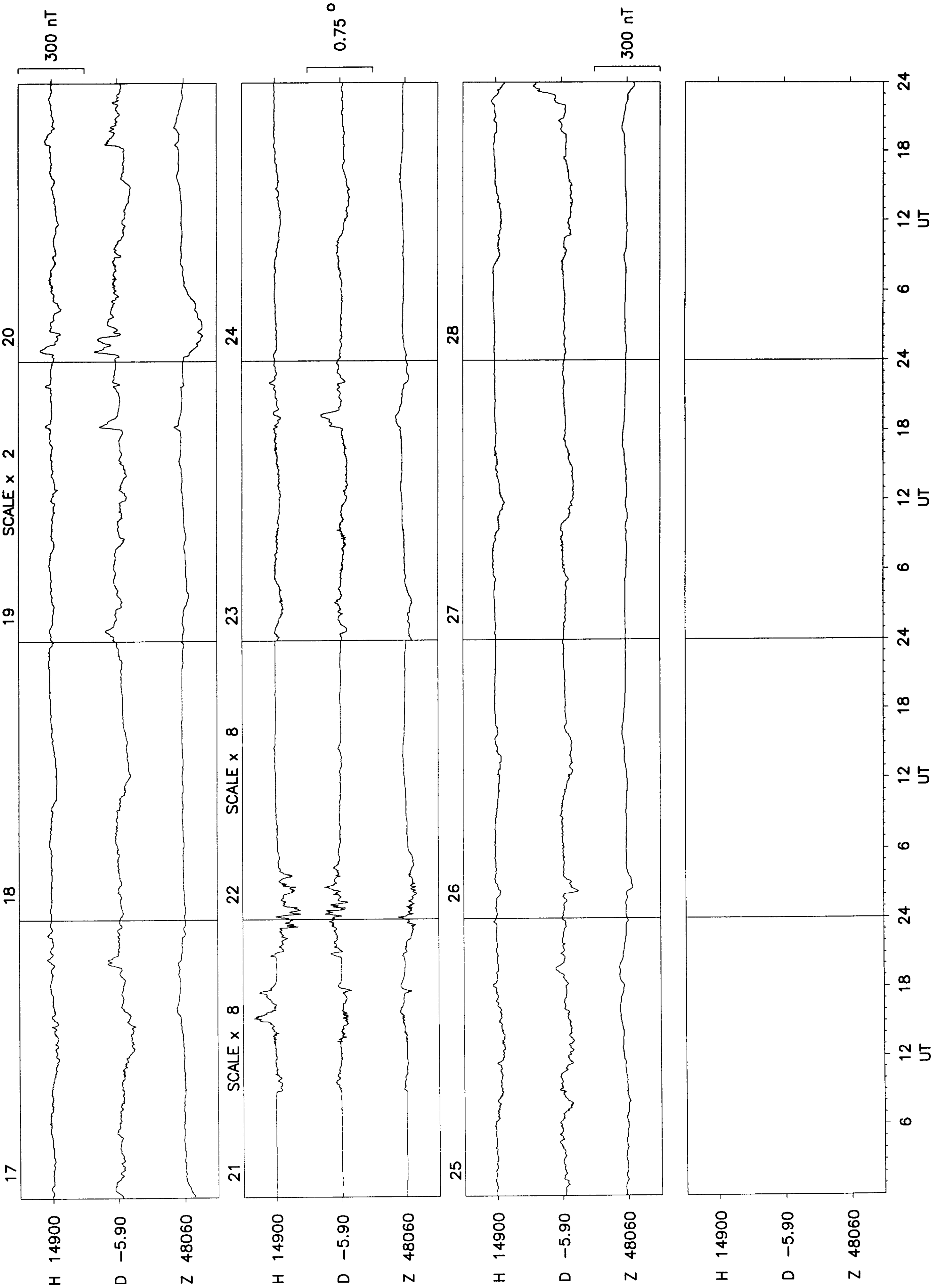
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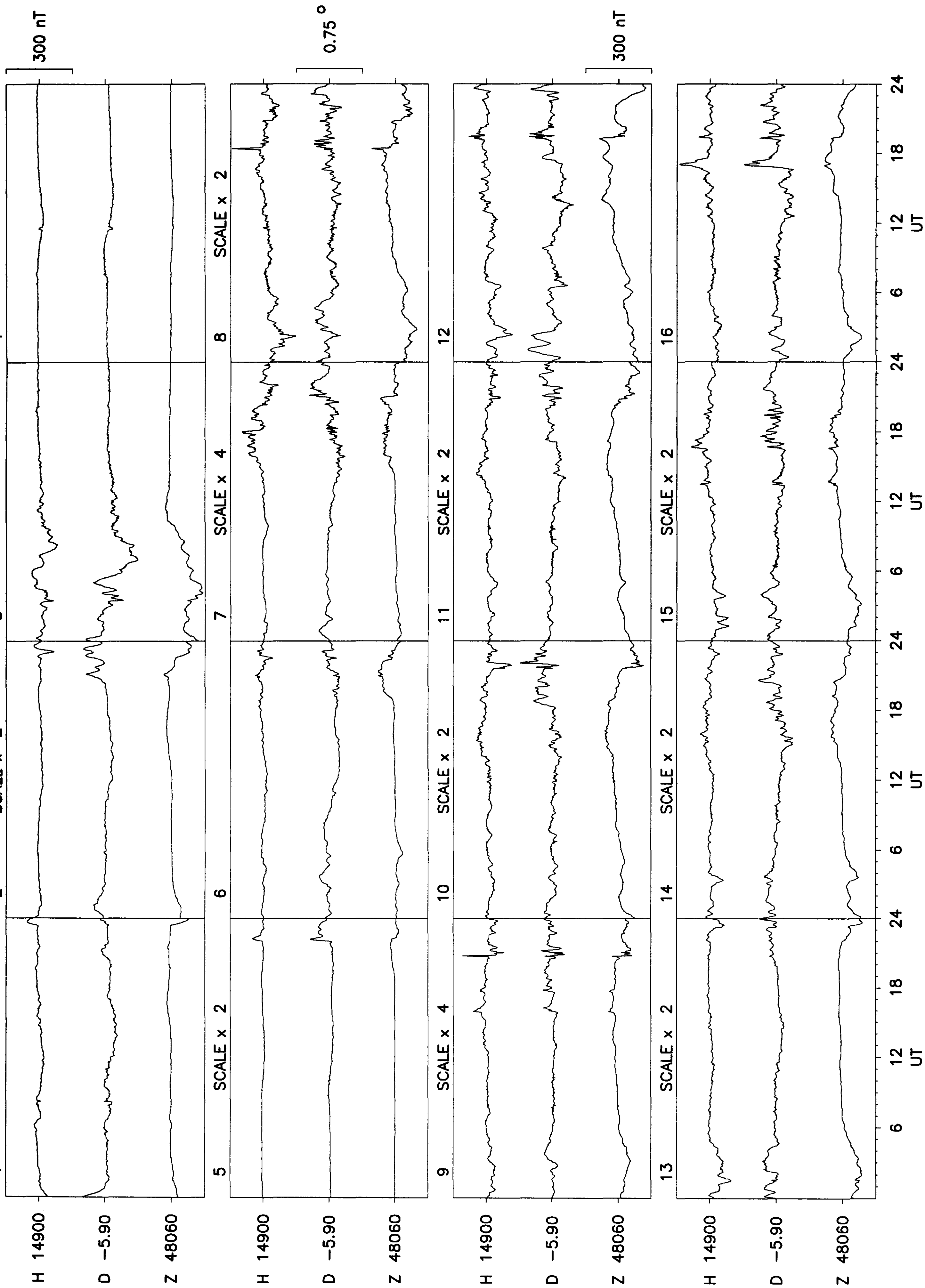

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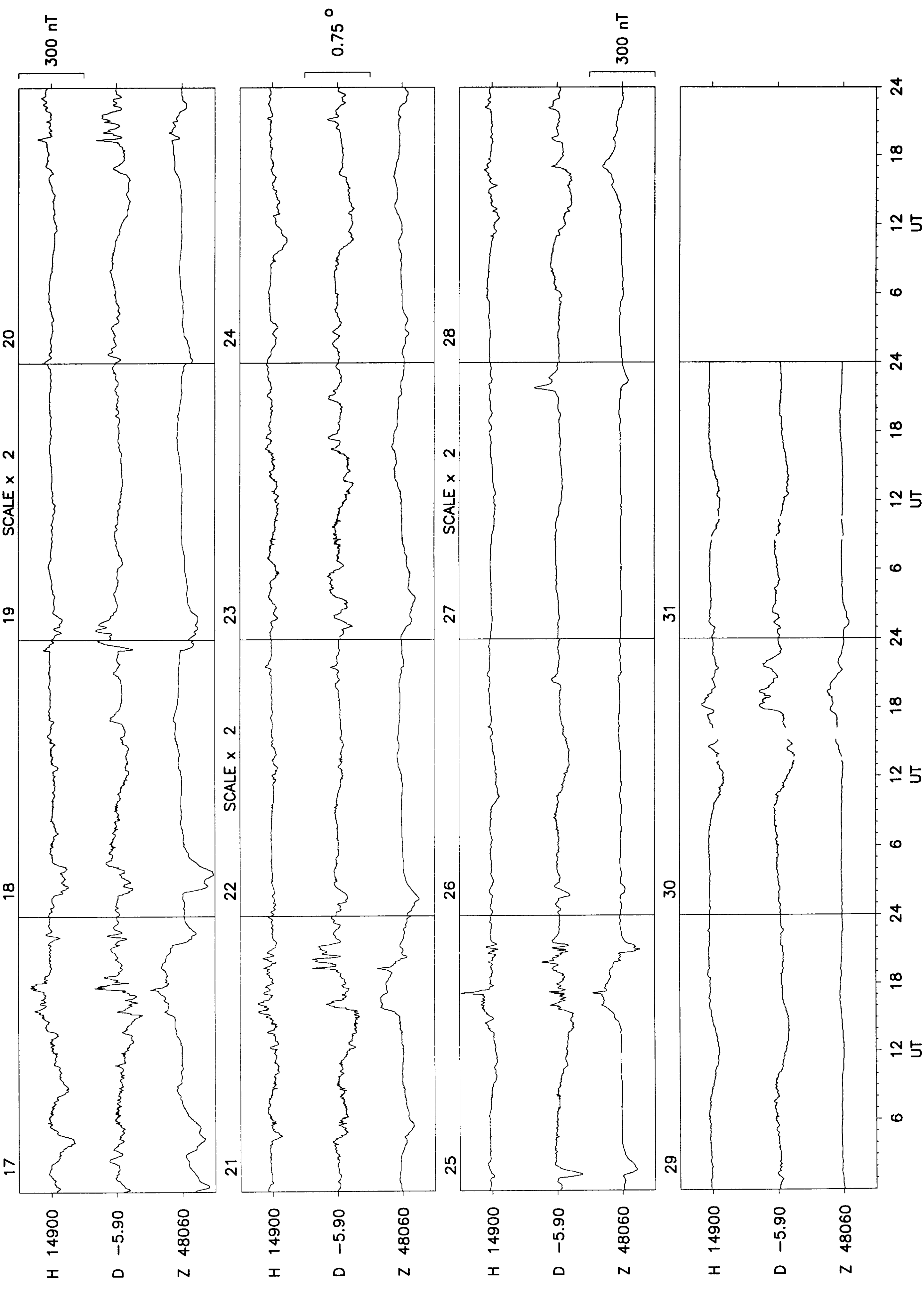

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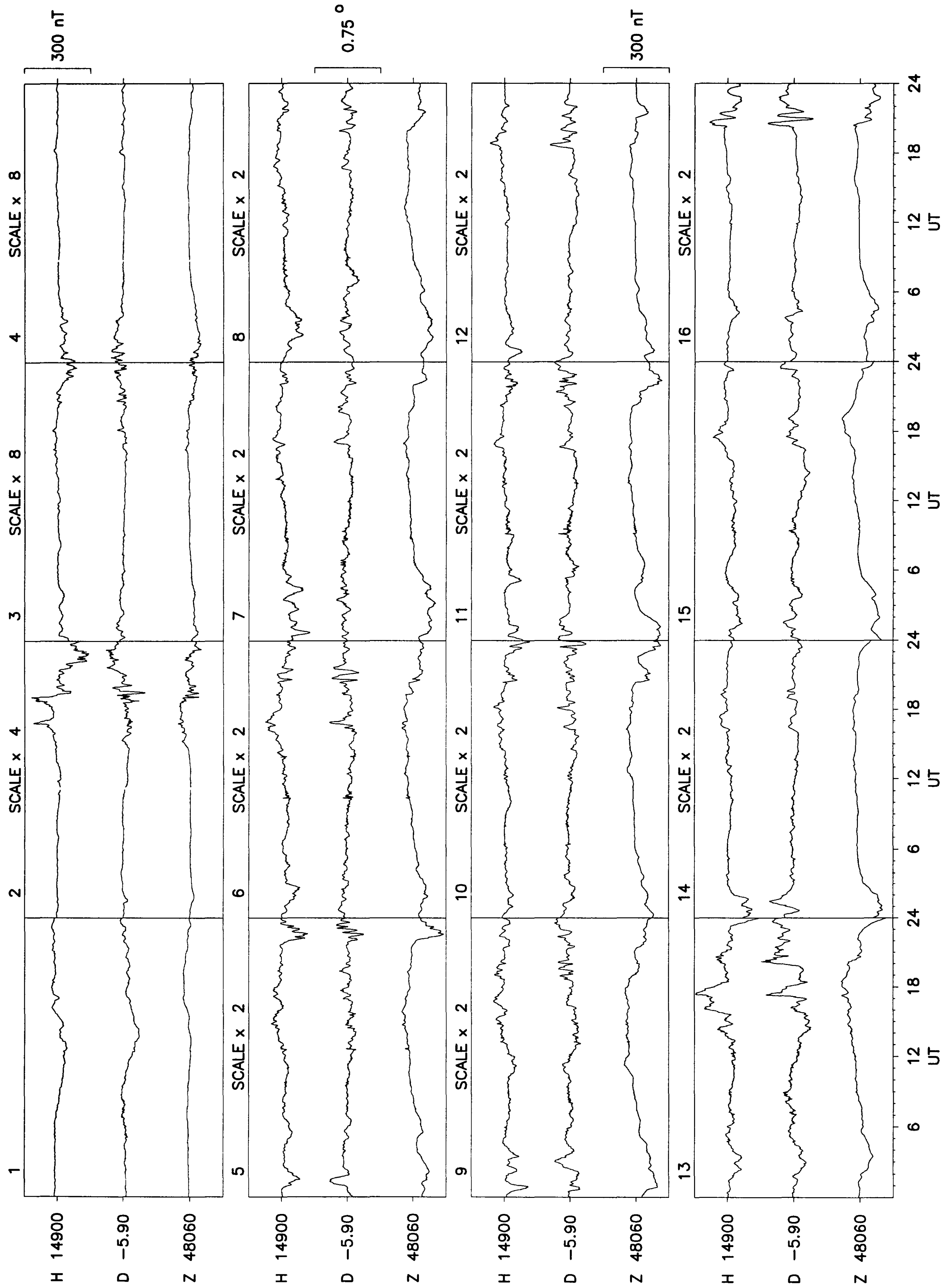

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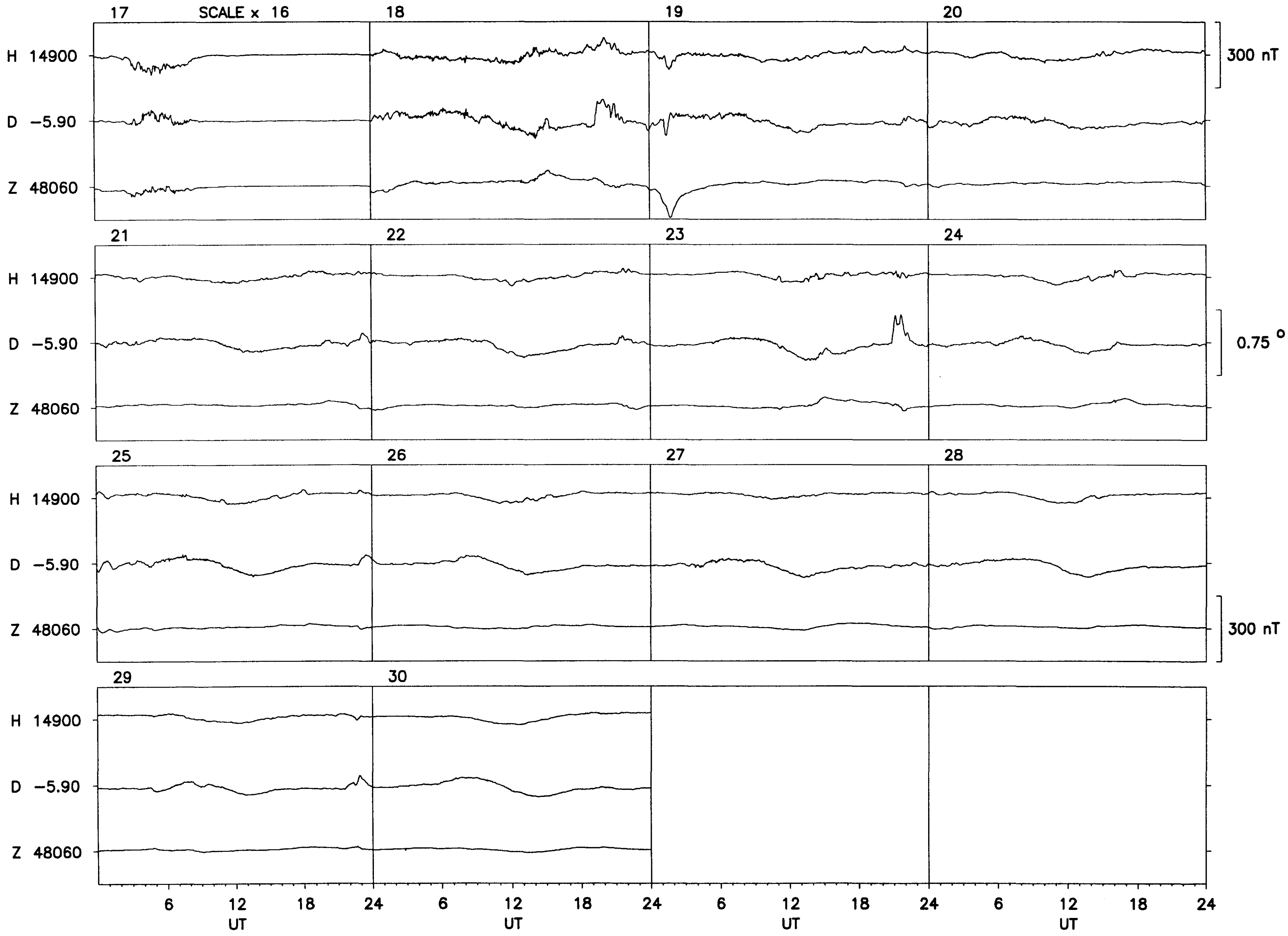
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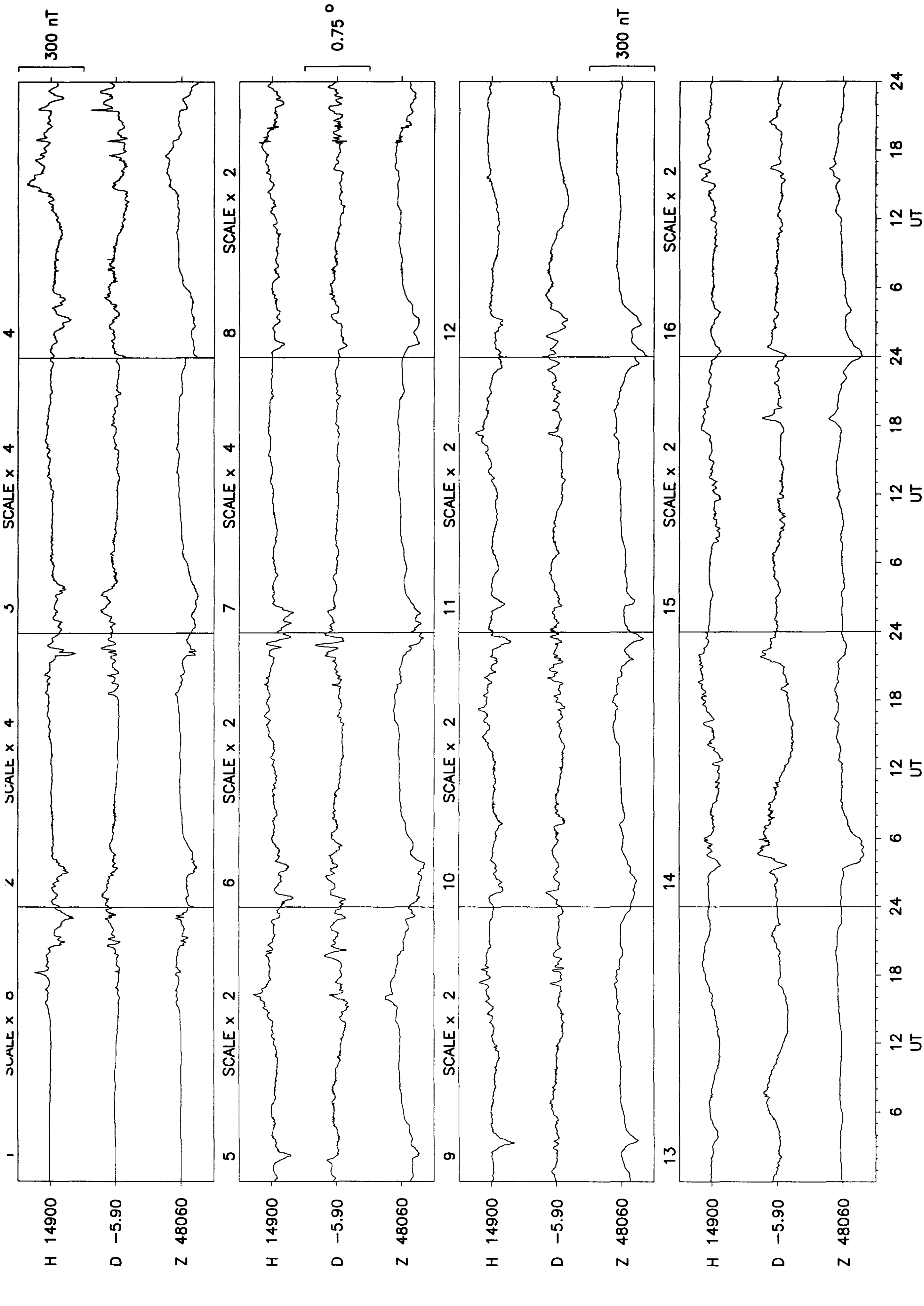

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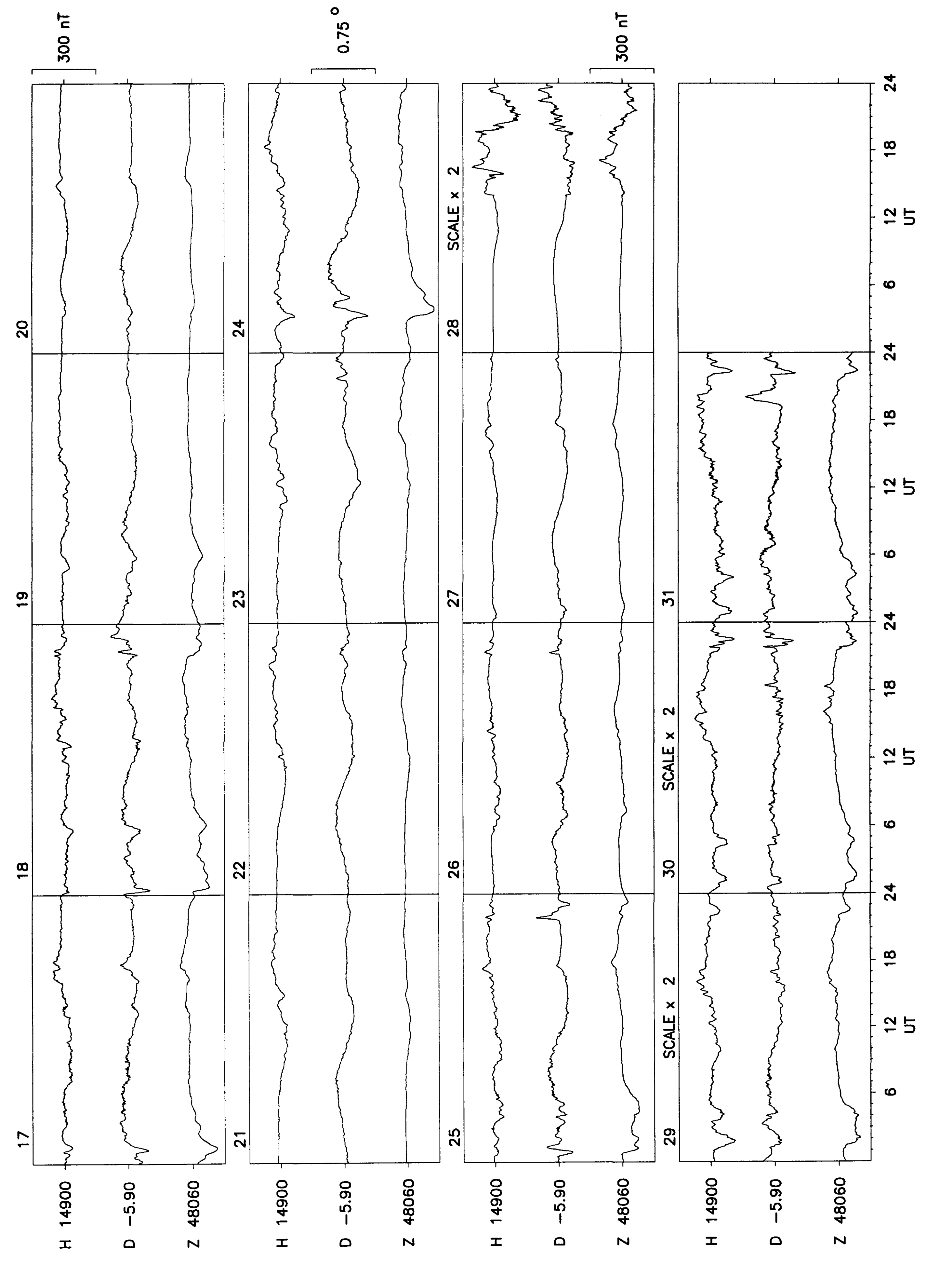
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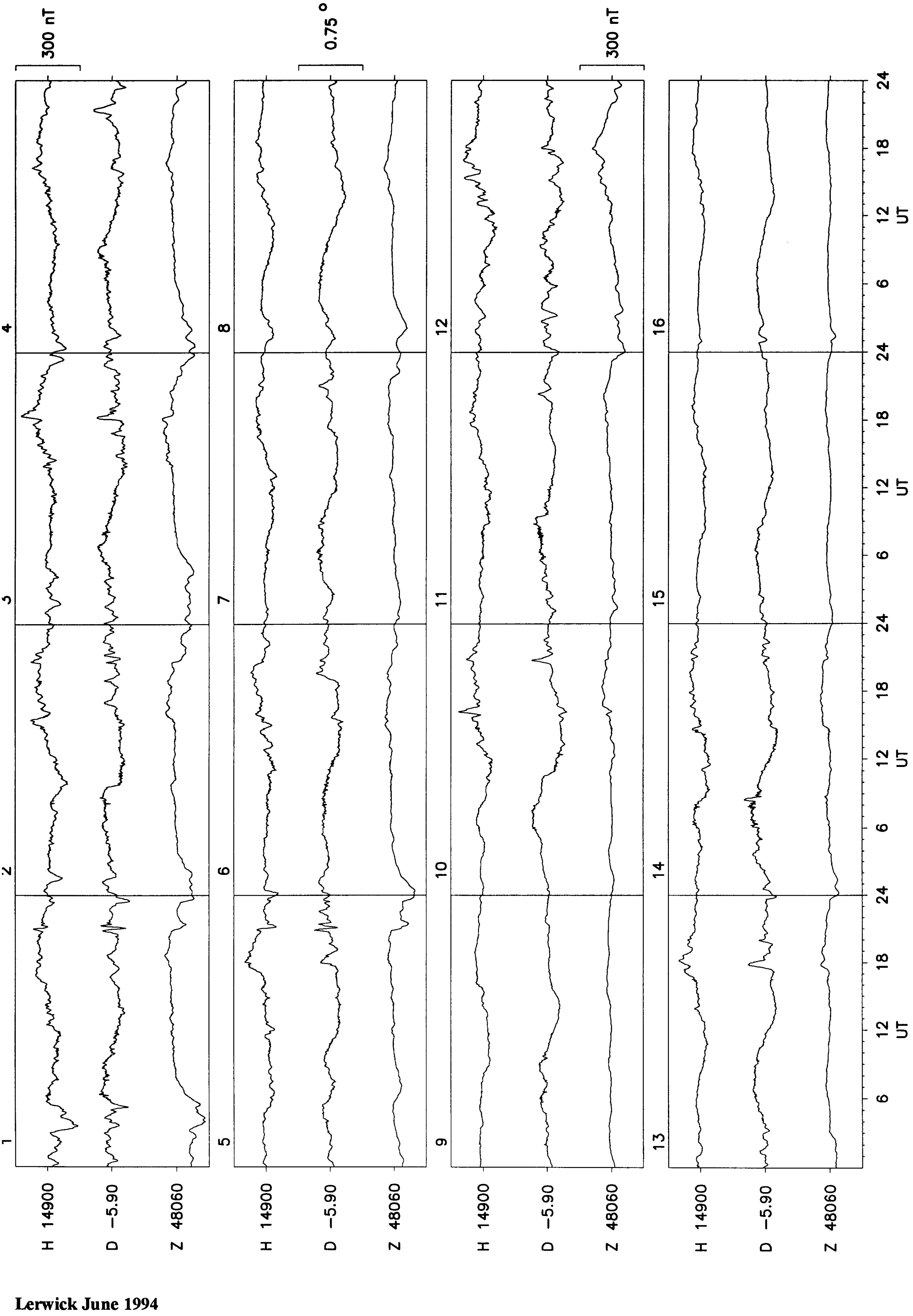

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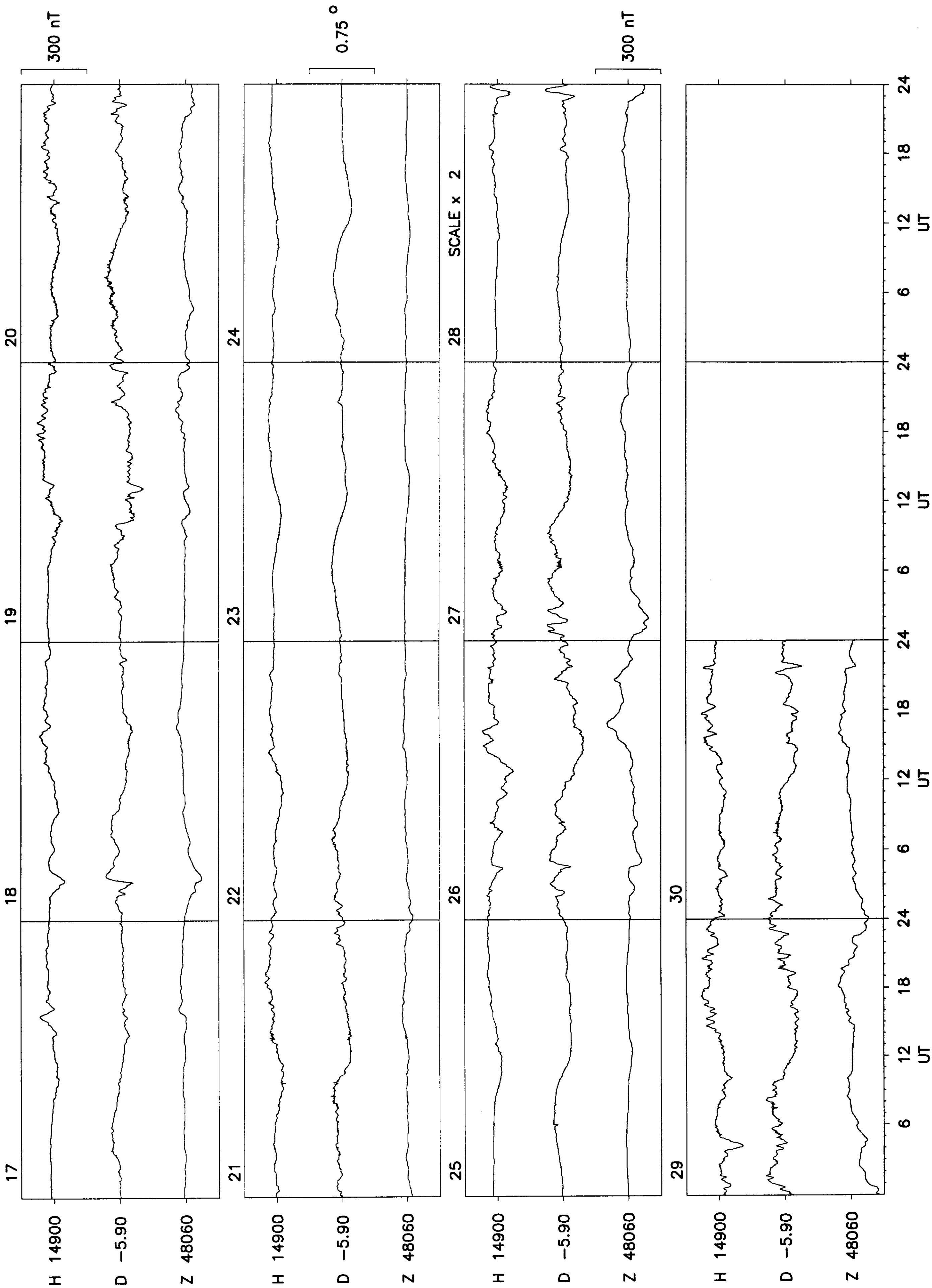

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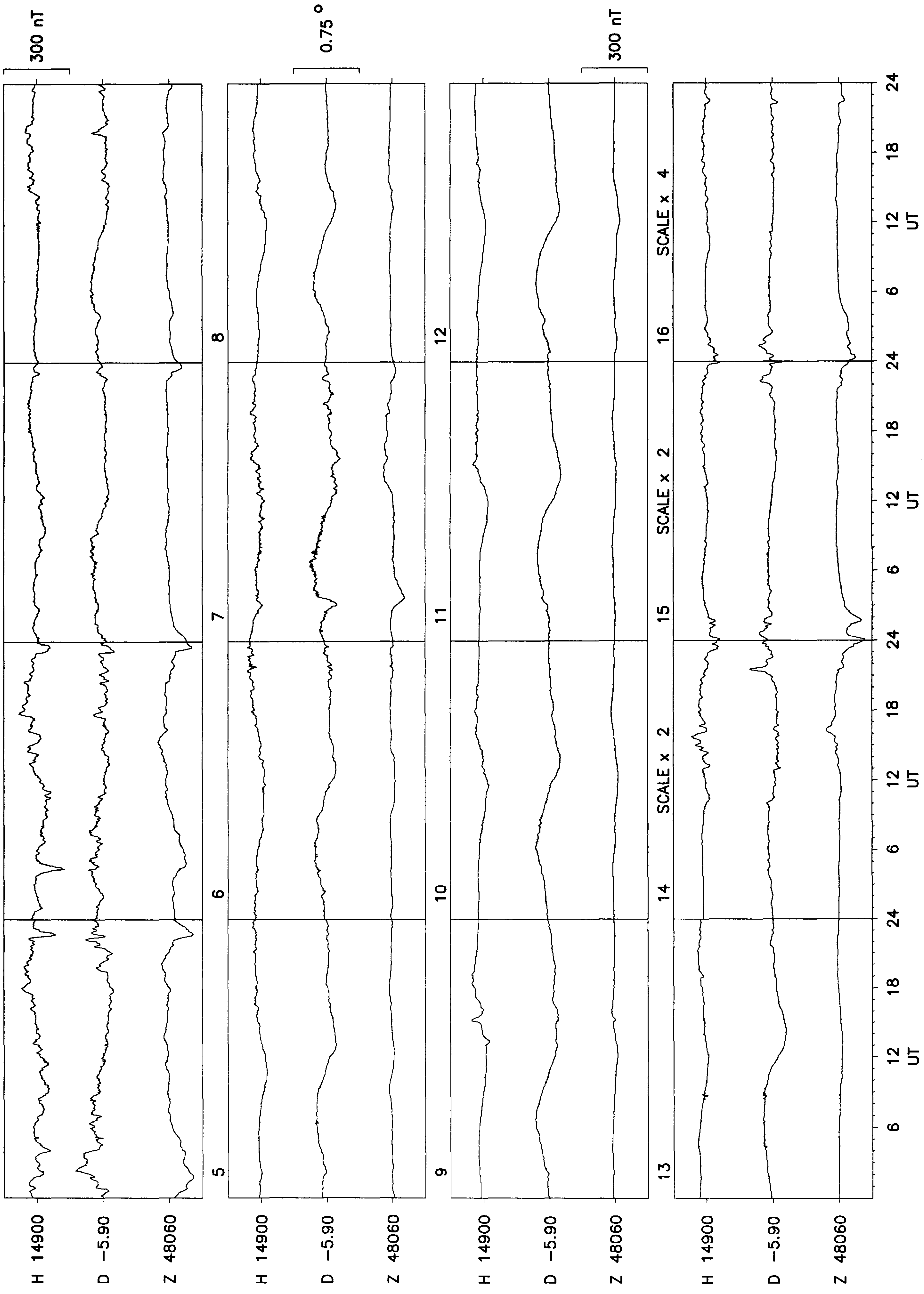

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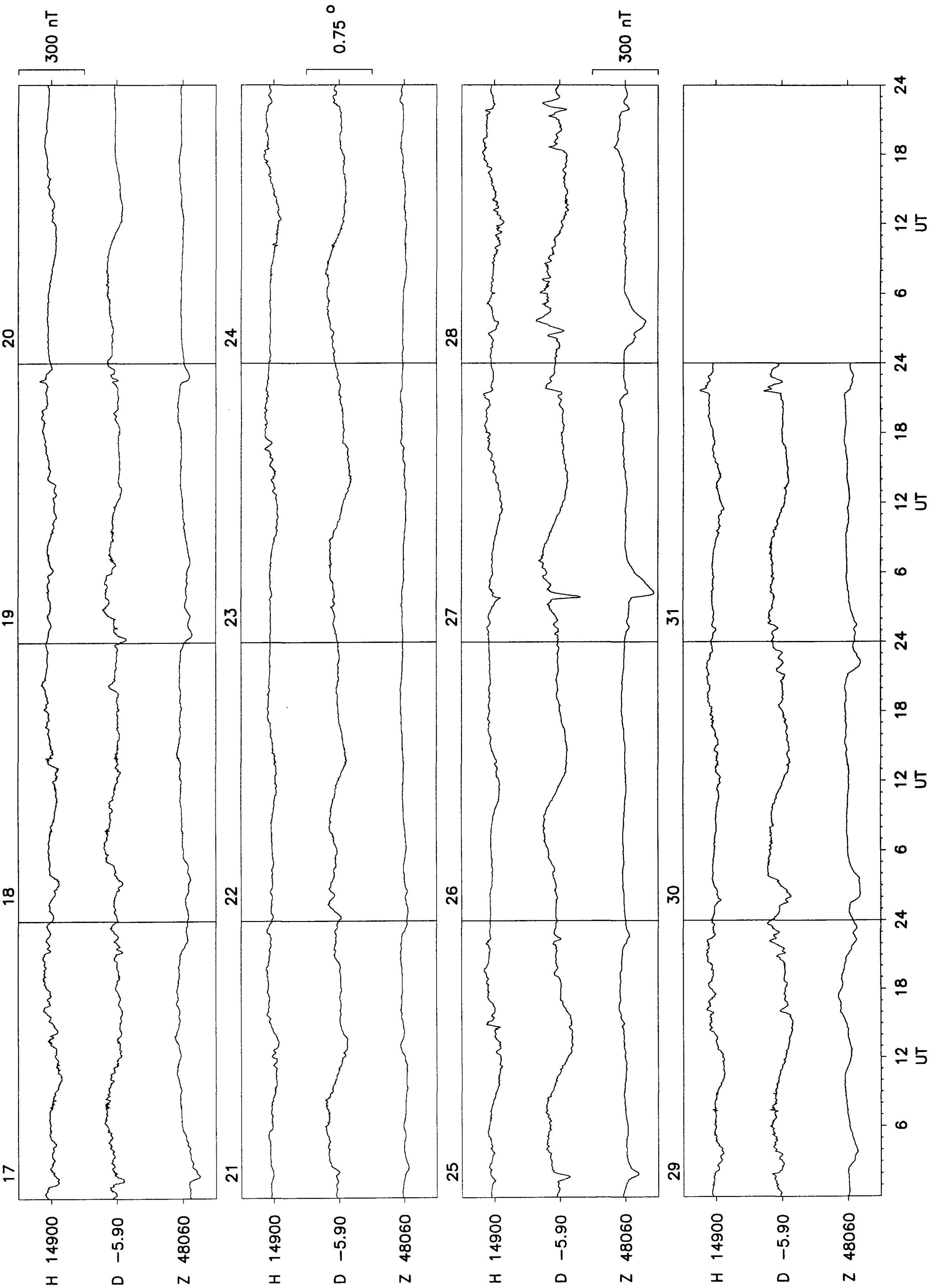
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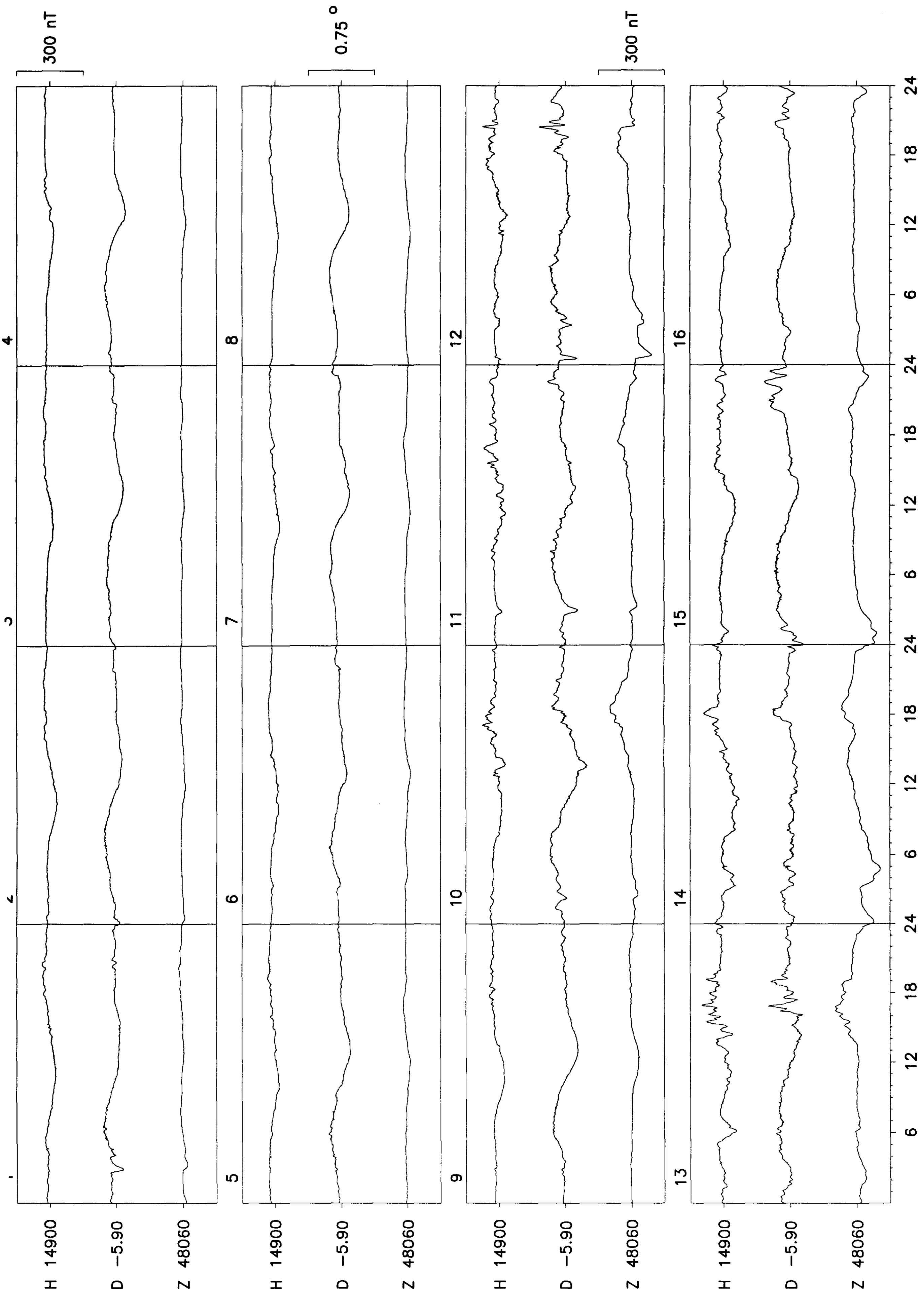

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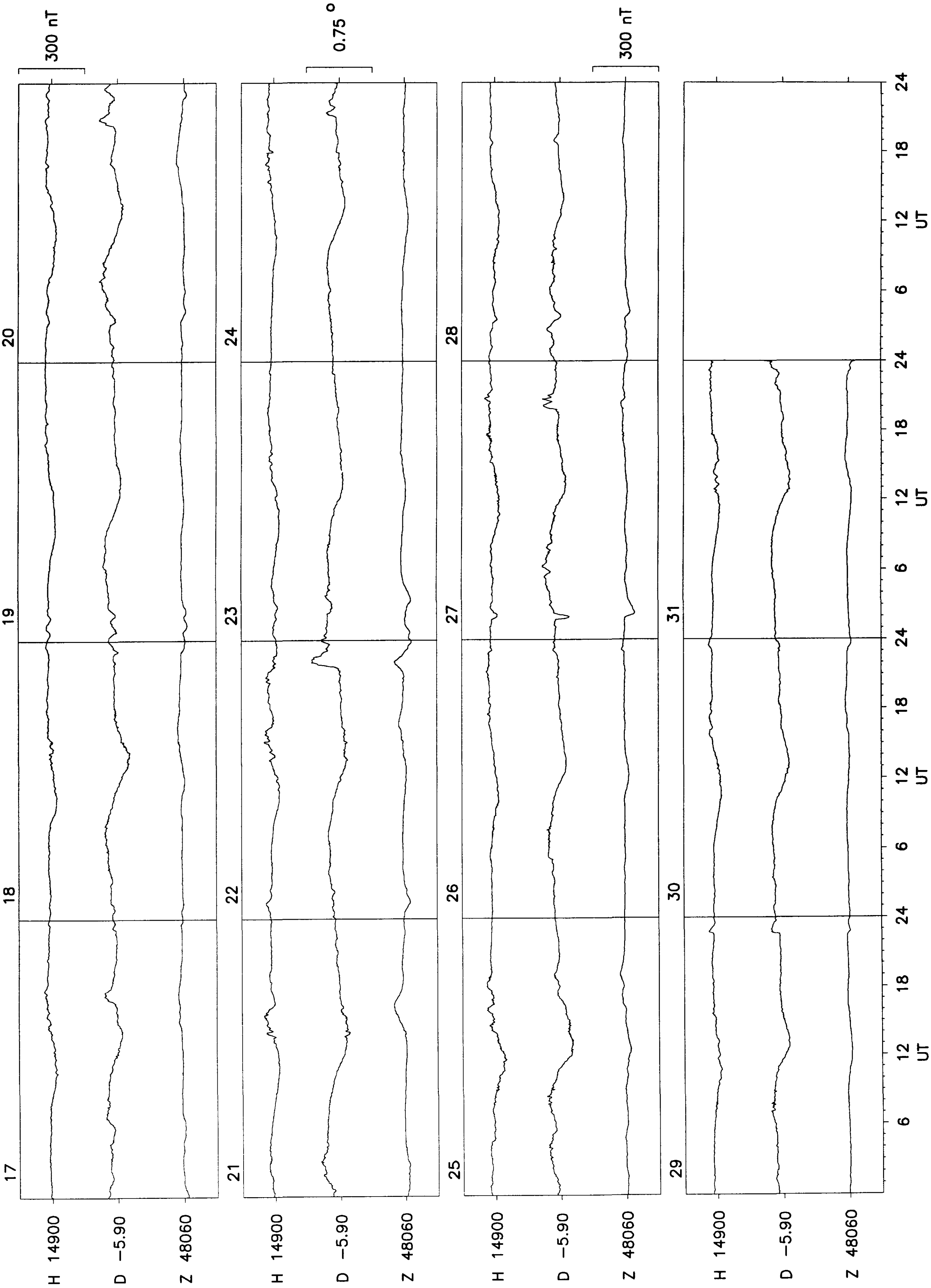
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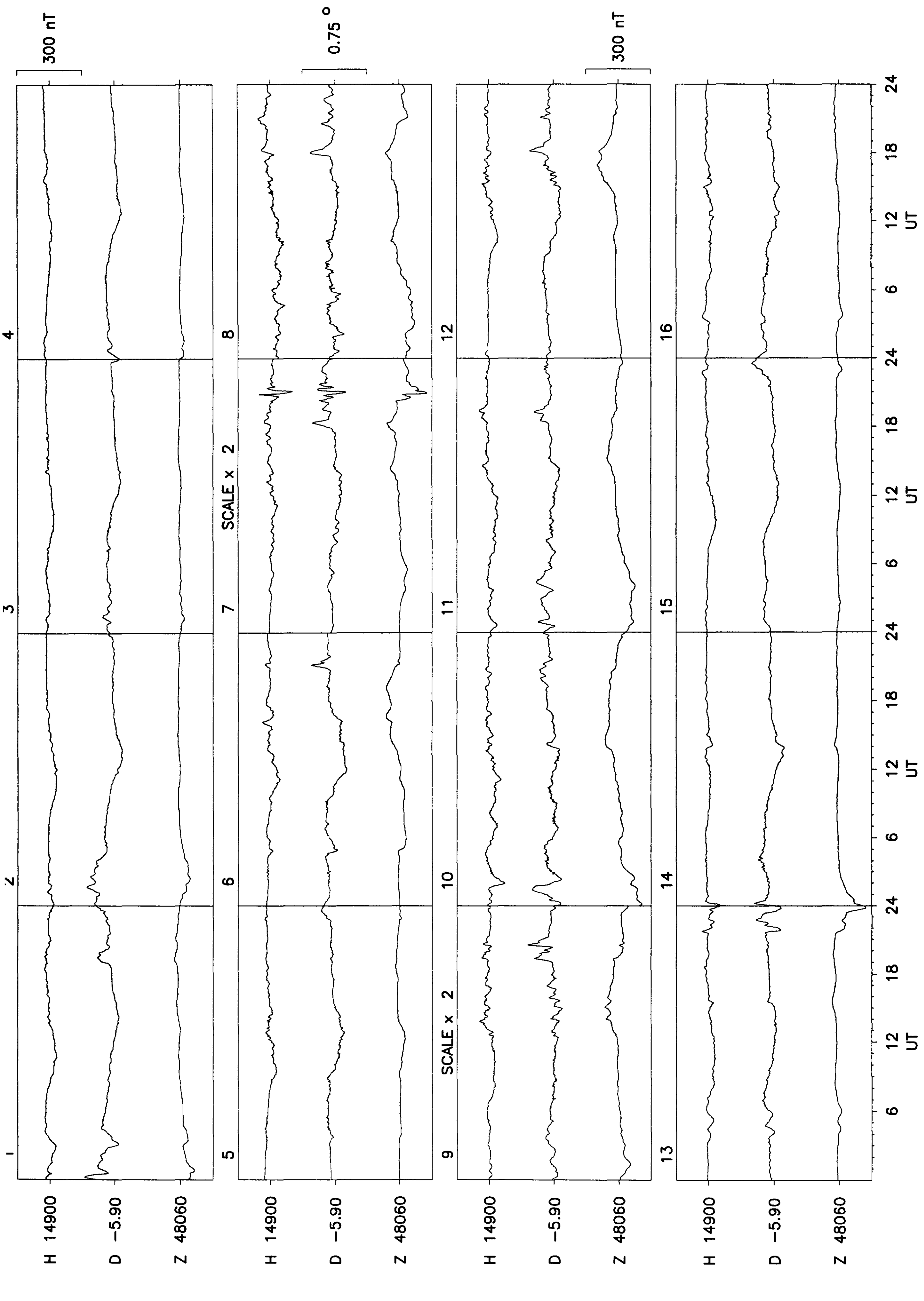

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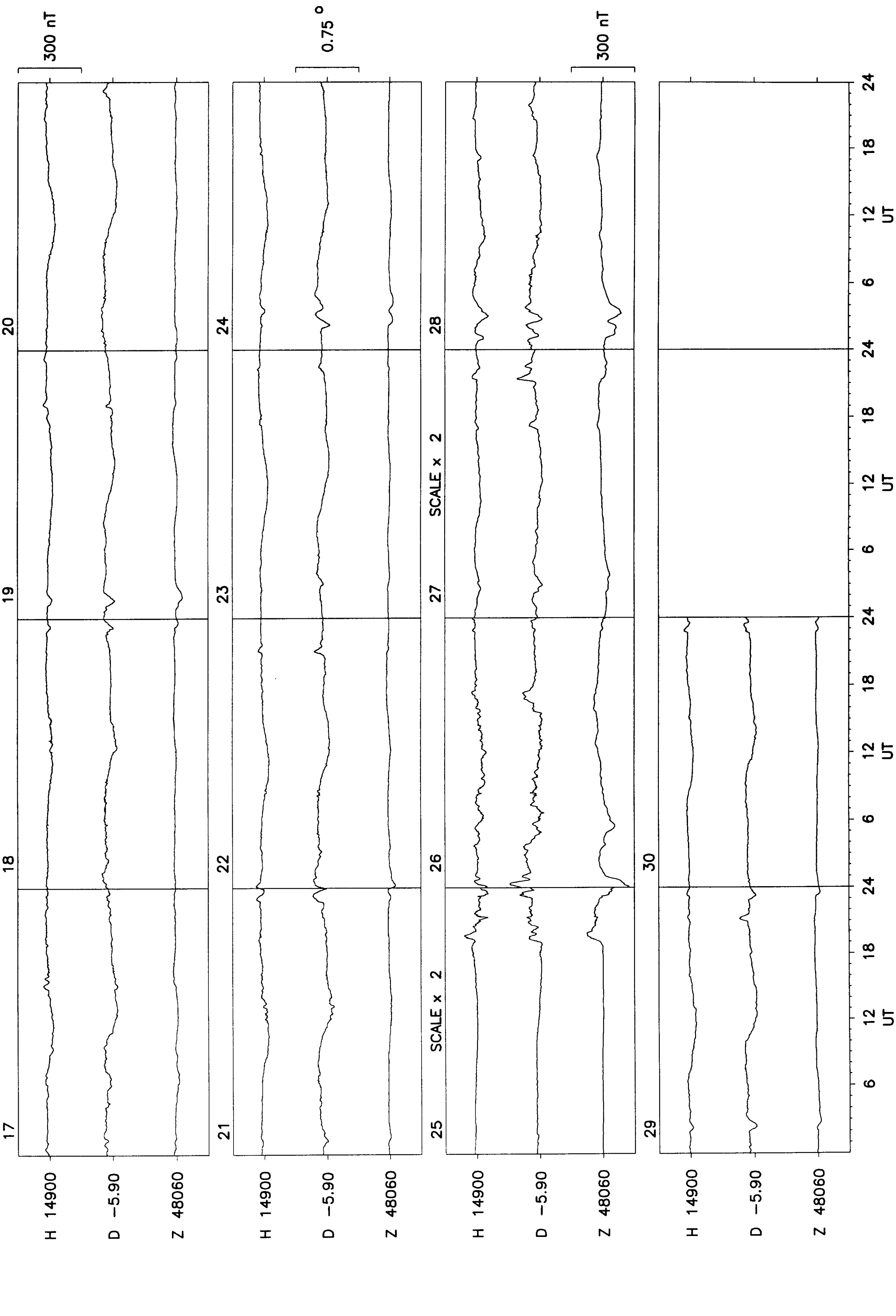
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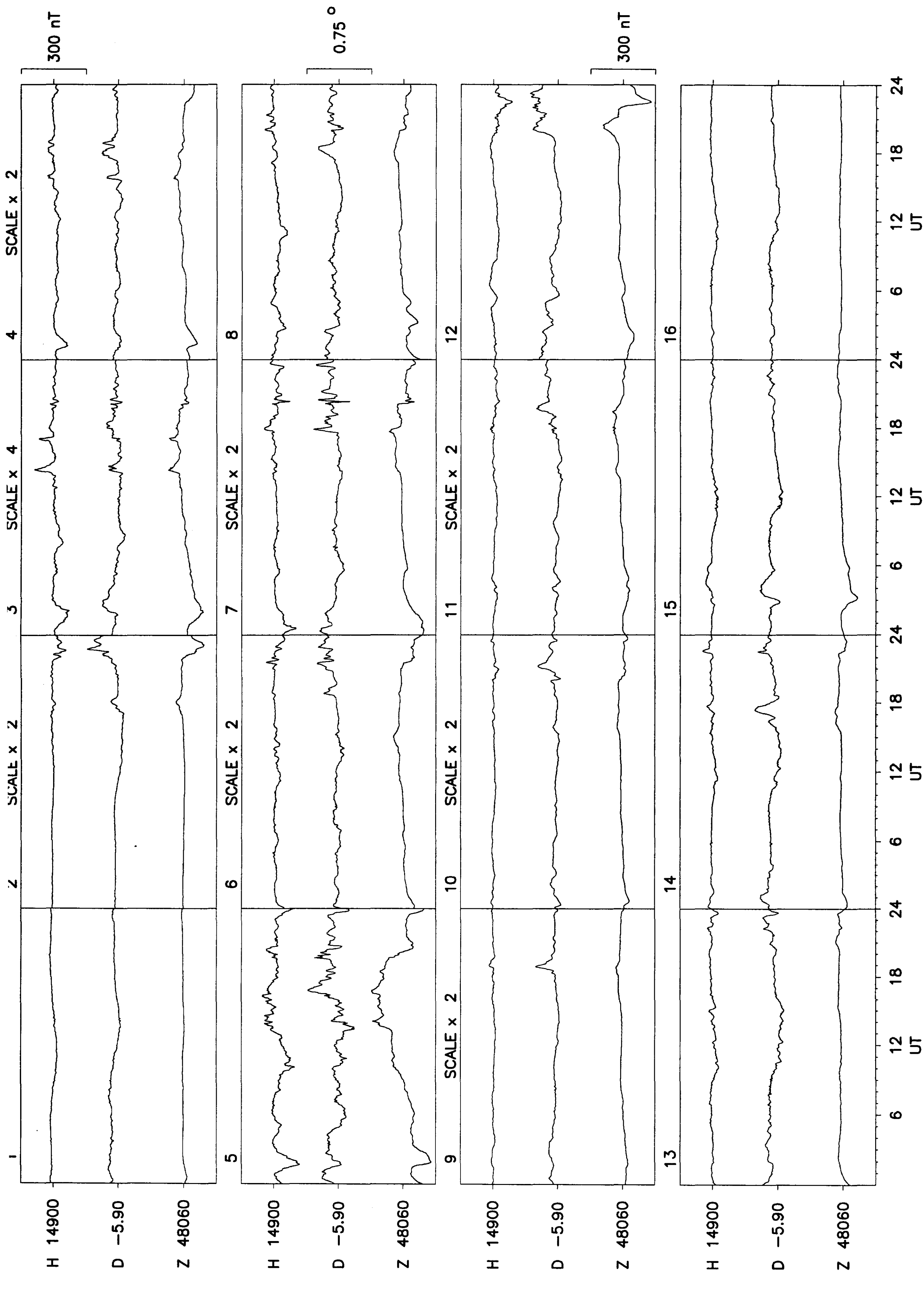

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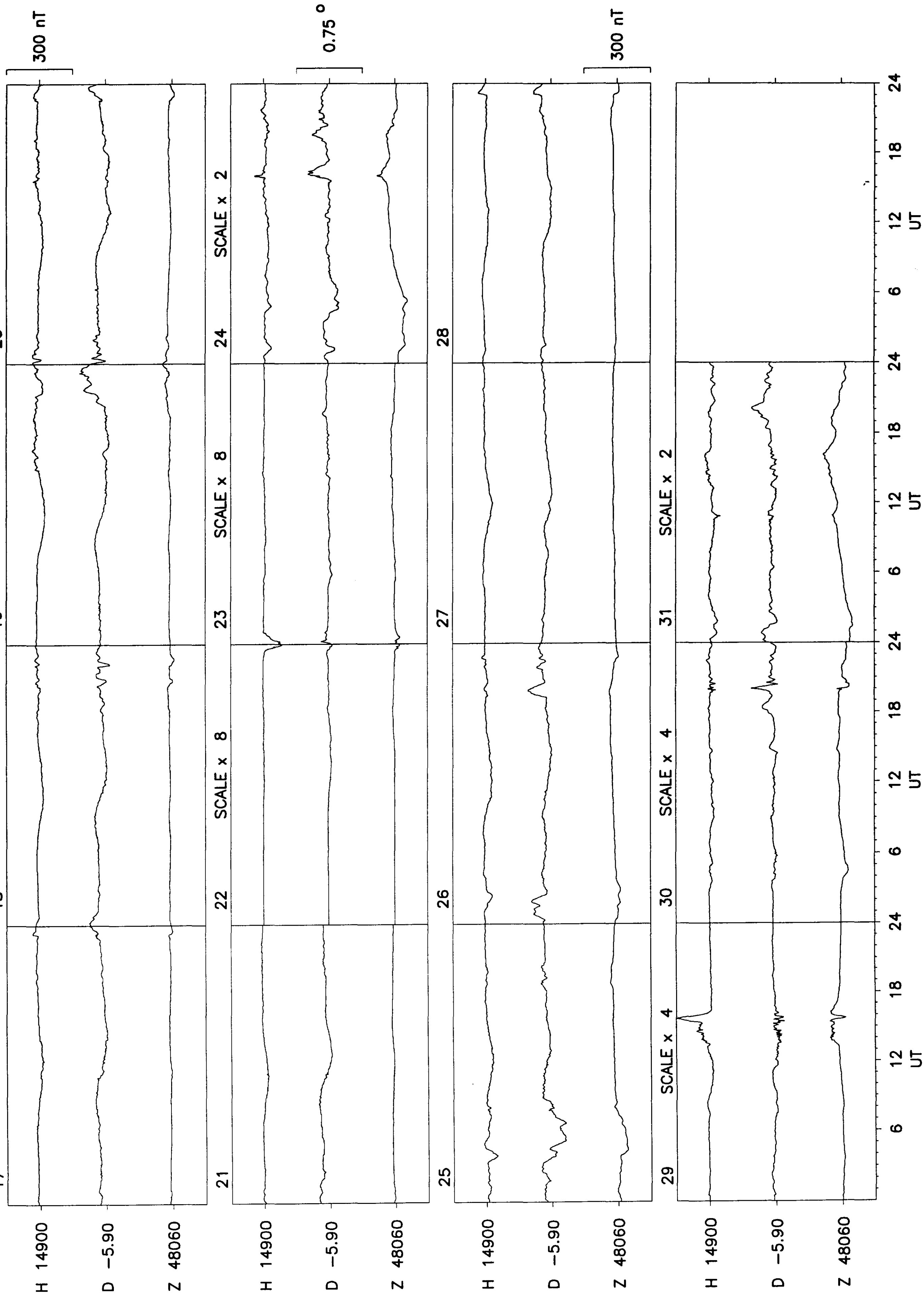

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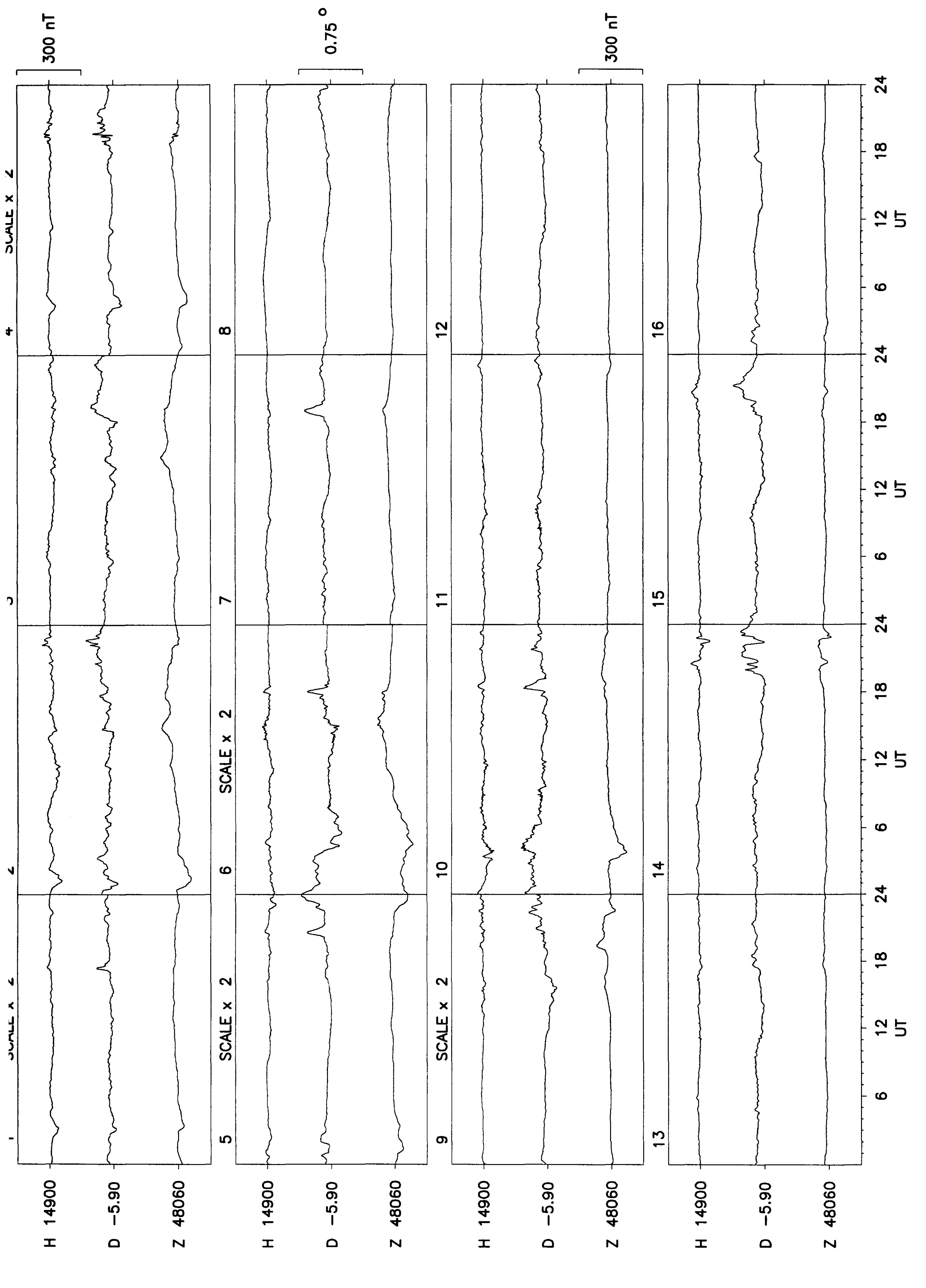

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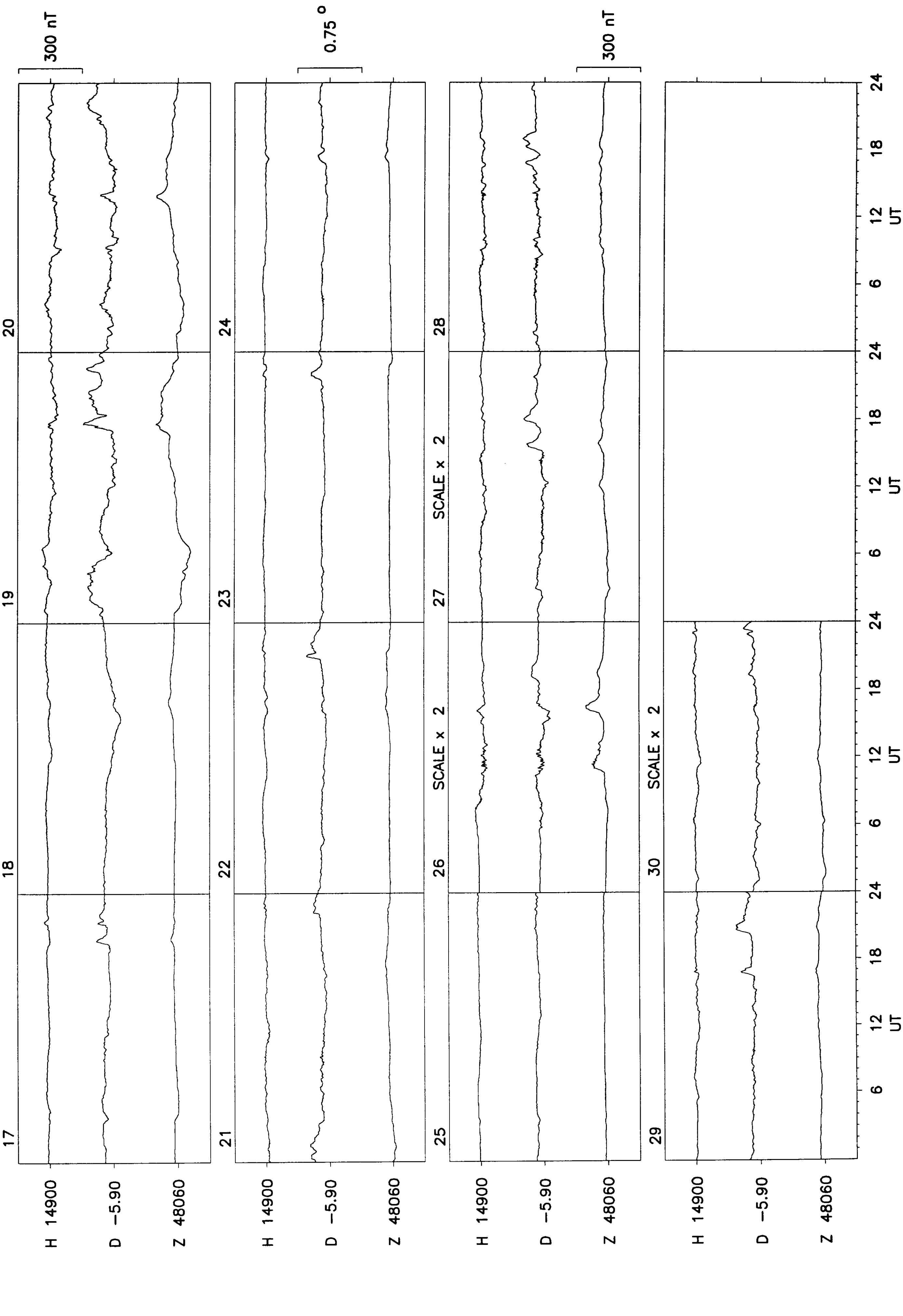
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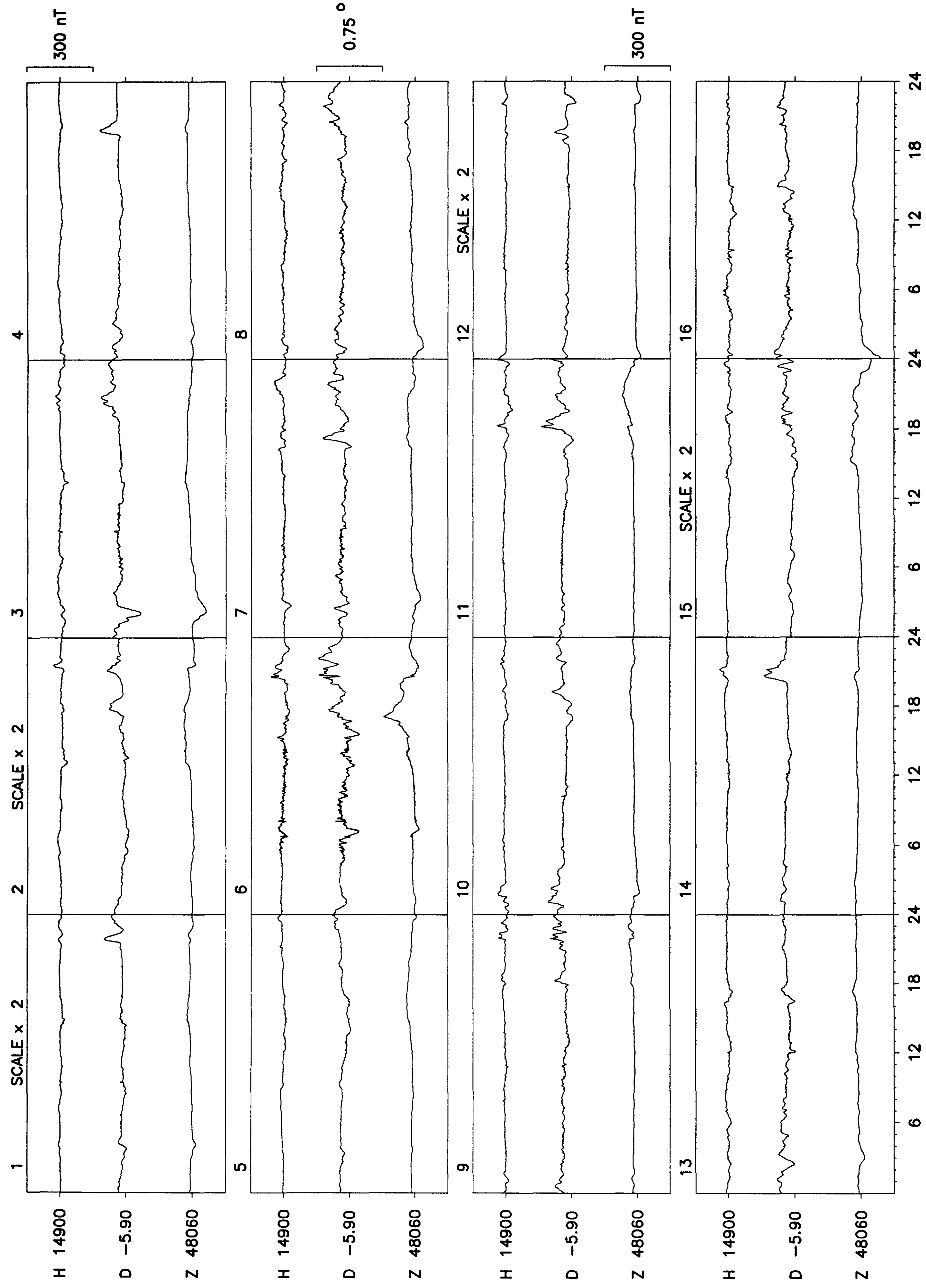
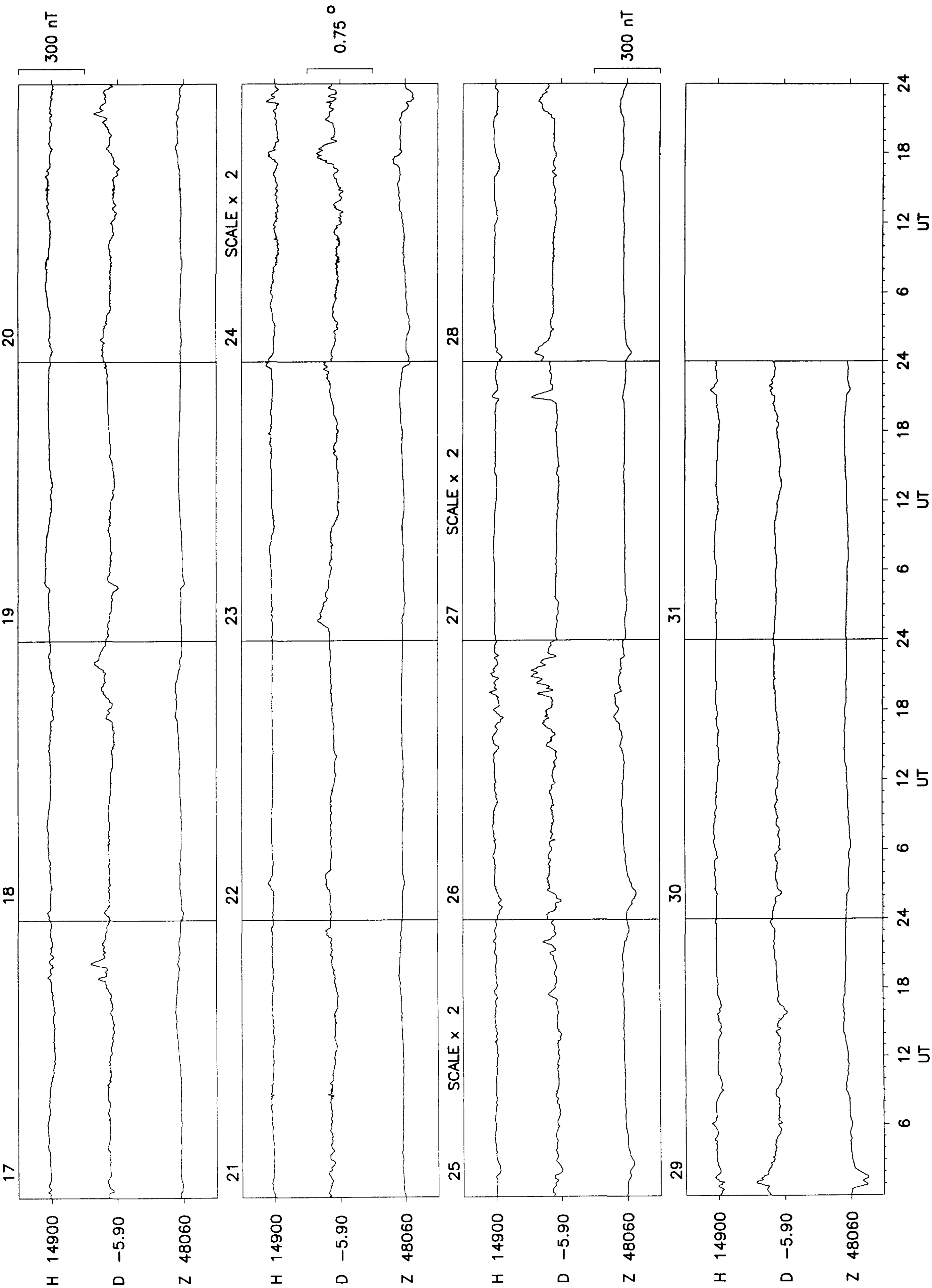


Lerwick December 1994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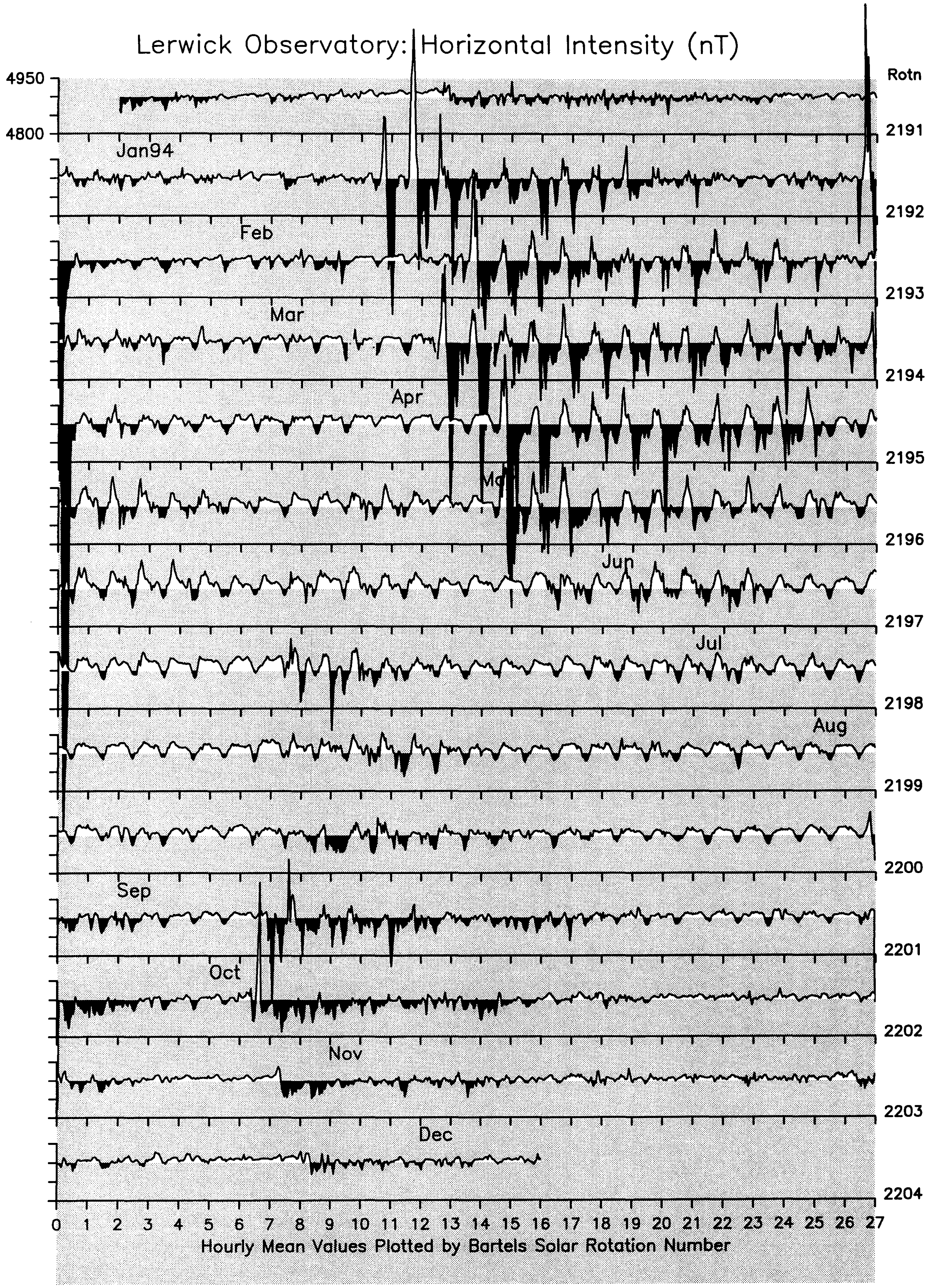

Lerwick Observatory: Horizontal Intensity (nT)
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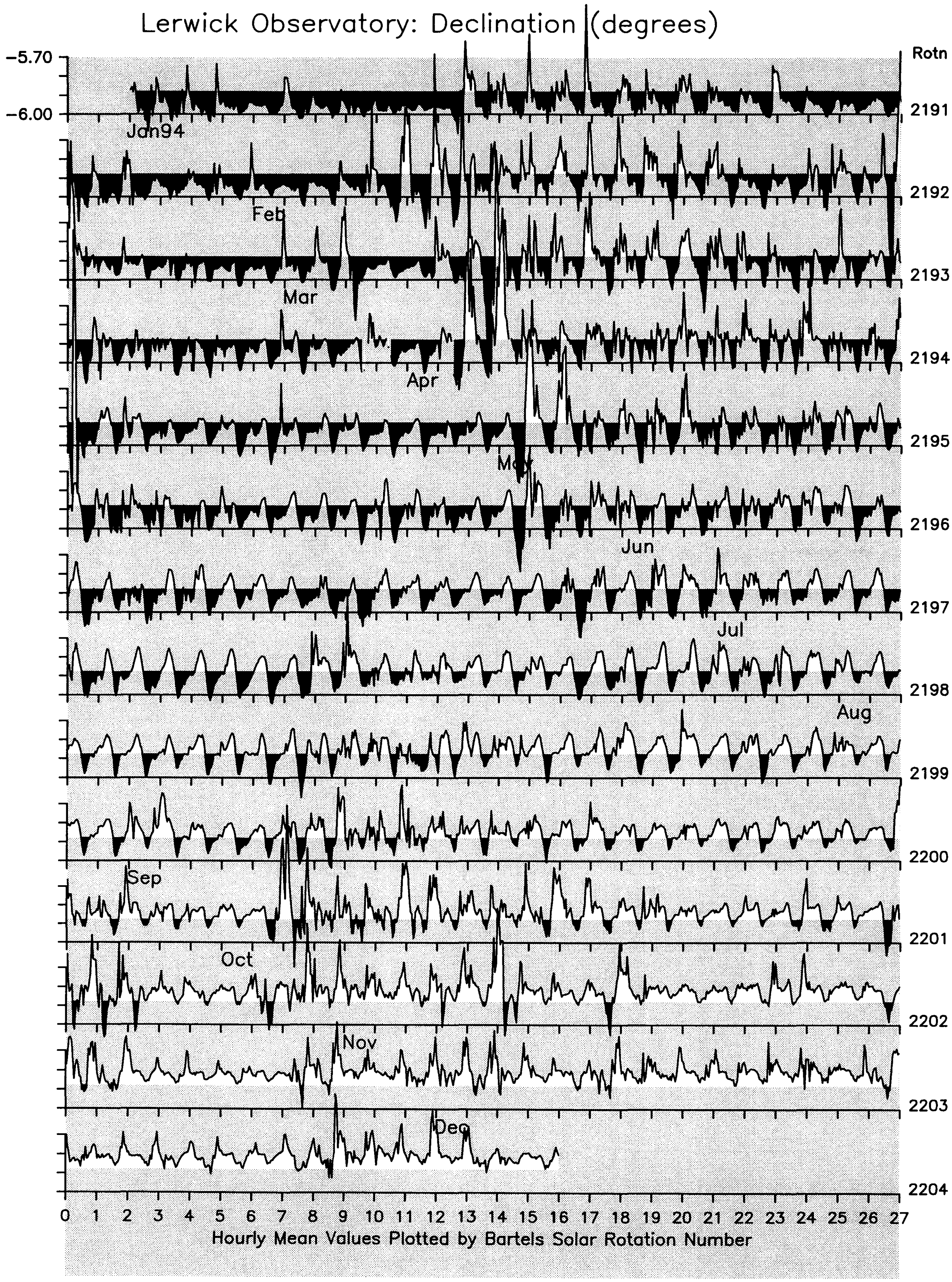
Hourly Mean Values Plotted by Bartels Solar Rotation Number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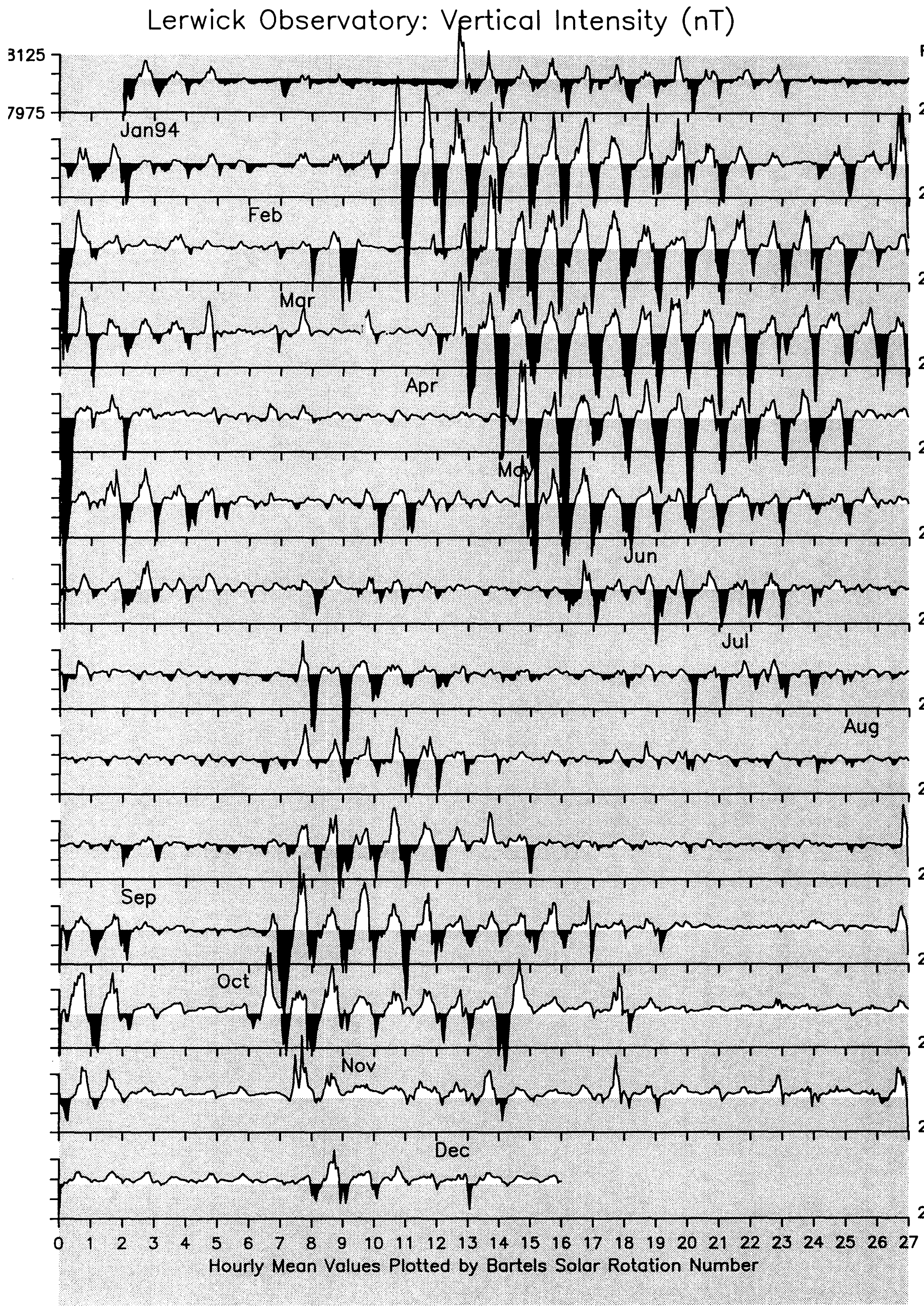
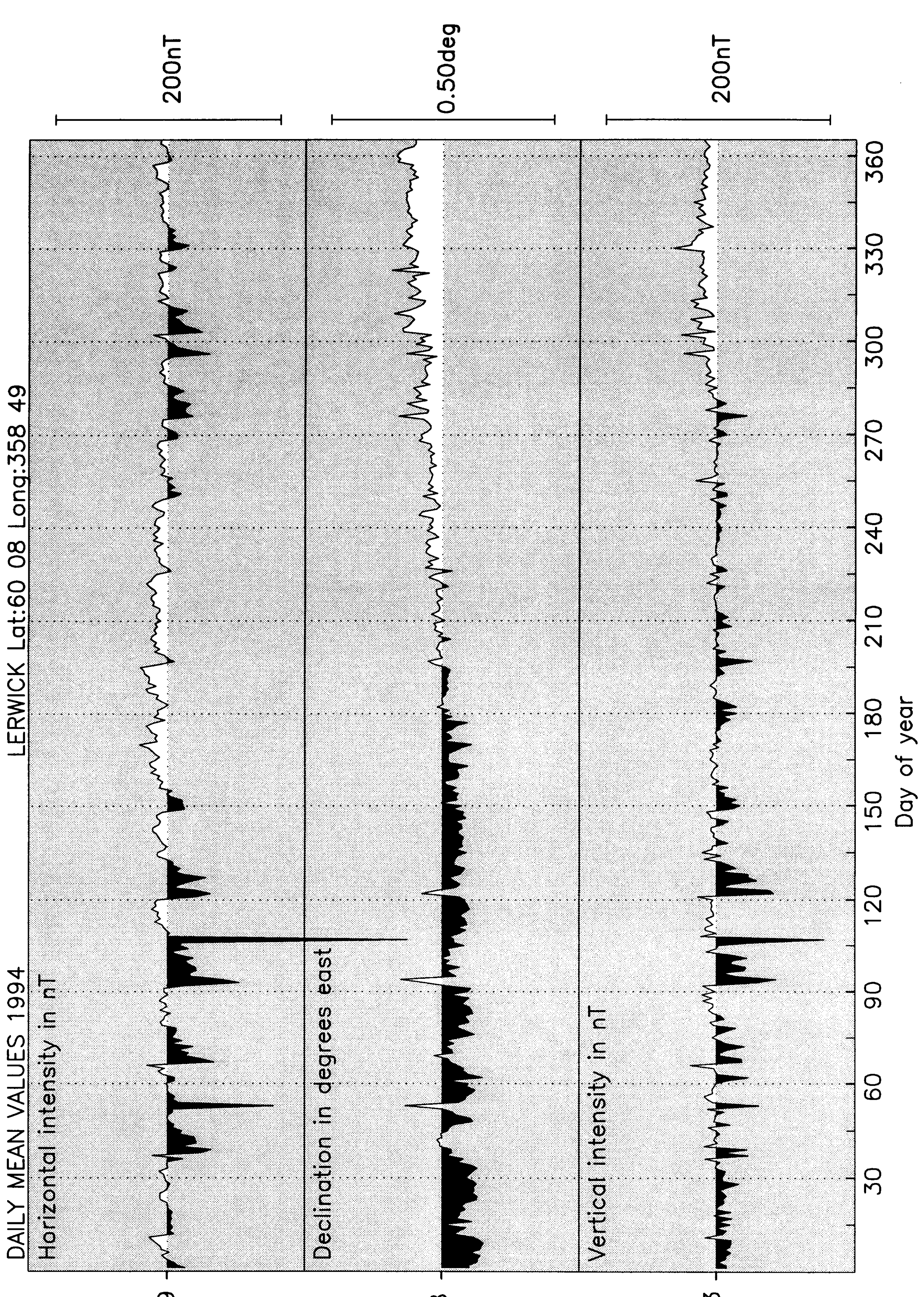
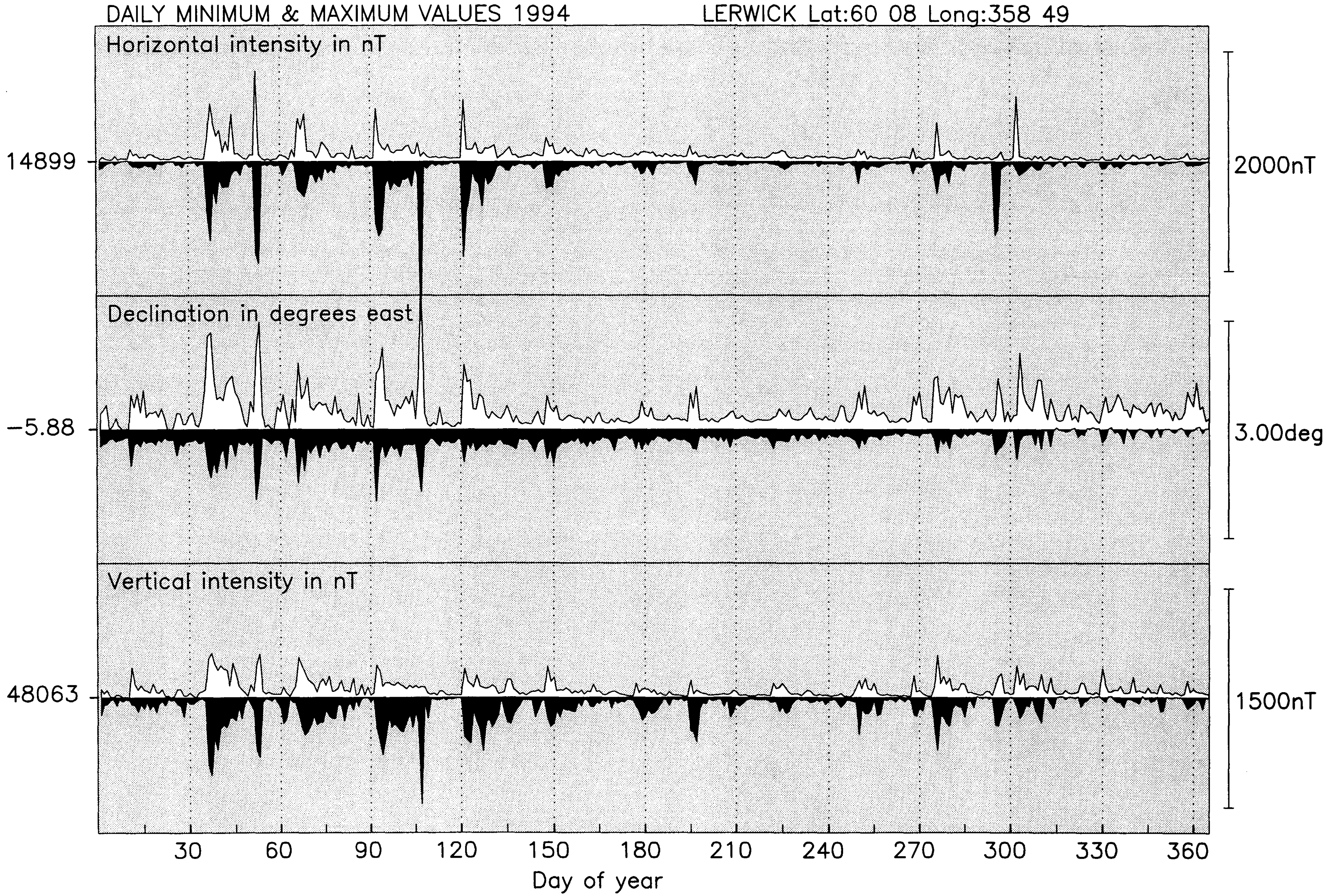
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number



Lerwick Observatory: Vertical Intensity (nT)
8125
7975
Rotn
Jan94
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
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 1994
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
14899
-5.88
48063
200nT
0.50deg
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year


DAILY MINIMUM & MAXIMUM VALUES 1994
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
14899
-5.88
48063
2000nT
3.00deg
1500nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Lerwick 1994

Month	D	H	I	X	Y	Z	F
Jan	-5 56.5	14899	72 46.5	14819	-1542	48056	50313
Feb	-5 54.5	14888	72 47.3	14809	-1533	48061	50314
Mar	-5 55.3	14895	72 46.8	14816	-1537	48060	50315
Apr	-5 54.4	14884	72 47.4	14805	-1532	48054	50306
May	-5 54.7	14895	72 46.7	14816	-1534	48055	50310
Jun	-5 54.3	14908	72 46.0	14829	-1534	48061	50320
Jul	-5 52.7	14910	72 45.8	14832	-1527	48059	50319
Aug	-5 51.7	14909	72 46.0	14831	-1523	48063	50322
Sep	-5 51.1	14901	72 46.5	14823	-1519	48063	50320
Oct	-5 49.9	14893	72 47.1	14816	-1513	48069	50323
Nov	-5 48.7	14898	72 47.0	14821	-1509	48078	50333
Dec	-5 48.2	14903	72 46.6	14827	-1507	48075	50332
Annual							
All days	-5 52.7	14899	72 46.6	14821	-1526	48063	50319
Q days	-5 53.4	14907	72 46.2	14828	-1530	48066	50325
D days	-5 51.7	14885	72 47.4	14807	-1520	48056	50308

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

Lerwick Observatory K Indices 1994

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3333 3443	2011 1000	4121 1223	0110 2221	0122 4598	3532 3334	4333 3334	3210 1111	4301 1122	1000 0000	3421 2412	2322 3214
2	2222 3343	0122 3220	3211 2145	3223 4787	5632 3347	4223 2434	3523 3424	1001 0111	2201 1101	0000 1335	3222 3223	2221 3434
3	2122 2341	0011 2332	3443 2111	6644 5468	5642 4443	3322 3344	2222 2112	1100 1111	2110 1102	6554 7653	1211 2242	4222 2032
4	1210 1021	1111 2453	0011 1000	7634 4444	3422 4434	3222 2324	1211 3232	1000 1100	2001 1200	4322 3443	2422 1243	2100 0030
5	0000 0002	3223 2577	0001 1024	5433 5436	5332 4544	2223 3433	1010 1111	1111 1110	0112 2112	4323 4444	3211 1245	0100 1112
6	3111 1313	8323 7676	2211 1123	5333 4555	5532 3335	3222 3333	1111 2123	0111 1101	1212 2323	4333 3245	4533 4541	2132 3433
7	0000 1022	5534 7464	5324 4676	5533 4434	6443 3343	3222 2223	3322 2322	0011 1212	1223 3365	5332 3554	1111 0131	3221 1423
8	1110 1112	6633 4566	5434 3465	5543 3344	4333 3455	3211 2322	1100 2110	1000 0100	3332 2433	3322 1332	1000 1102	2111 2233
9	1000 0010	3223 3646	5443 4576	5524 5444	3523 3442	1122 1211	1000 2320	1100 1121	3332 4454	3221 1242	2101 2333	2111 1123
10	0000 0000	4333 4555	4333 4445	4223 3455	4343 4445	1222 3433	0011 1110	2111 3322	4232 3222	3211 1244	3322 1232	3111 0232
11	0111 2554	5524 3566	3433 5455	5544 3434	5332 4434	2222 2333	1100 2200	3322 2323	3322 3232	2322 2242	1111 1002	1000 1333
12	4322 3434	5323 3455	4333 4343	5322 3354	3311 1212	3333 4432	1100 1100	3322 3342	1112 2332	2321 1134	1100 0010	3221 1243
13	3322 3334	4323 3574	5522 2225	3322 4545	2210 0122	2211 2433	0120 1121	2332 3432	0221 1224	2112 2213	0101 1221	3221 2211
14	3222 3434	4332 3545	4522 4444	5222 3433	2432 3323	2233 4222	1113 4534	3332 2433	3210 3110	2101 1323	1111 1133	1101 1033
15	3321 2354	3222 3445	5433 4543	3322 2433	2343 3443	2011 2111	4212 3225	4211 3233	1111 2113	2311 2112	2111 1133	1221 3334
16	2222 3233	5423 3333	3331 3533	3422 3365	4423 3532	2000 2210	6323 3434	2112 1223	2221 2211	1111 1000	2100 1200	2322 3222
17	3332 2344	2211 2232	3443 3433	6985 4332	3222 2332	1101 2311	3212 3322	1121 1211	1111 1211	0001 1002	1201 0032	1111 1132
18	2222 3432	1001 1002	4421 2314	2222 3243	3322 3324	3321 2312	3311 3221	1011 2212	2100 2102	1001 0123	0001 1211	2000 1223
19	3432 3144	4332 3243	4232 1222	4122 2222	1222 2211	1123 3233	3221 2123	2010 1110	2010 0121	0000 1223	3332 2433	1200 1001
20	3221 2232	4322 2232	3211 1343	2222 1211	1210 2200	2321 3323	1000 2210	1211 1232	1100 1112	3011 1222	2233 3223	2111 1223
21	2101 1243	2236 6868	2322 3443	1211 1122	0001 3221	1122 2222	2111 2212	2100 2310	1000 2113	1001 1000	2111 1102	1110 1101
22	3110 1012	8742 4222	4222 3223	1112 2112	1101 2222	2111 2111	2110 1110	2101 2324	2100 0122	0012 3338	0100 1133	1200 0000
23	1101 1112	3212 1132	3322 2333	0002 2234	0102 2212	0000 0111	0110 2211	2201 1110	1100 0111	7443 4343	1000 0002	3111 0112
24	2000 0000	1001 1100	3313 2213	1111 2211	3422 3332	1100 1010	1112 2222	0000 1222	2200 0100	3432 3443	1000 0211	3333 3444
25	0100 0012	1222 2221	4111 3533	2212 1222	3322 2324	0010 2111	3211 3222	1222 3220	1000 1254	2331 1010	0000 0001	3221 2323
26	2232 3242	3210 2100	3112 1221	1011 2110	1122 2102	2333 4333	0100 1110	0111 0112	3332 2311	3111 1032	1233 3431	3111 2333
27	3321 2233	0112 2100	1101 2124	1111 1111	2100 1221	3321 2221	1421 1123	3121 1232	3311 1324	0001 1001	3223 3443	1211 2154
28	3212 2112	0021 1124	0112 3323	1000 2100	0001 4676	2111 2235	3322 3233	2211 1010	3312 0212	1000 1013	1122 2321	3000 1213
29	0121 2112		1011 1111	0111 1012	5523 4434	3433 4333	2321 2322	0011 1102	2111 1113	3234 6723	1110 1333	3232 1201
30	3101 1333		0012 3433	0000 1100	5533 5445	3322 3324	3211 2222	0000 1111	0000 0102	2343 4464	2323 3233	2111 1100
31	3111 1103		2111 1000		4433 3244		2112 2213	1000 2202		4224 3343		0000 0012

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	1	11	48	SSC*	C	-7	3.3	
15	1	21	00	SI	B	-51	-17.7	39
25	1	21	52	SSC	C	17	4.7	-9
21	2	09	01	SSC*	A	-190	8.8	101
5	3	09	54	SSC*	C	9	-3.3	3
9	3	20	42	SI*	B	+454/-525	23.8	-366
22	3	11	50	SSC*	C	27	-3.1	-10
2	4	11	44	SSC*	B	25	2.1	-12
16	4	11	50	SSC*	B	18	-3.2	-3
28	5	13	56	SSC*	A	39	-3.9	6
14	7	10	24	SSC*	B	14	-1.9	2
24	7	10	07	SI*	C	23		-9
27	7	17	57	SI	B	17	-1.4	-6
30	7	13	18	SSC*	C	-13	1.1	7
10	8	12	36	SSC*	B	11	-0.8	4
24	8	17	51	SSC*	A	-31	2.1	9
25	8	09	01	SI	B	+12/-15	-2.3	+4/-4
27	8	19	46	SI*	C	-7	+1.5	-3
29	8	06	58	SSC*	C	-4	0.9	2
29	8	22	34	SSC	B	18	4.4	-2
18	9	12	10	SSC*	C	12	-1.6	3
19	10	14	52	SSC*	B	19	-1.4	2
22	10	08	50	SSC*	B	11	-1.9	
29	10	00	26	SSC	B	27	-4.8	2
26	11	07	24	SSC*	B	-12/+12	2.9	5
5	12	21	05	SSC*	C	11	0.9	-4
10	12	10	07	SI*	B	-10	2.6	3

Notes

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

The quality of the event is classified as follows :

A = very distinct

B = fair, ordinary, but unmistakable

C = doubtful

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

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
4	3	11	26	11	34	11	45	16	-3.3	-6

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

Annual Values of Geomagnetic Elements

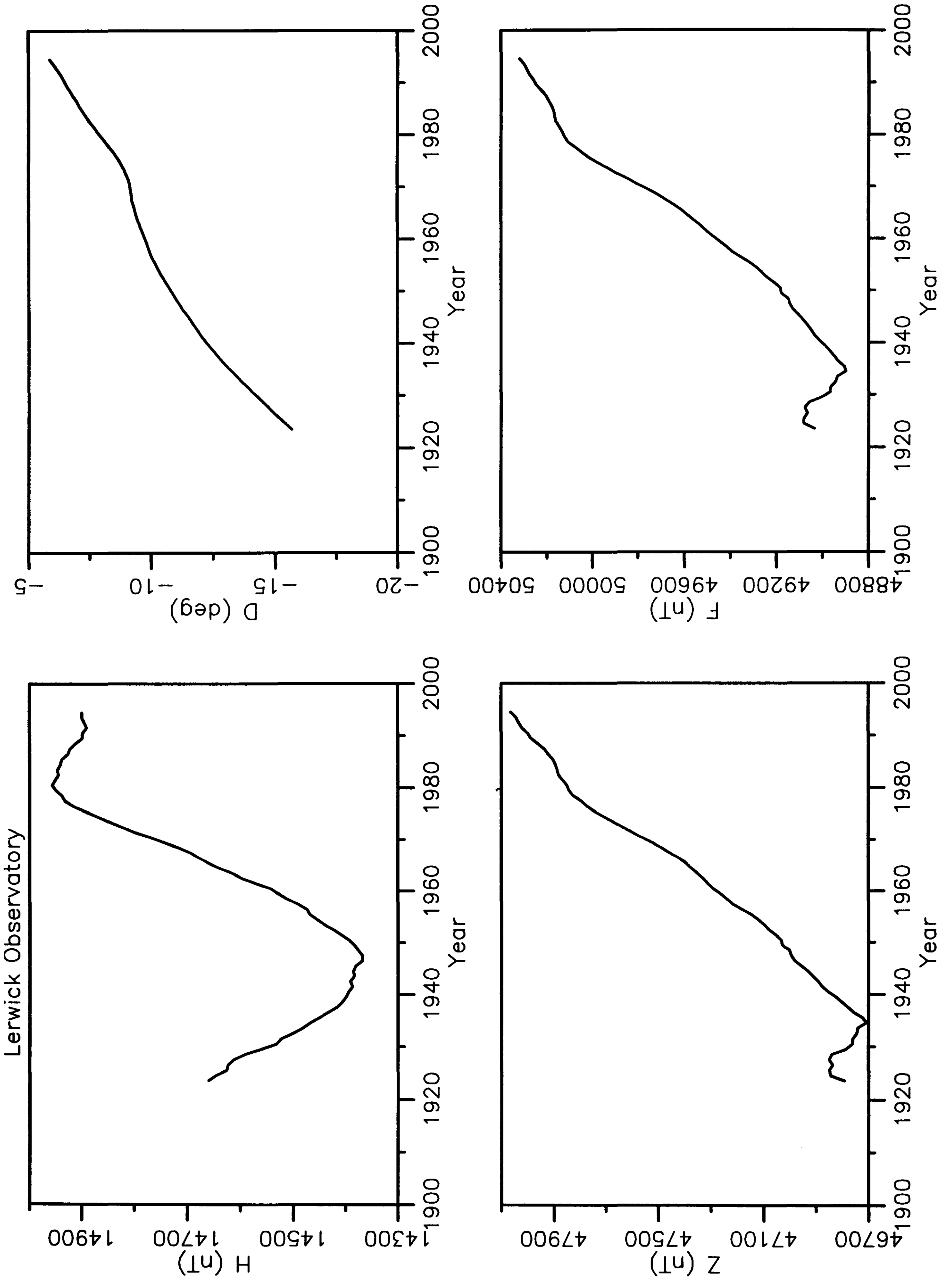
Lerwick

	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

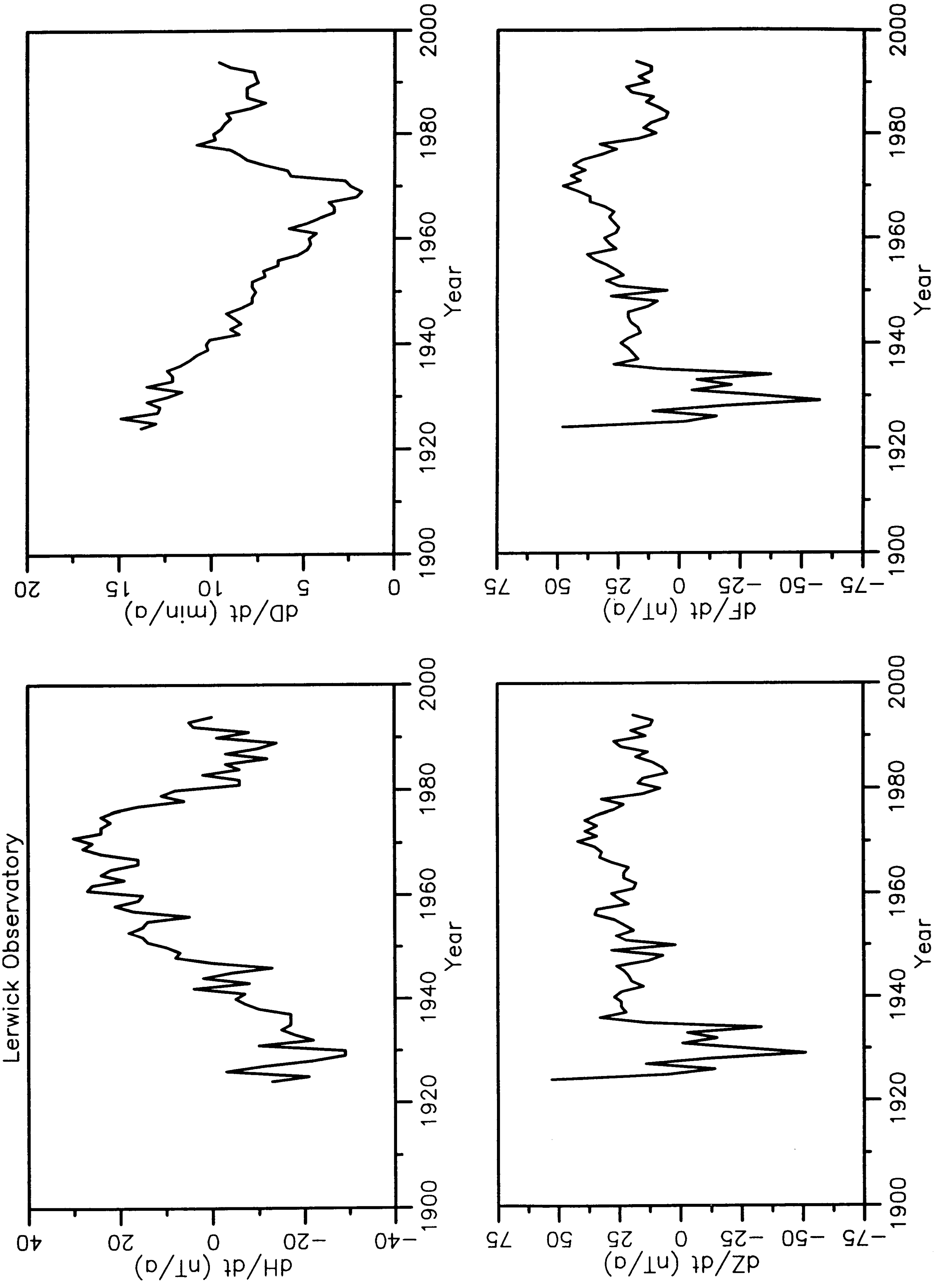
	Year	D		H	I		X	Y	Z	F
	1984.5	-7	13.4	14936	72	40.9	14818	-1878	47902	50177
	1985.5	-7	5.5	14933	72	41.3	14819	-1844	47913	50186
	1986.5	-6	58.4	14921	72	42.5	14811	-1811	47931	50200
	1987.5	-6	50.3	14918	72	43.0	14812	-1776	47944	50211
	1988.5	-6	42.2	14908	72	44.1	14806	-1740	47968	50231
	1989.5	-6	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

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

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

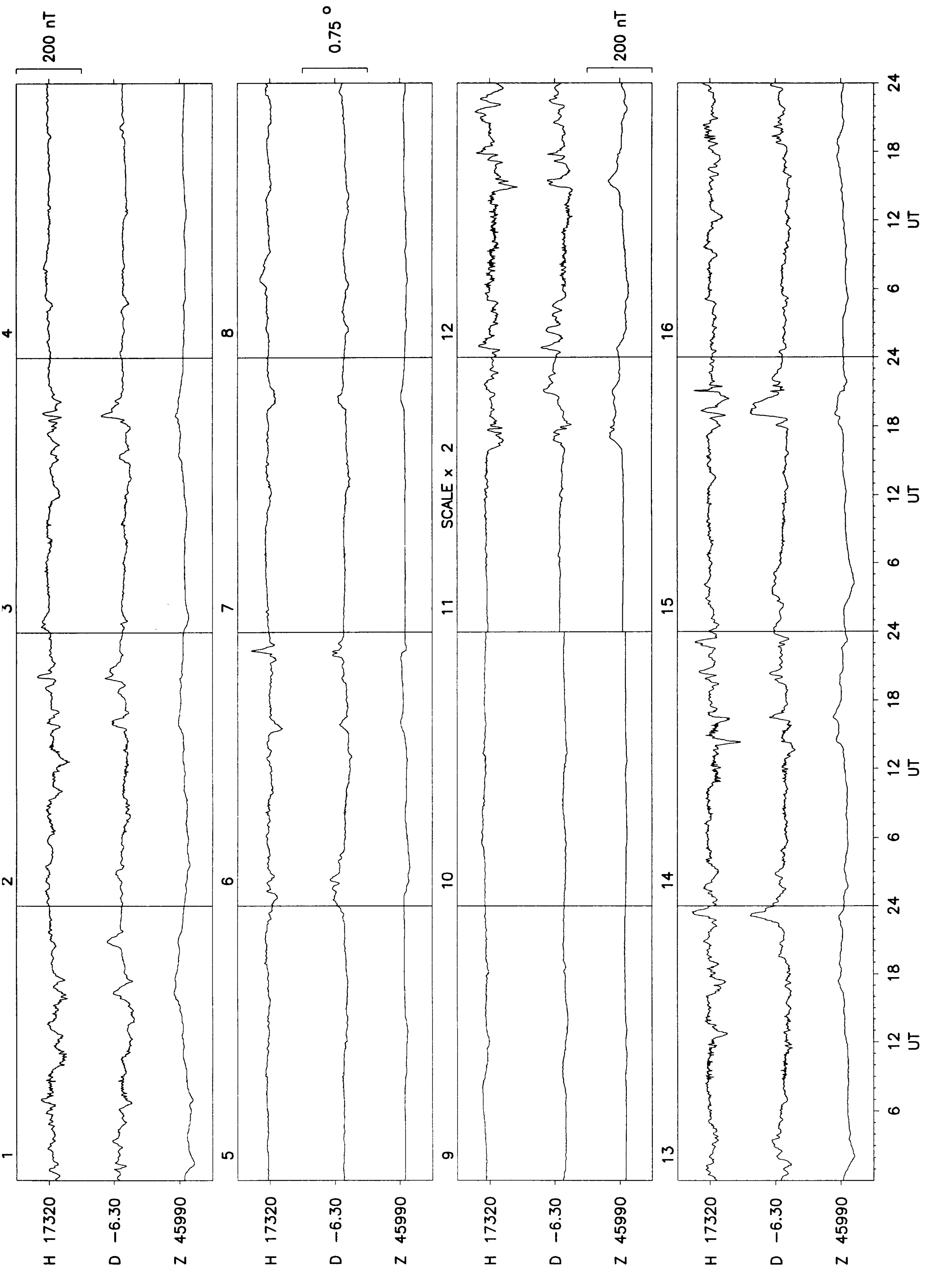


Annual mean values of H, D, Z & F at Lerwick

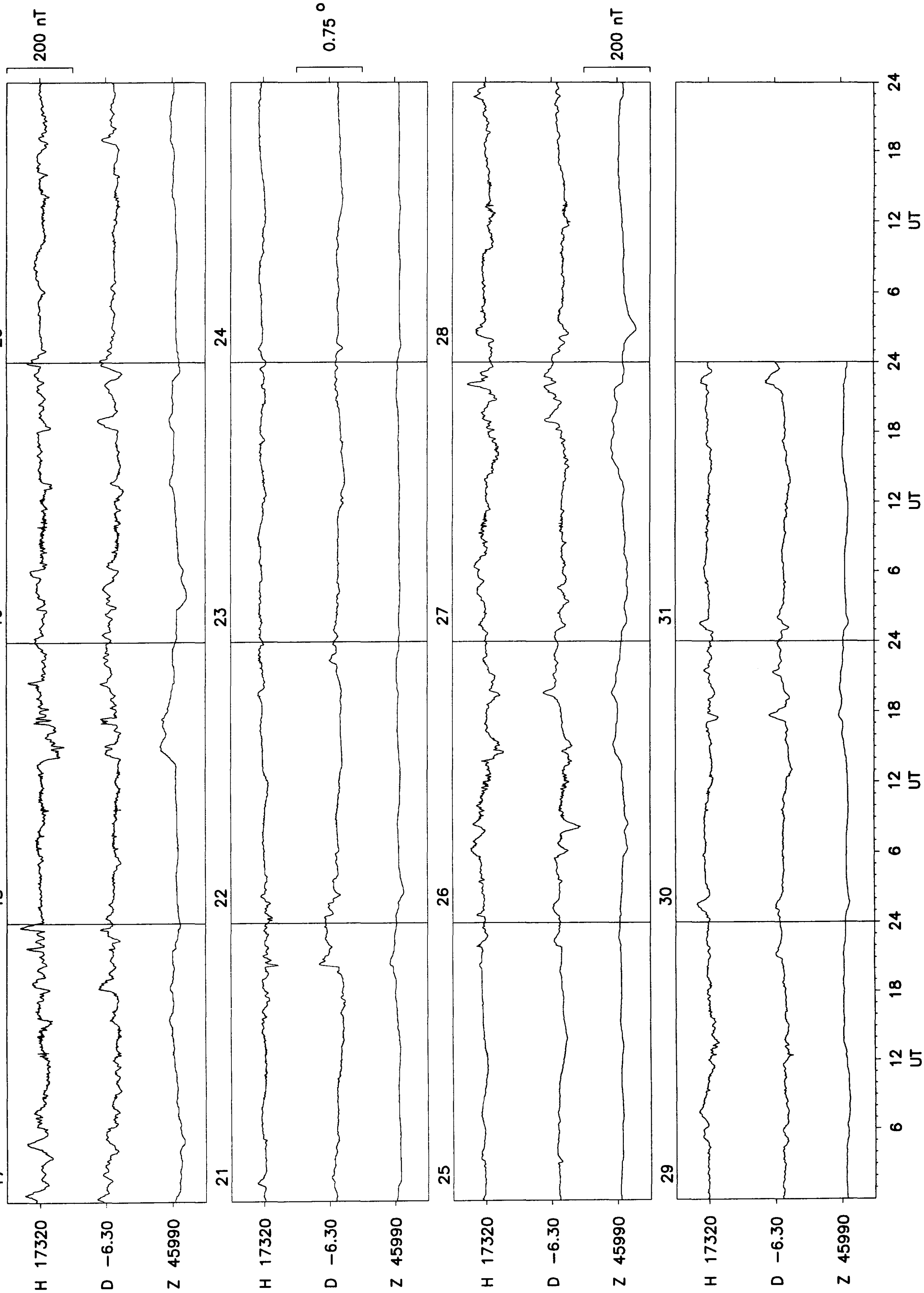


Rate of change of annual mean values of H, D, Z & F at Lerwick

Eskdalemuir 1994



Eskdalemuir January 1994


200 nT
0.75 °
200 nT
H 17320
D −6.30
Z 45990
17
18
19
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21
22
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25
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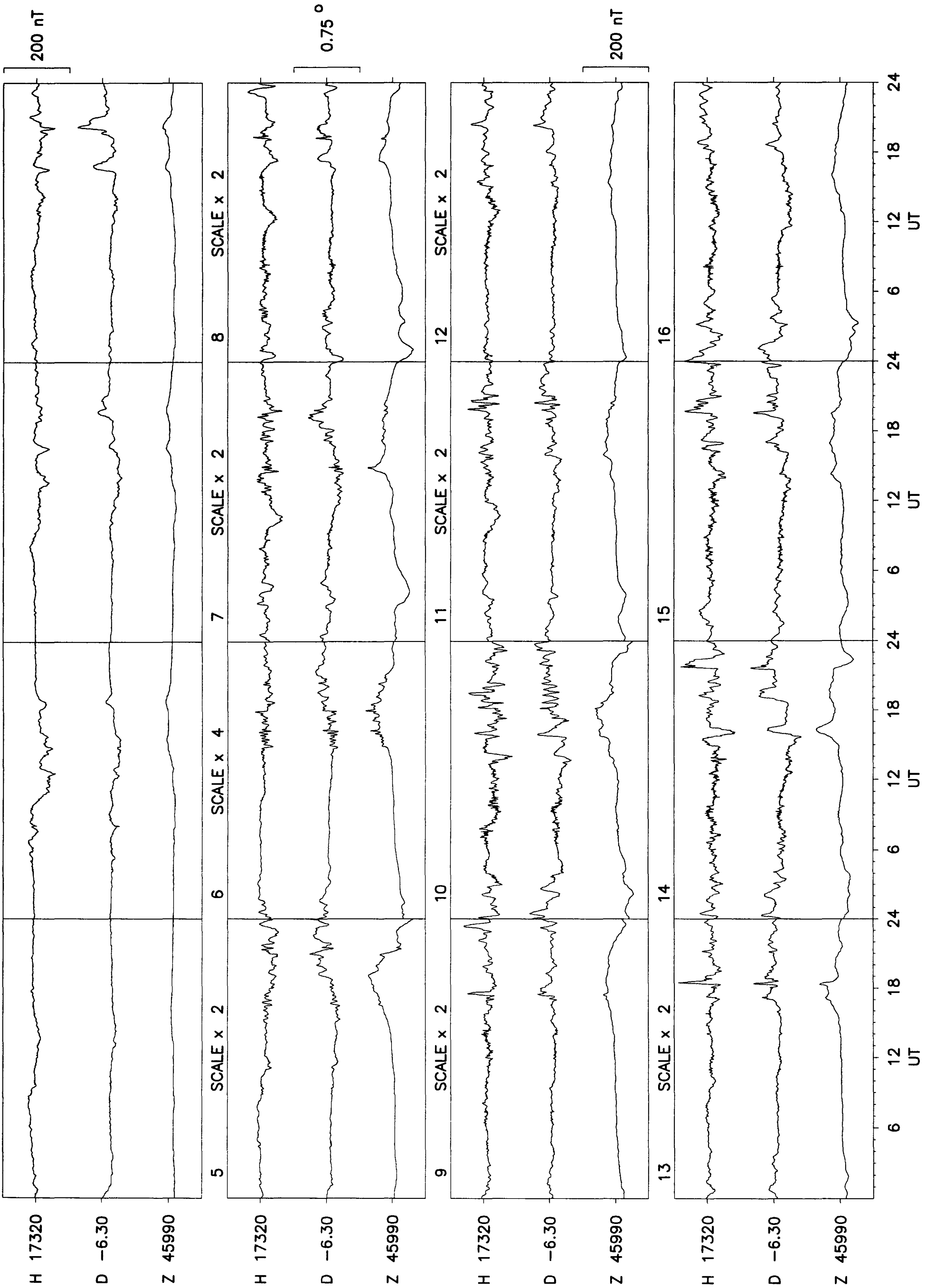
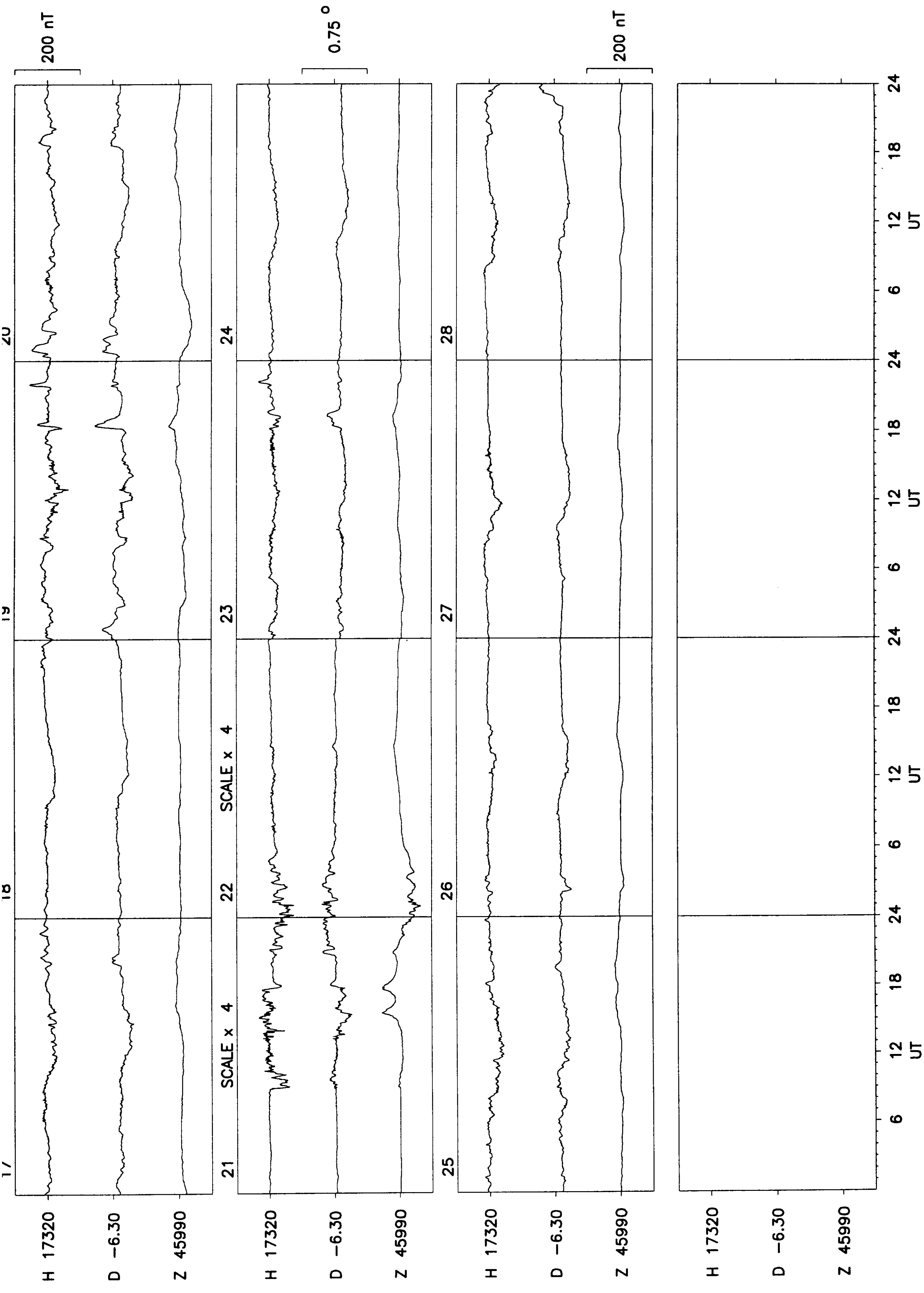
27
28
29
30
31
6
12
18
24
UT



Eskdalemuir February 1994


200 nT
0.75 °
200 nT
17
18
19
20
21
22
23
24
25
26
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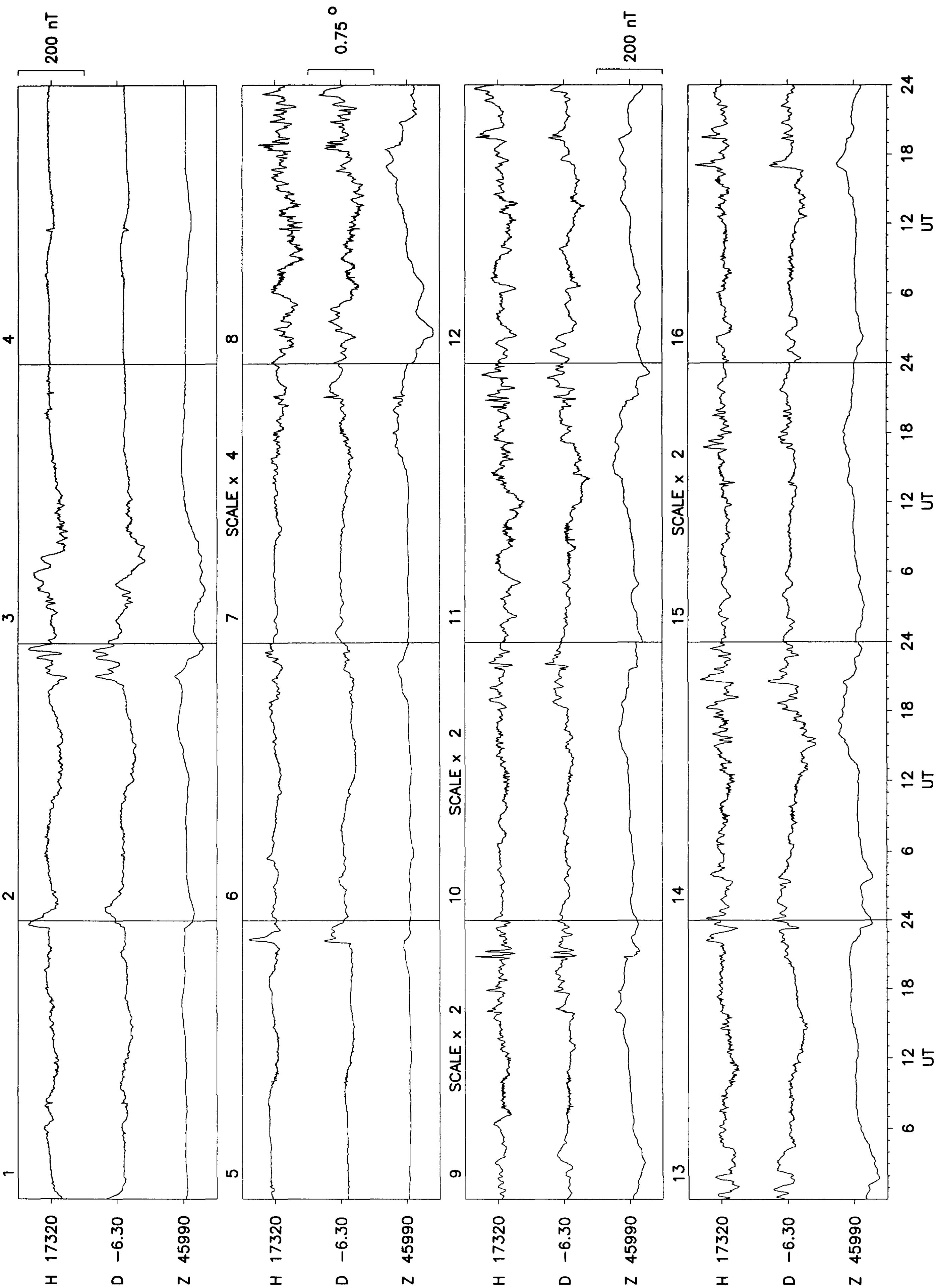
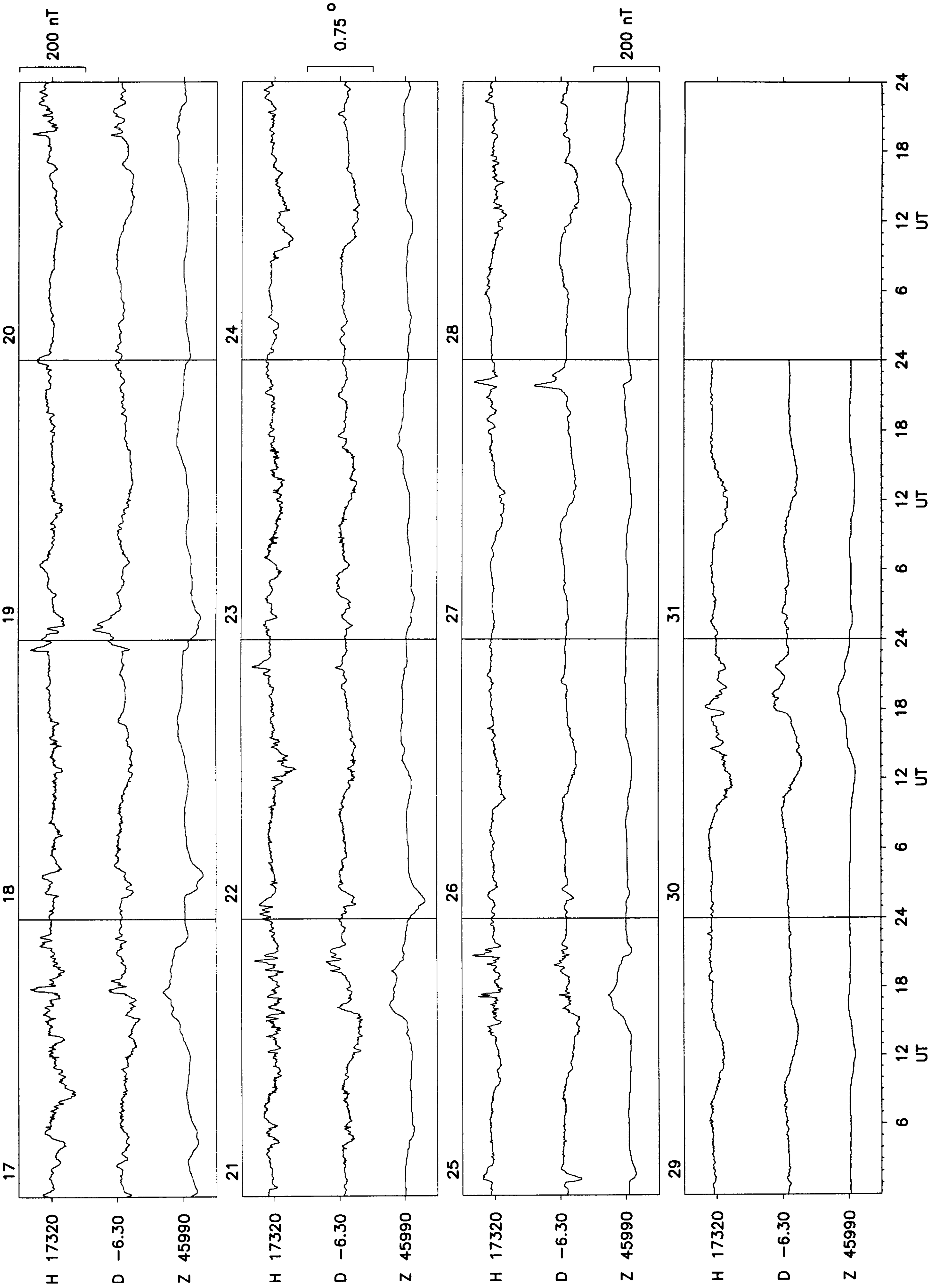
28
SCALE x 4
SCALE x 4
H 17320
D −6.30
Z 45990
6
12
18
24
UT



Eskdalemuir March 1994


200 nT
0.75 °
200 nT
H 17320
D −6.30
Z 45990
17
18
19
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27
28
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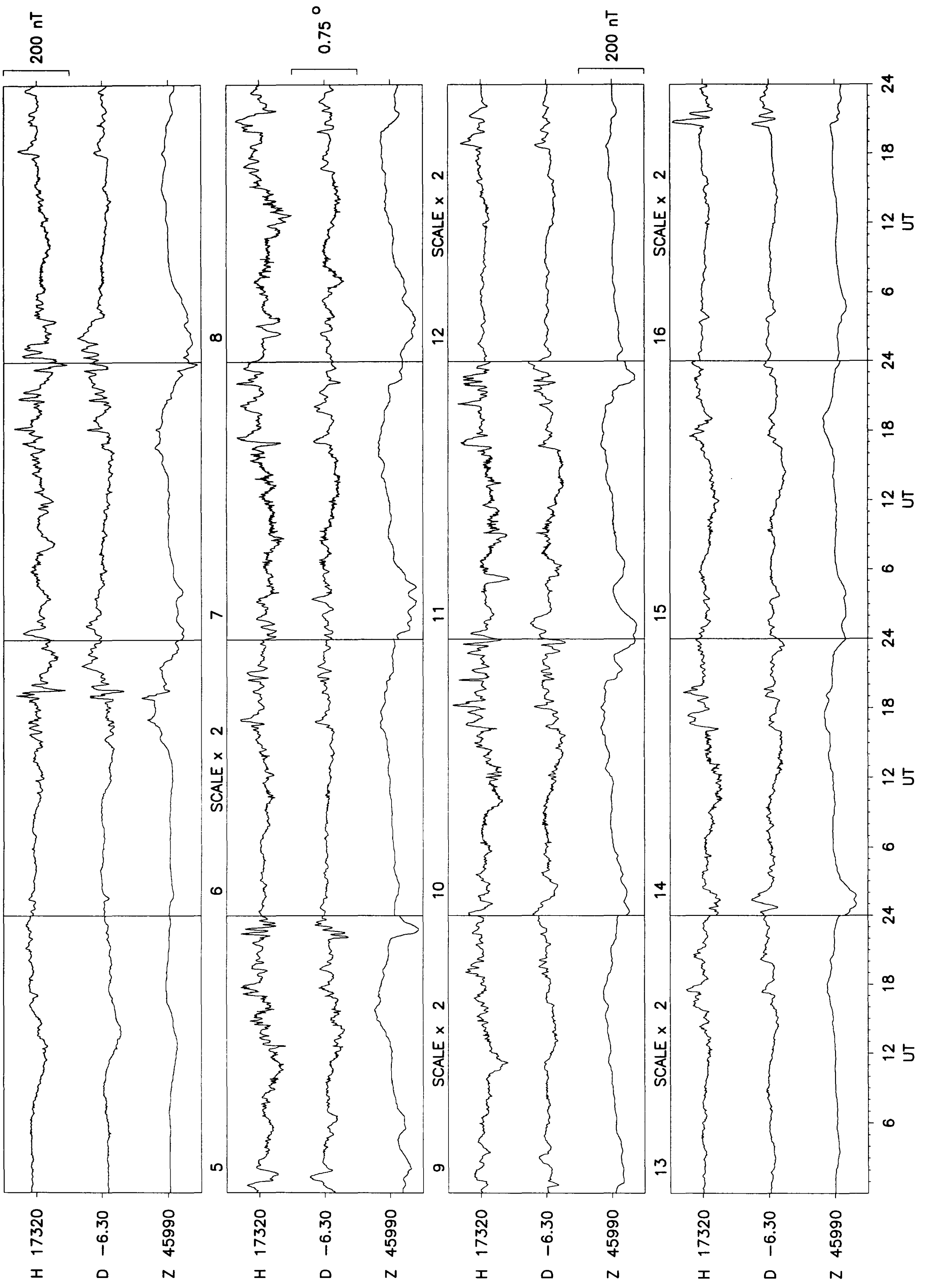
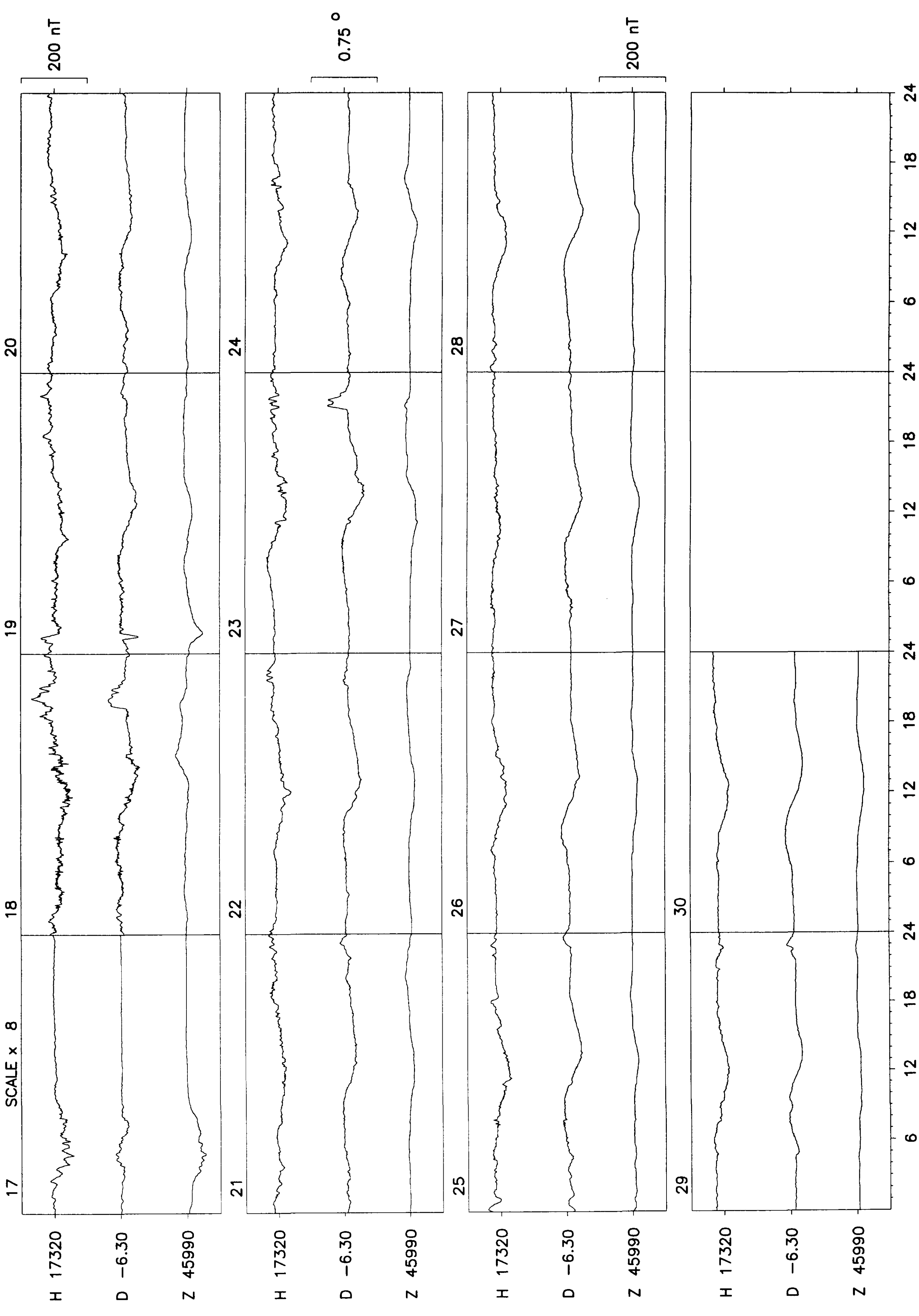
31
6
12
18
24
UT

ES 3 94



Eskdalemuir April 1994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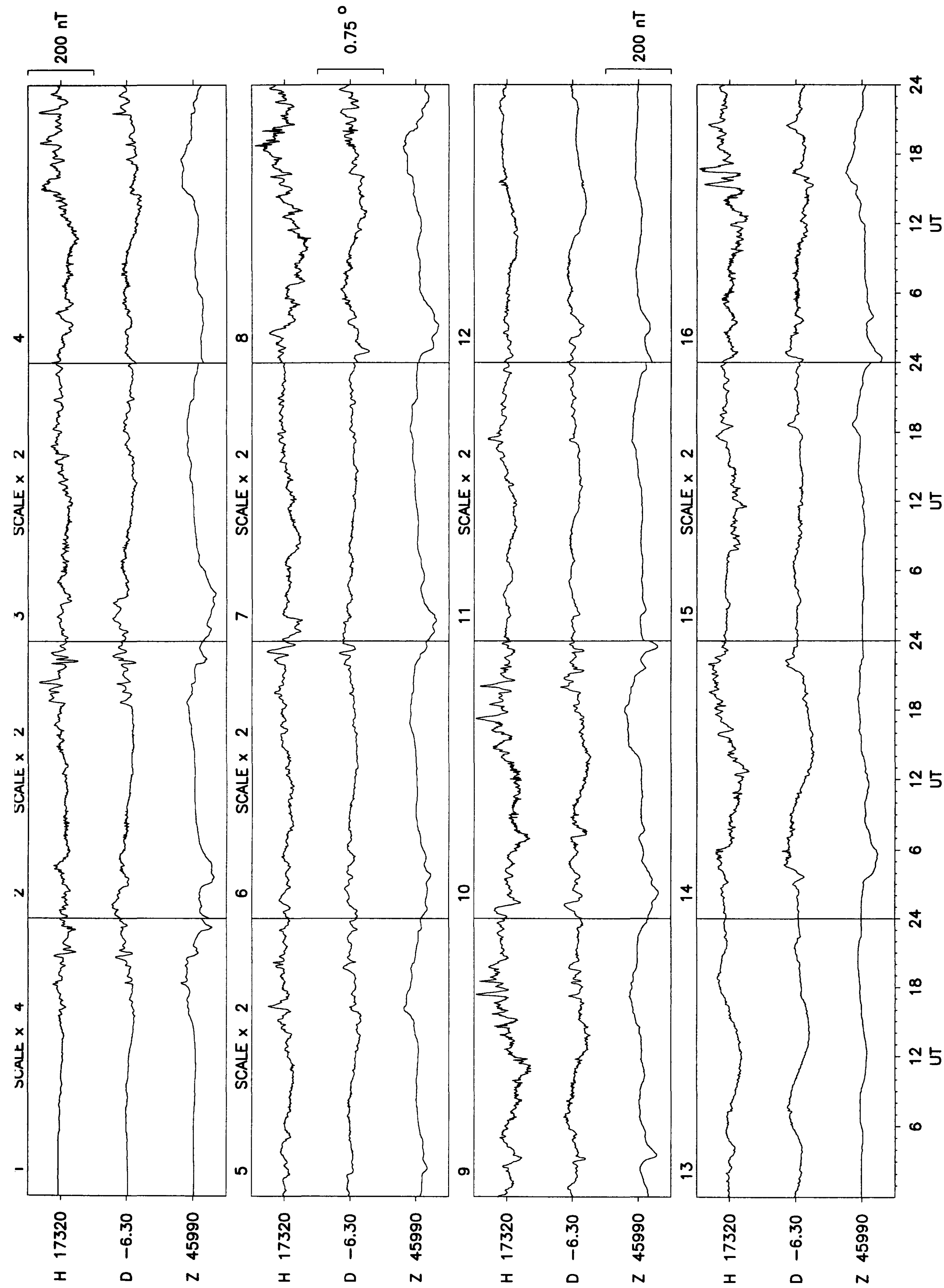
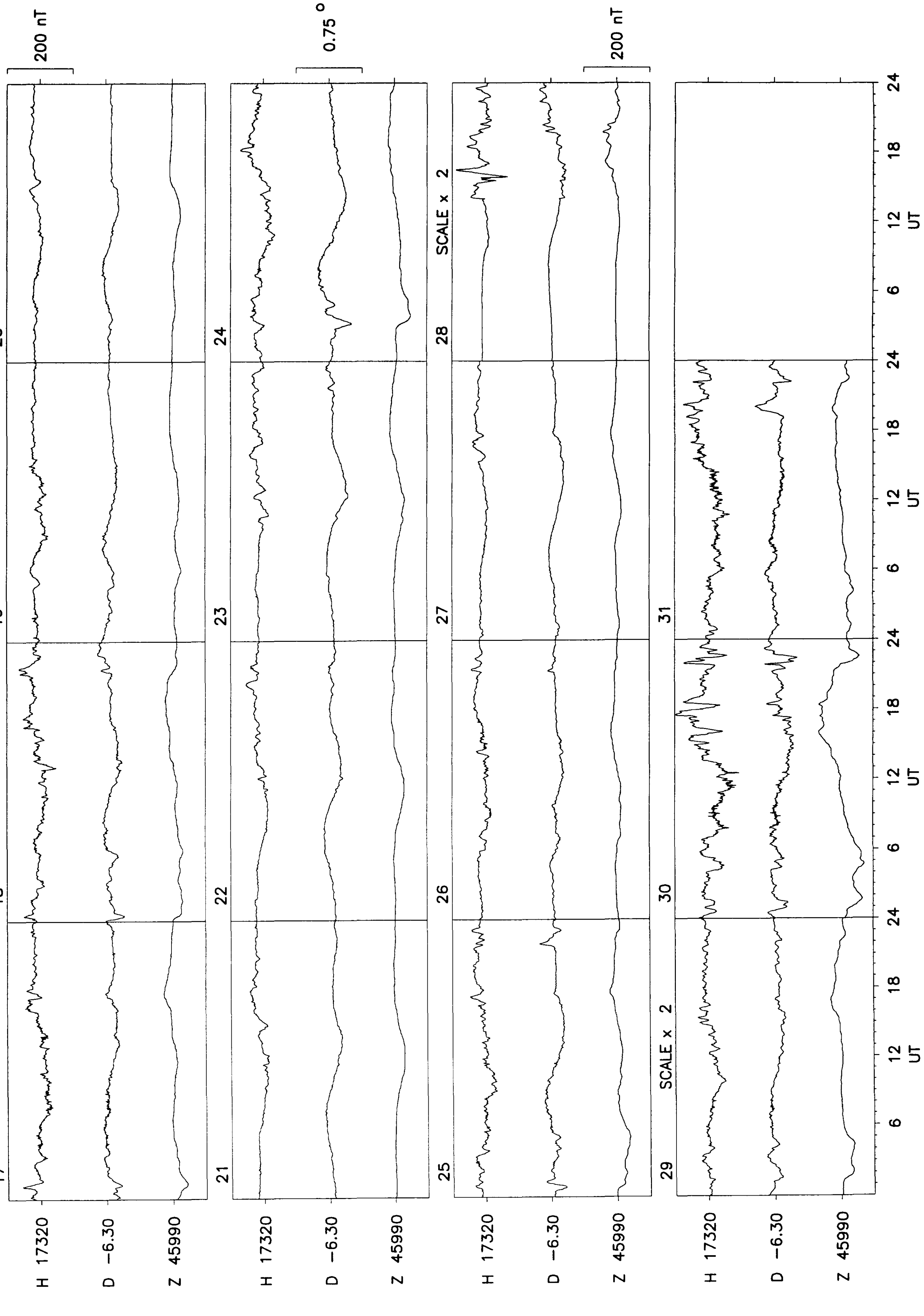
200 nT
0.75 °
200 nT
H 17320
D −6.30
Z 45990
17
18
19
20
21
22
23
24
25
26
27
28
29
30
UT



Eskdalemuir May 1994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31
H 17320
D −6.30
Z 45990
200 nT
0.75 °
SCALE x 2
UT
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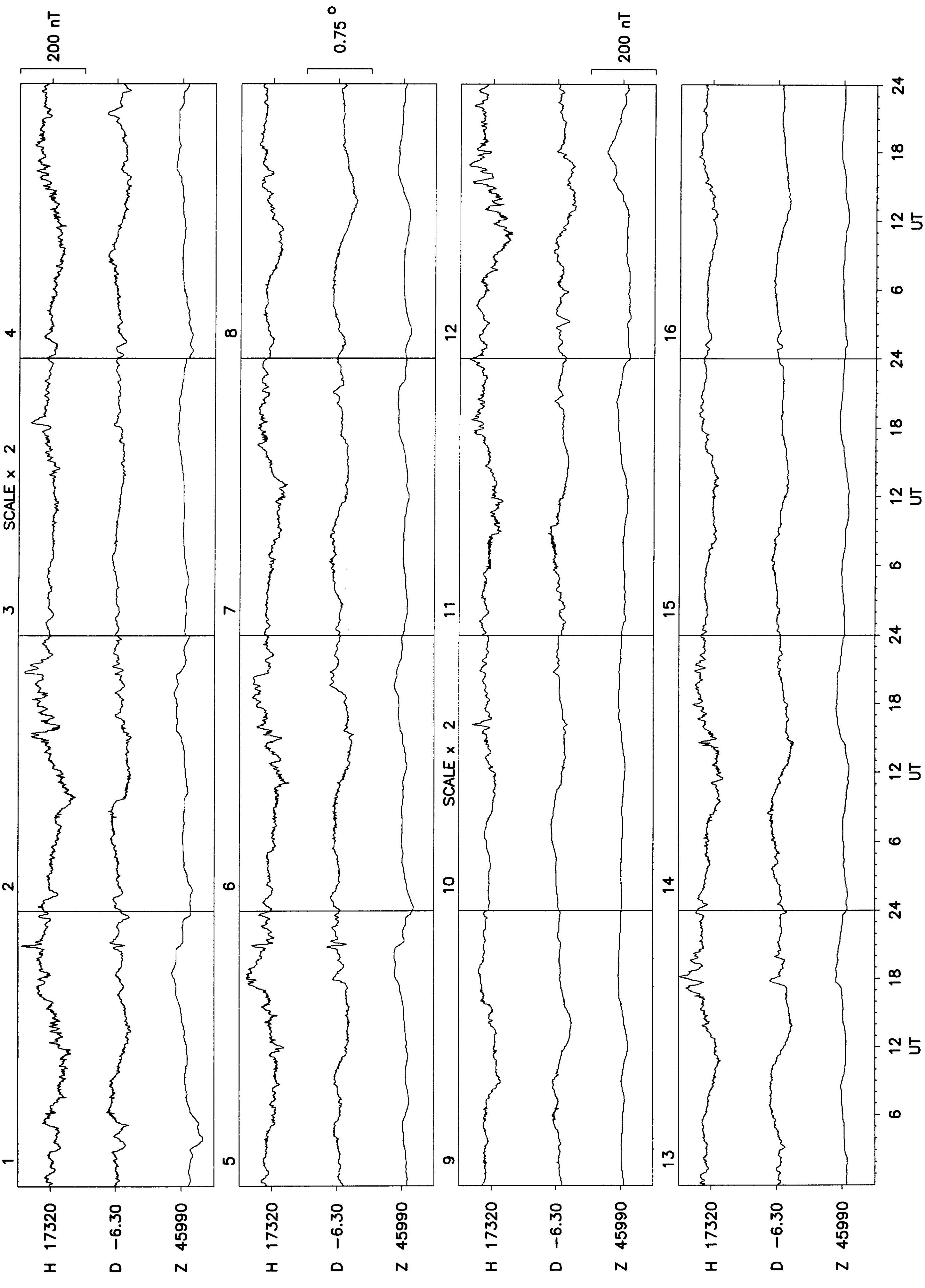
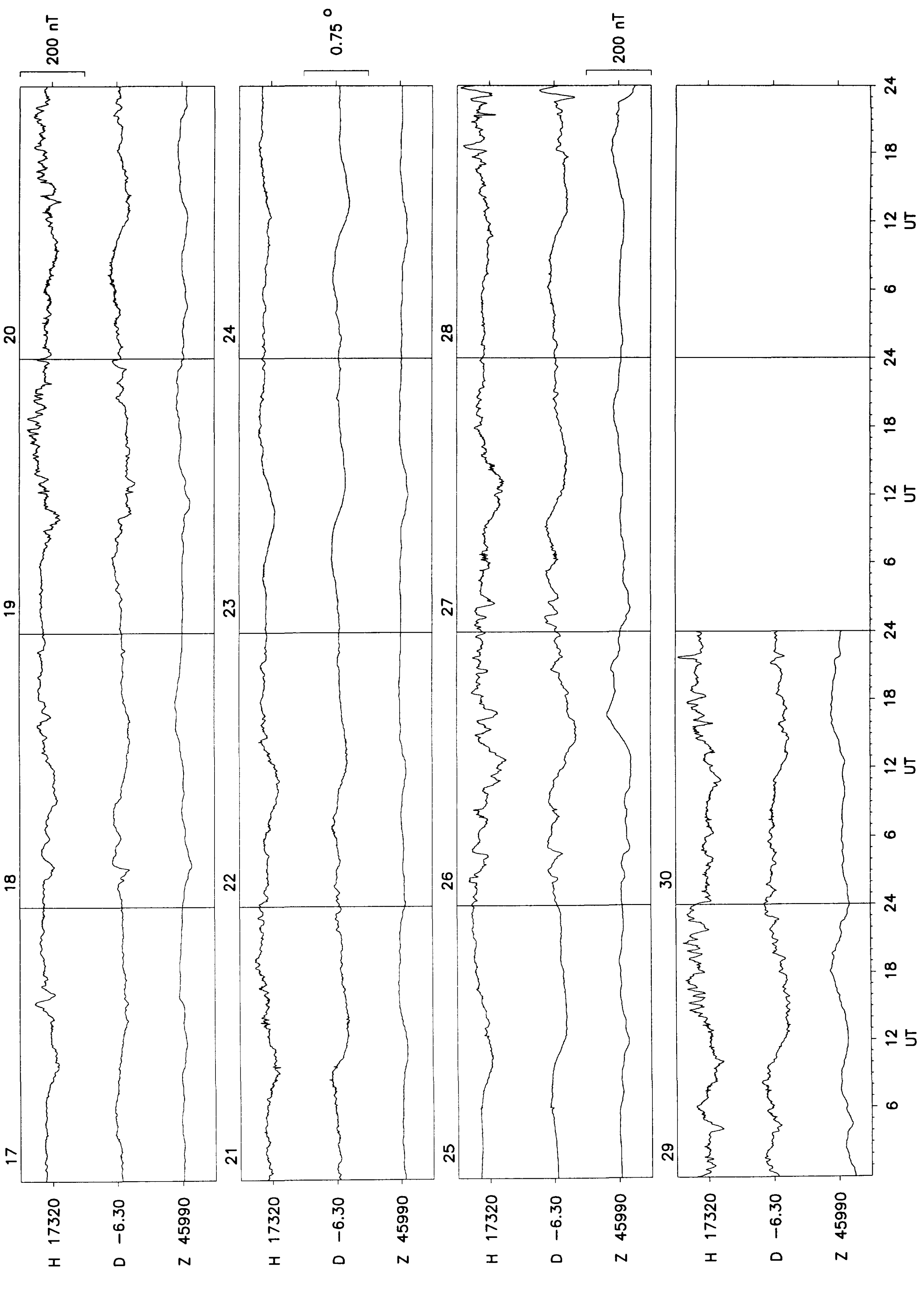
12
18
24



Eskdalemuir June 1994


200 nT
0.75 °
200 nT
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H 17320
D −6.30
Z 45990
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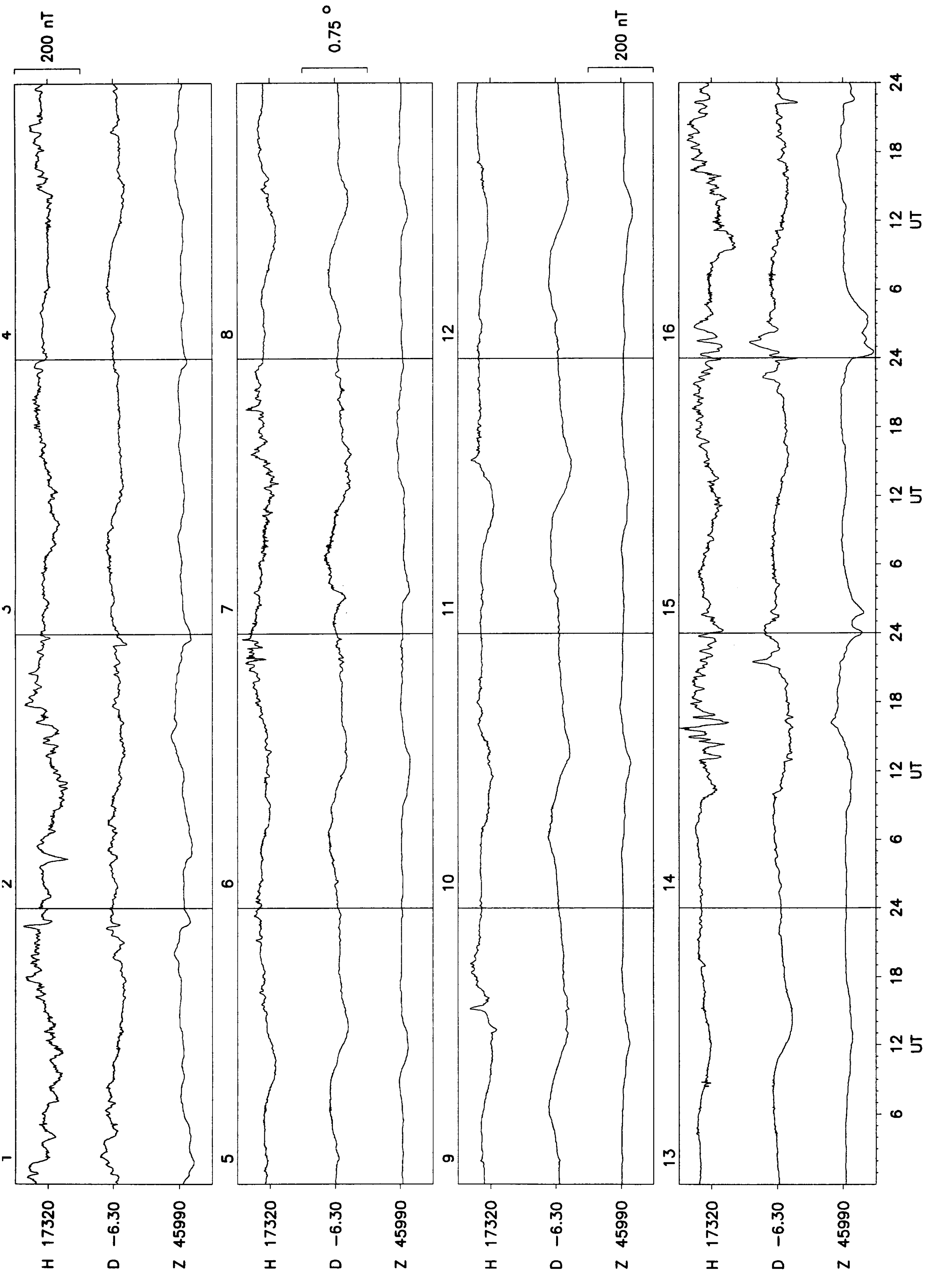
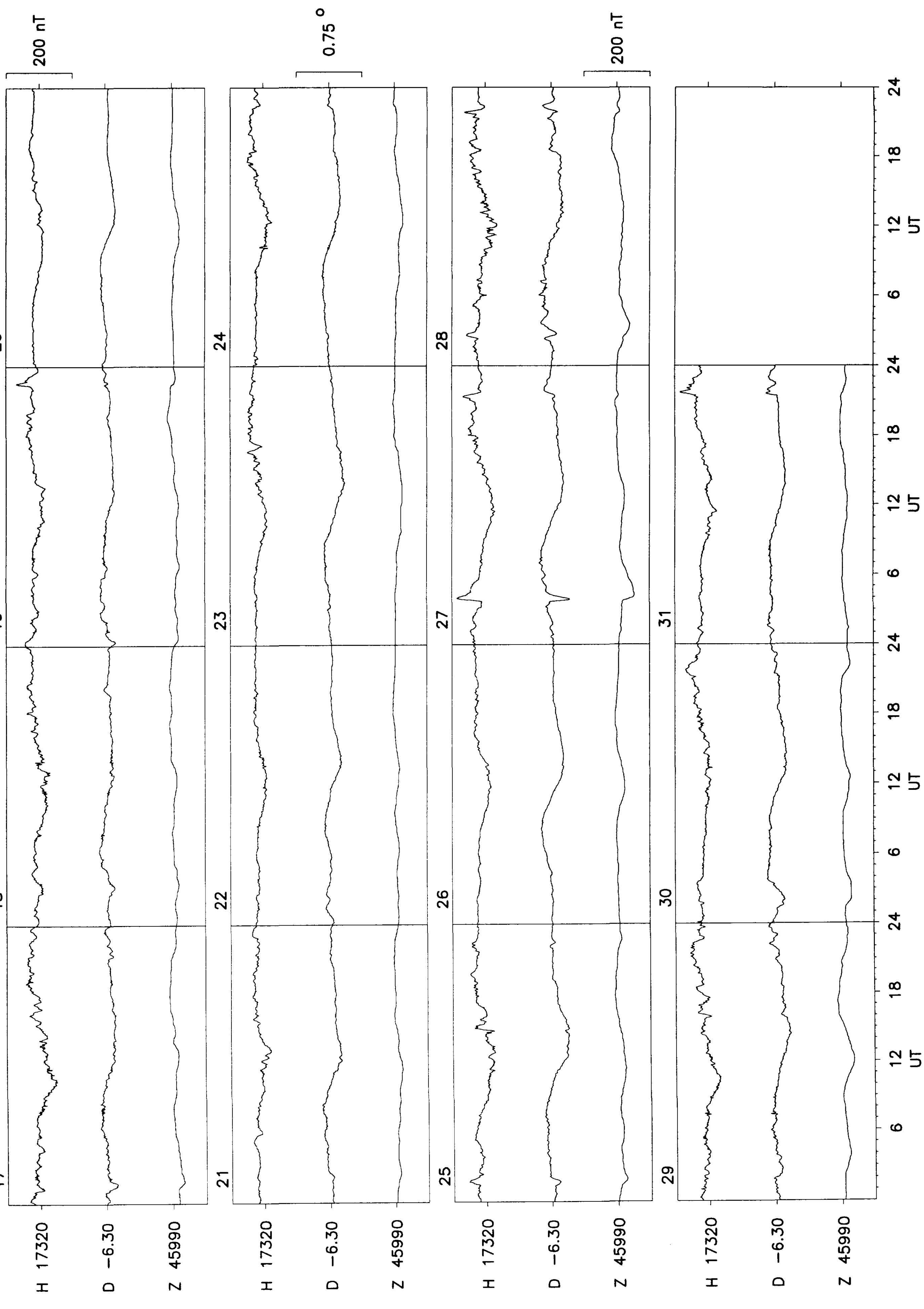


Eskdalemuir July 1994


200 nT
0.75 °
200 nT
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H 17320
D −6.30
Z 45990
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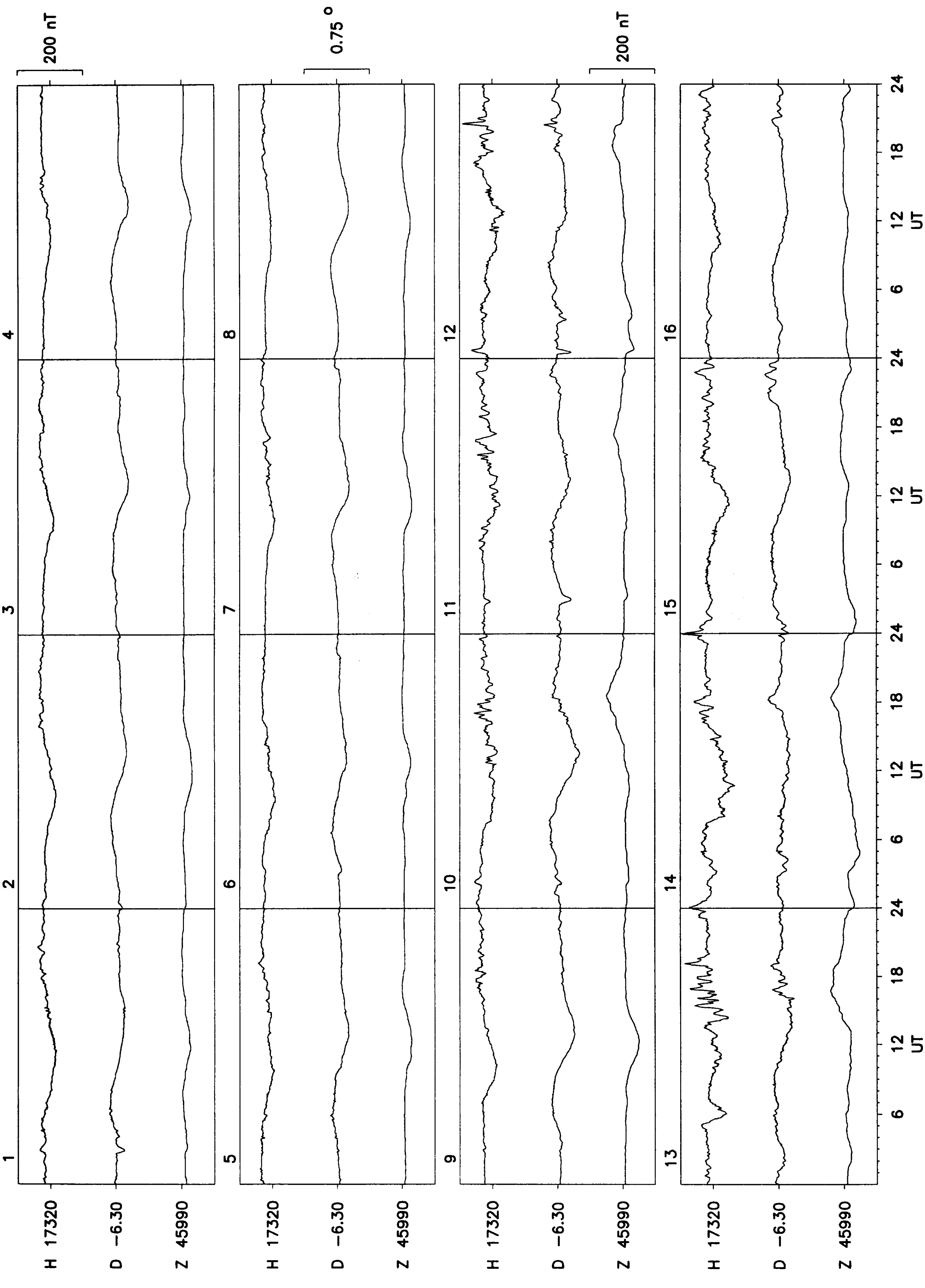
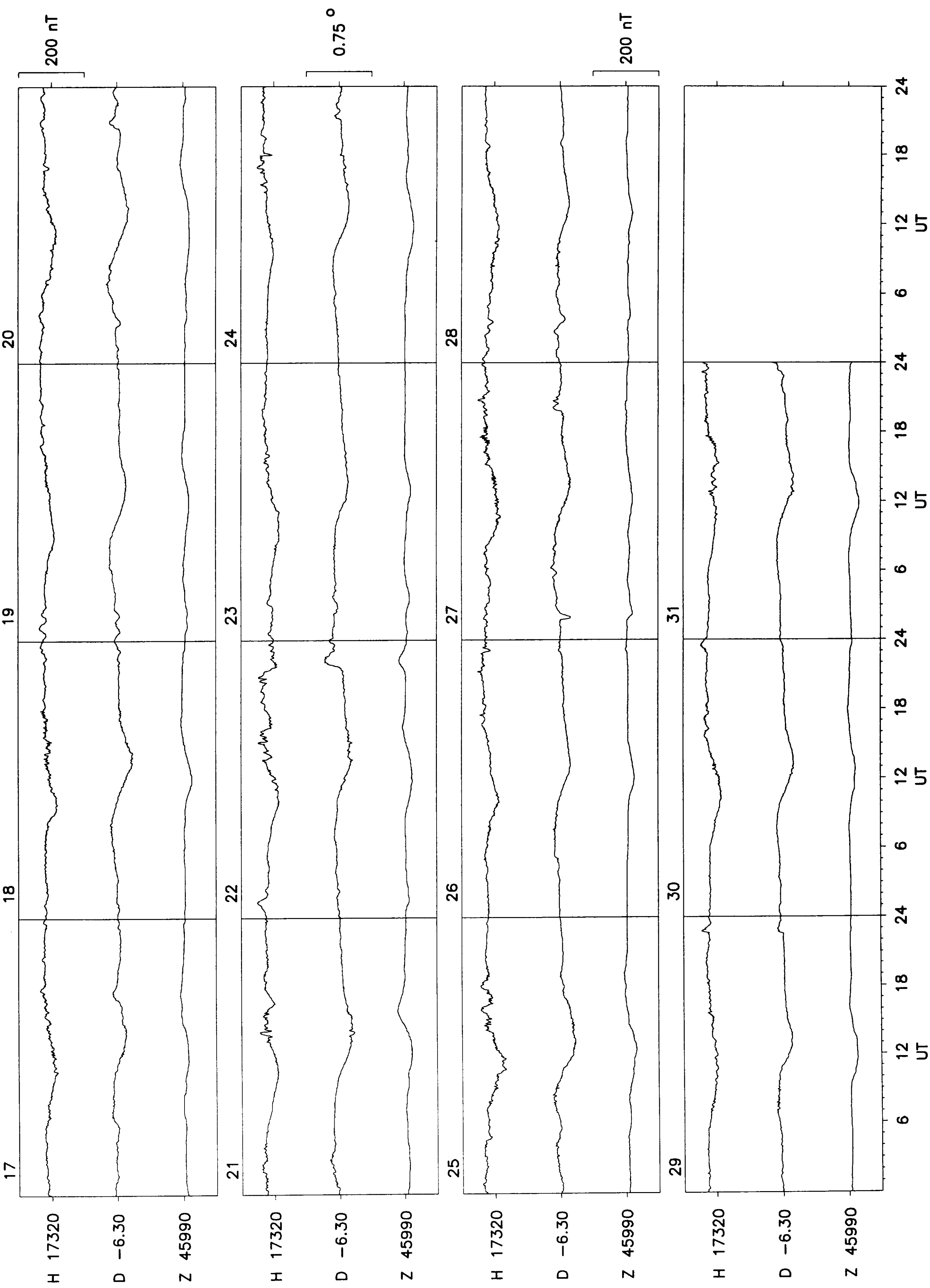
UT



Eskdalemuir August 1994


200 nT
0.75 °
200 nT
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H 17320
D −6.30
Z 45990
UT
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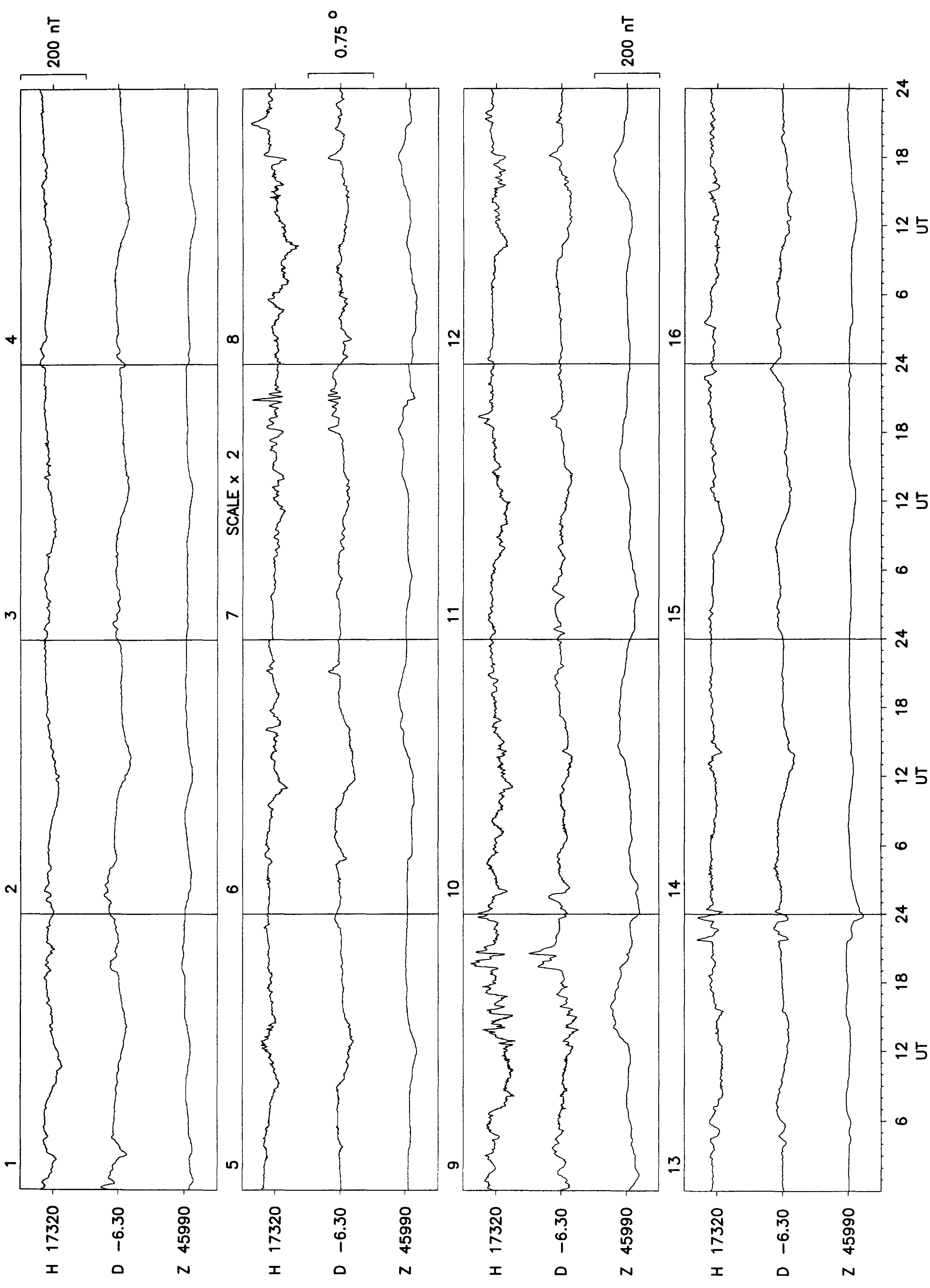
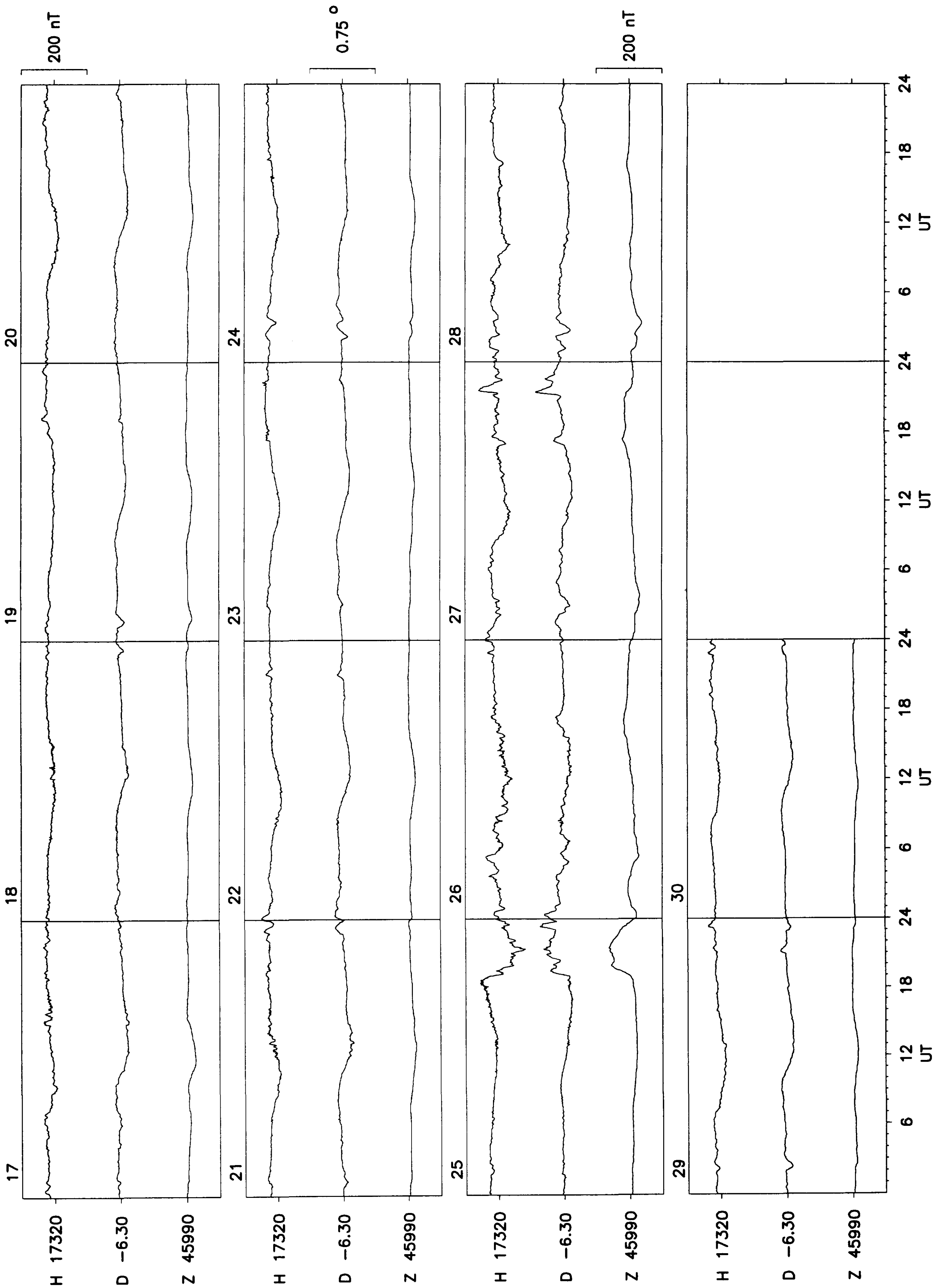


Eskdalemuir September 1994


200 nT
0.75 °
200 nT
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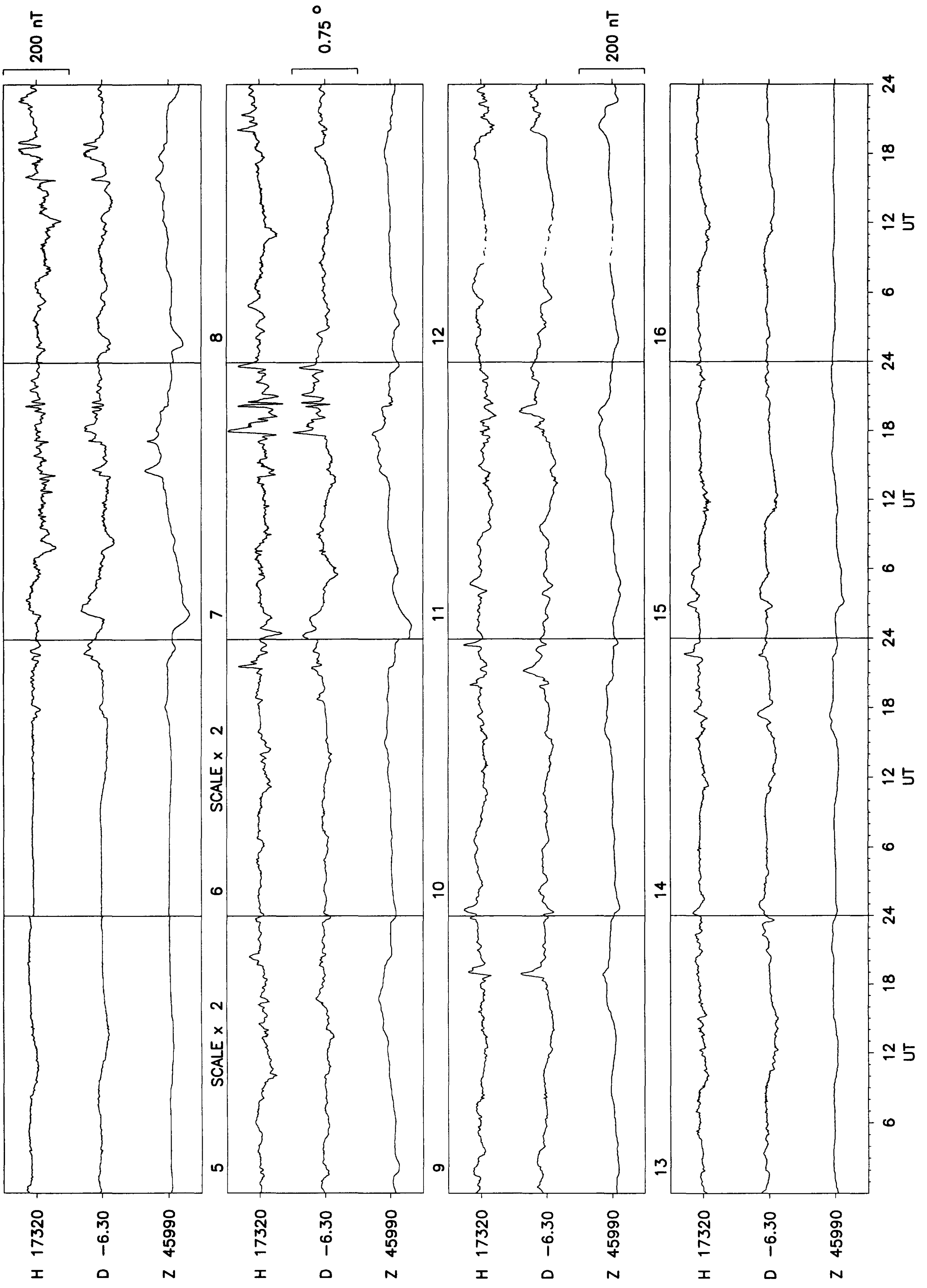
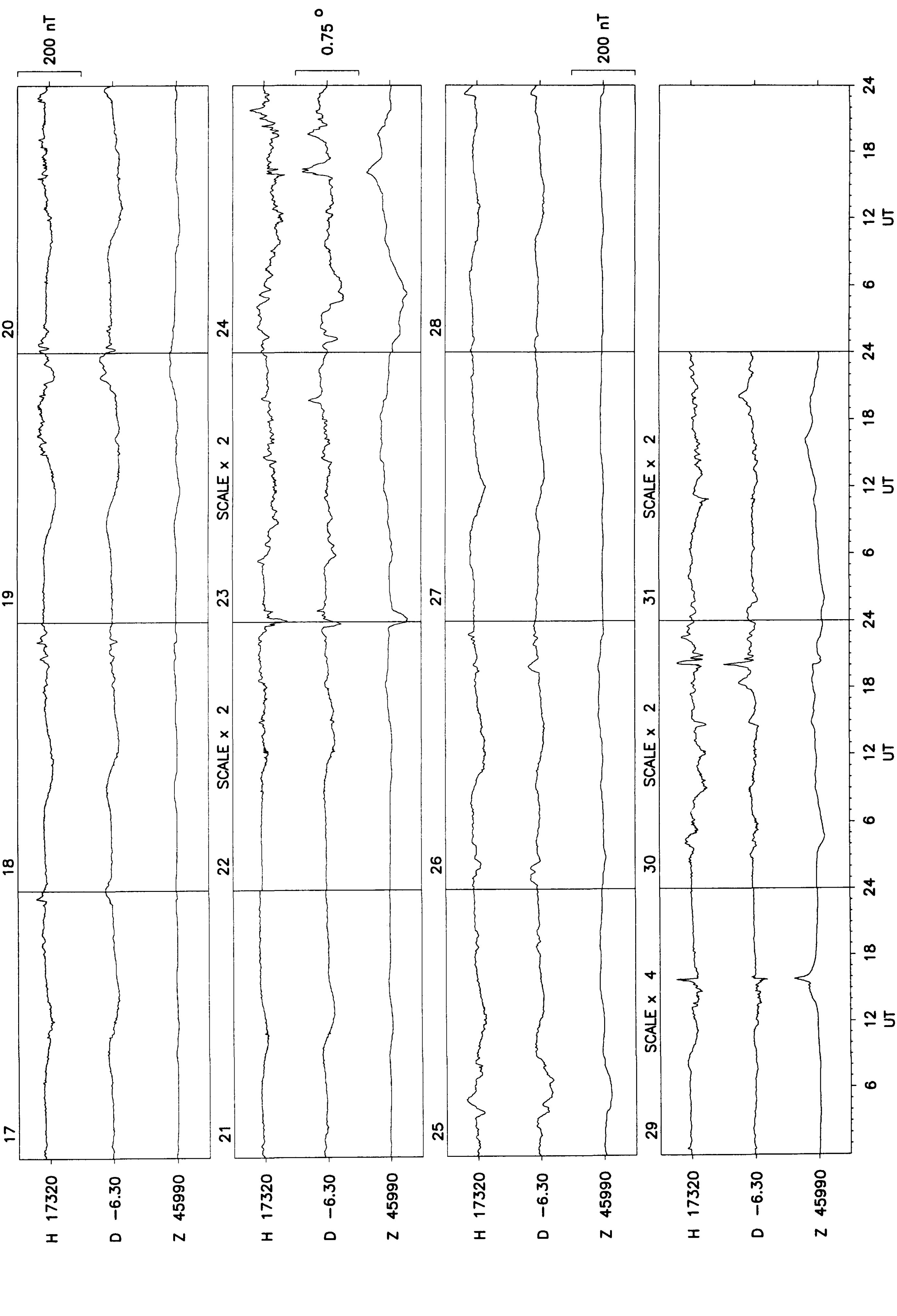
H 17320
D −6.30
Z 45990
UT



Eskdalemuir October 1994


200 nT
0.75 °
200 nT
H 17320
D −6.30
Z 45990
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31
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 2
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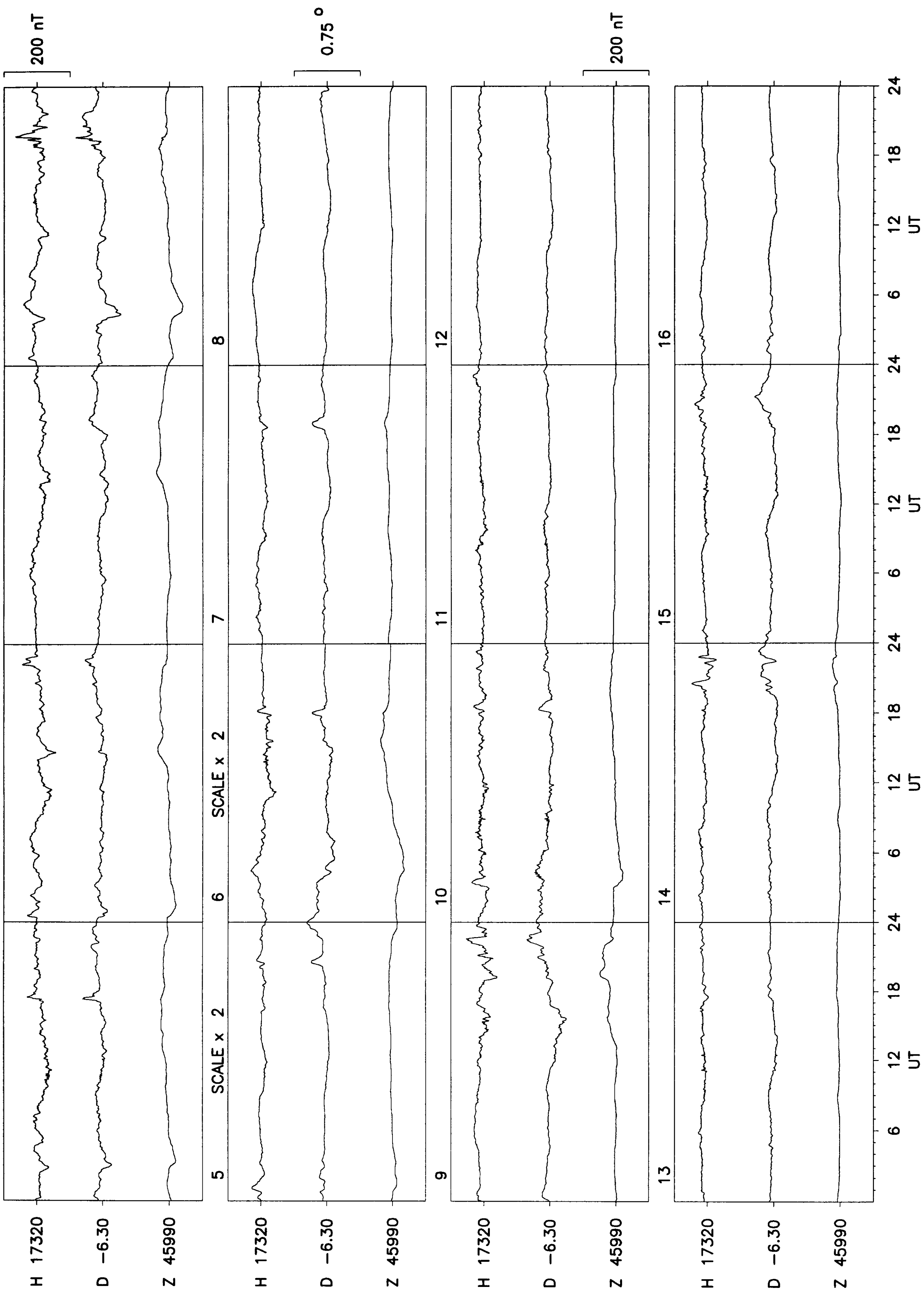
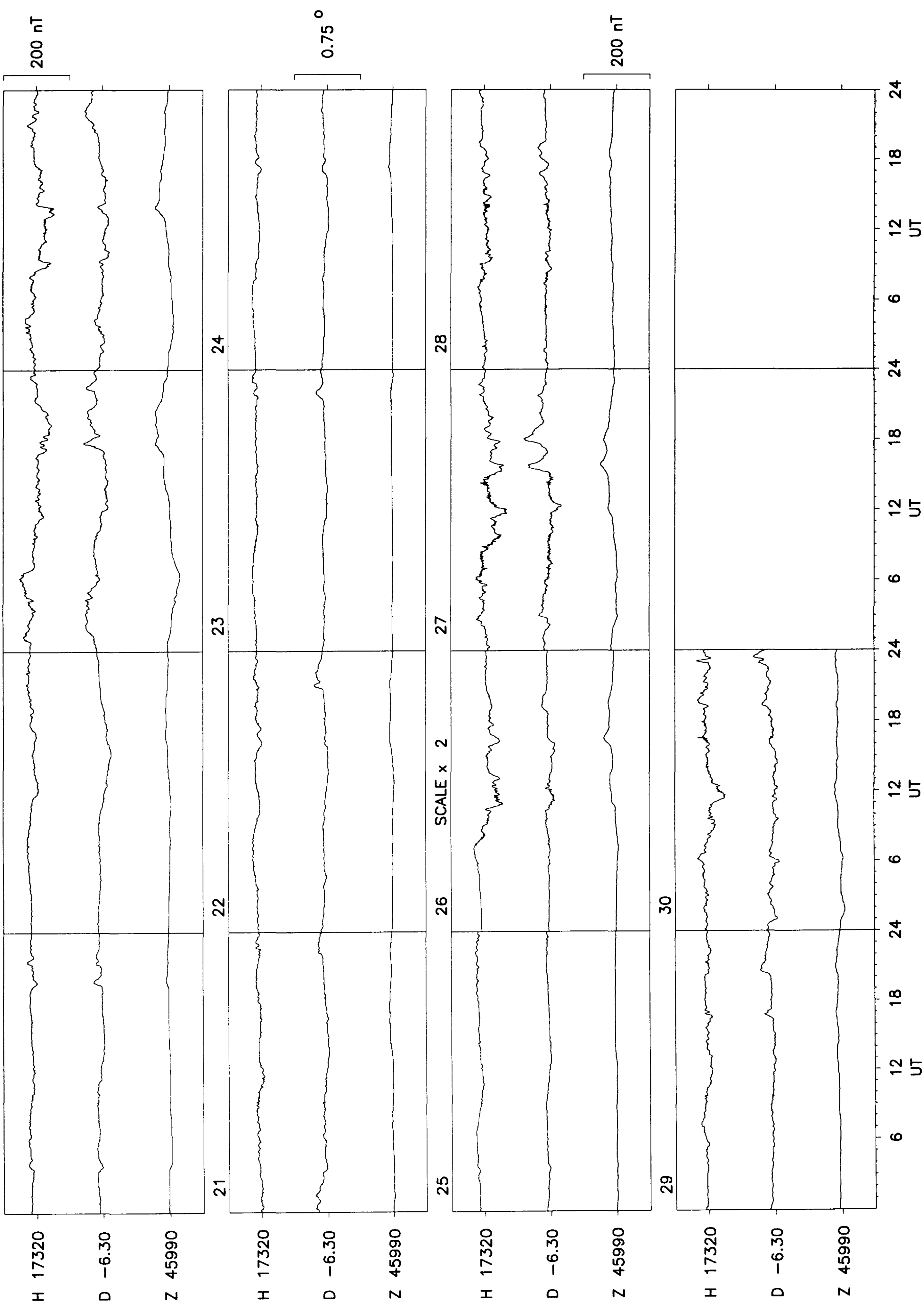


Eskdalemuir November 1994


200 nT
0.75 °
200 nT
17
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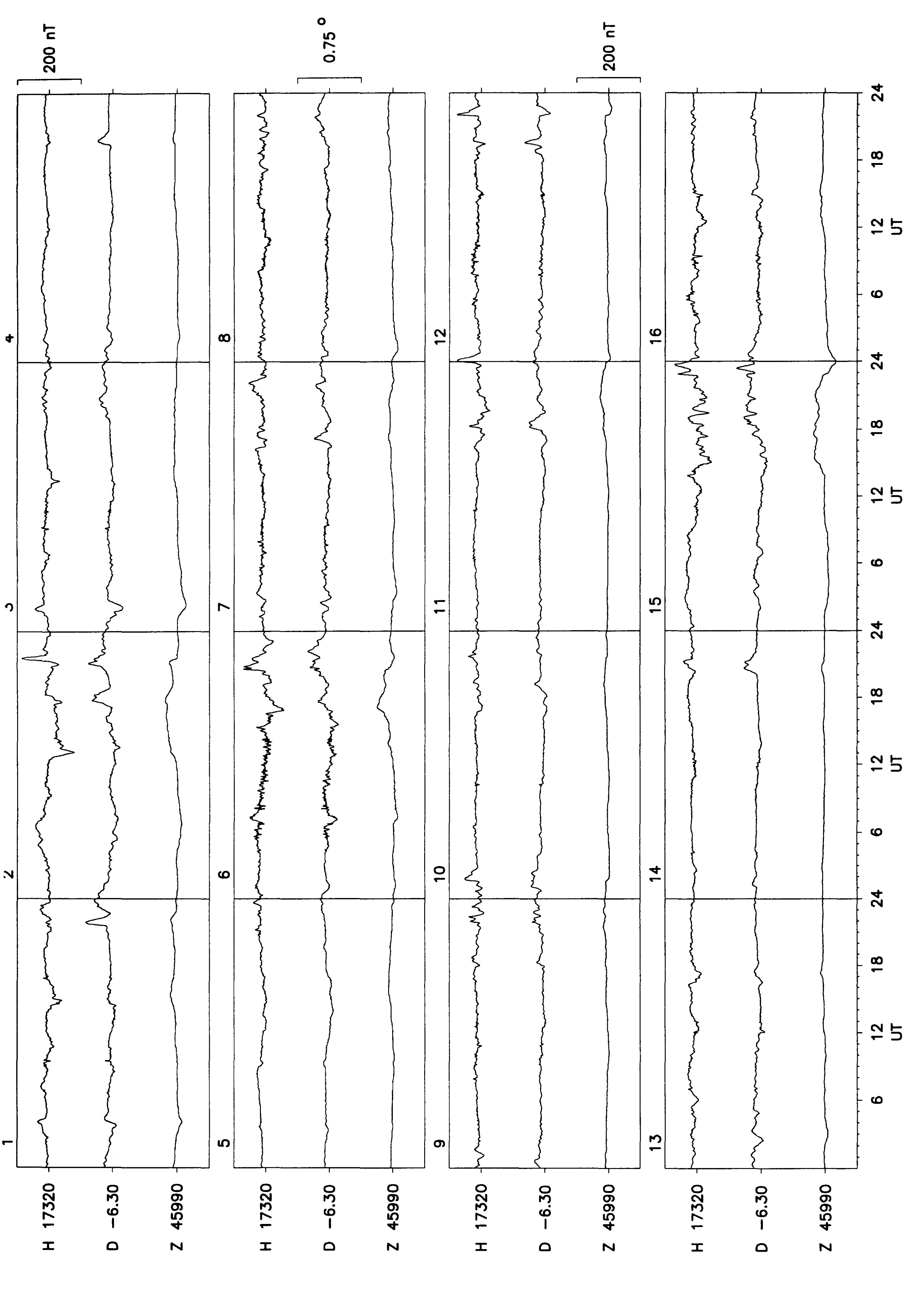
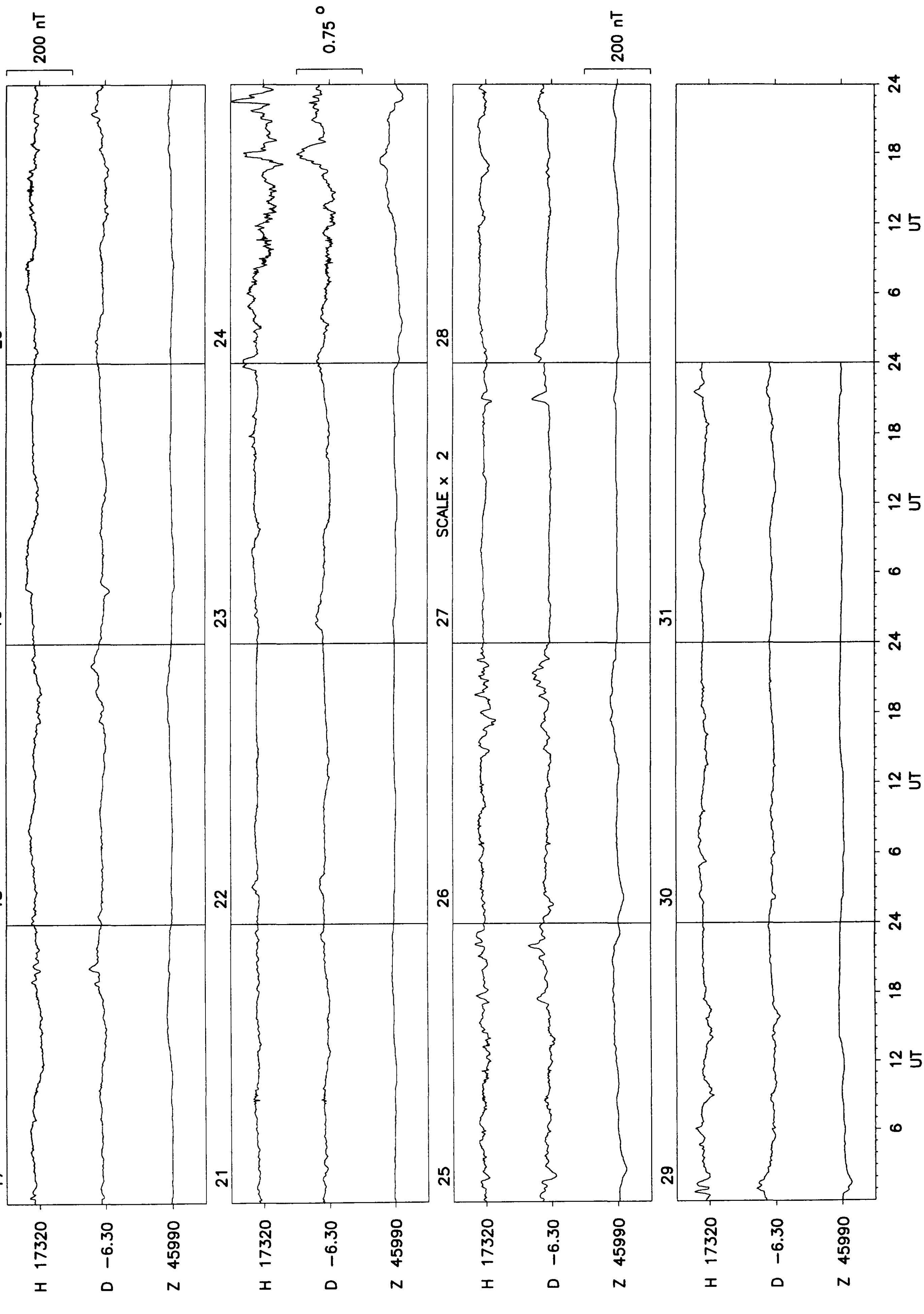
SCALE x 2
UT
H 17320
D −6.30
Z 45990



Eskdalemuir December 1994



200 nT
0.75 °
200 nT
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SCALE x 2
H 17320
D −6.30
Z 45990
H 17320
D −6.30
Z 45990
H 17320
D −6.30
Z 45990
H 17320
D −6.30
Z 45990
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12
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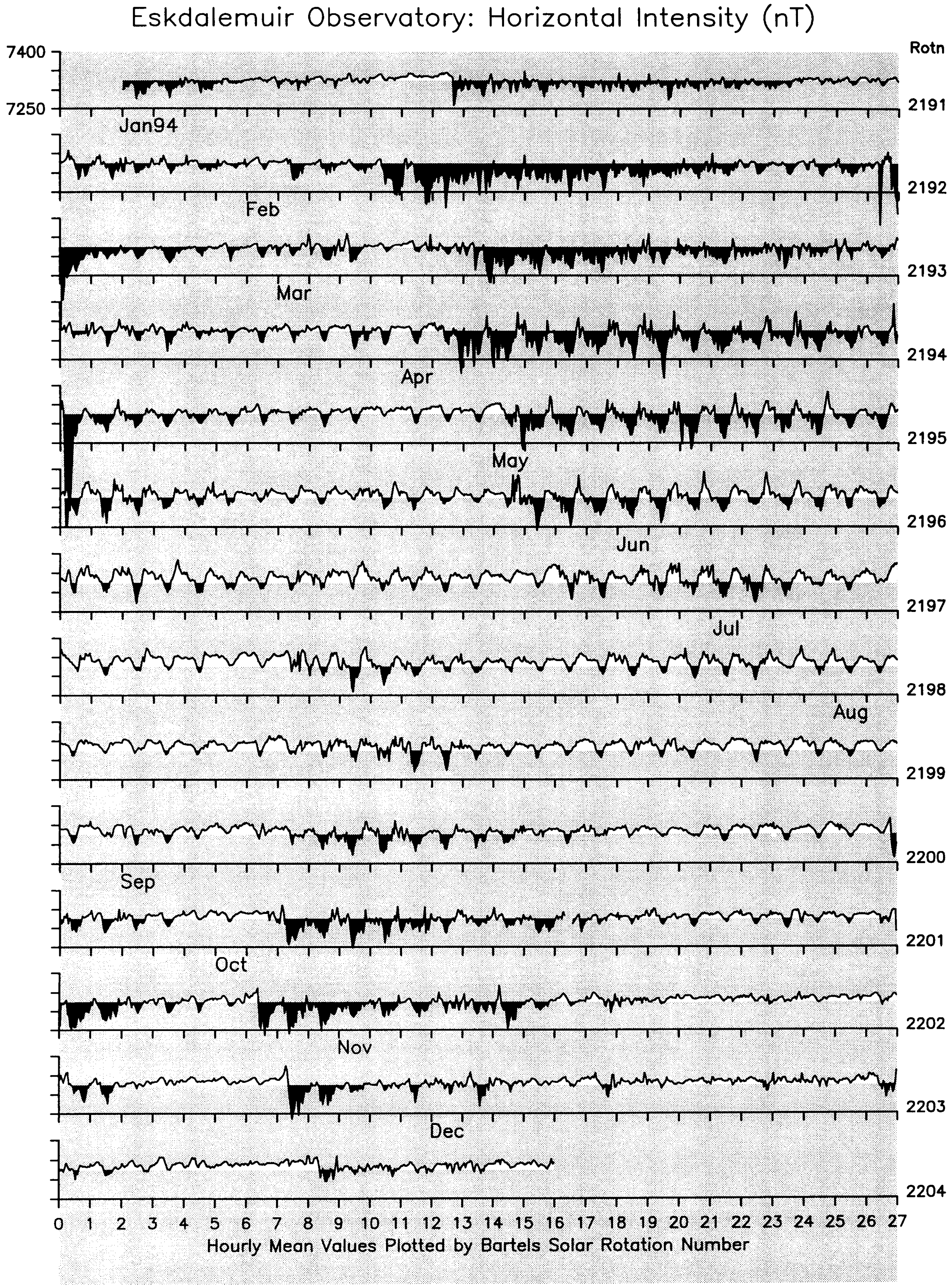
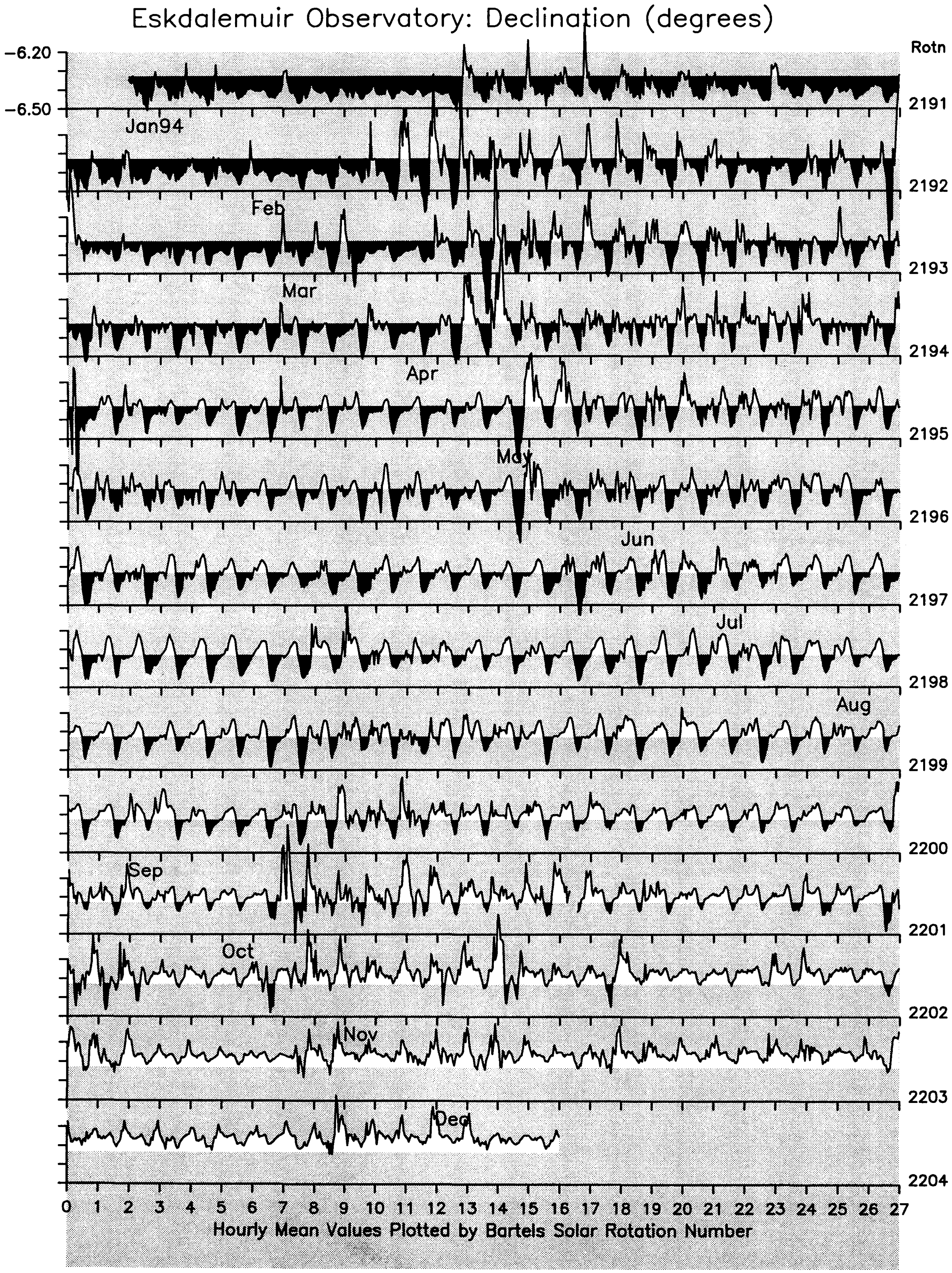
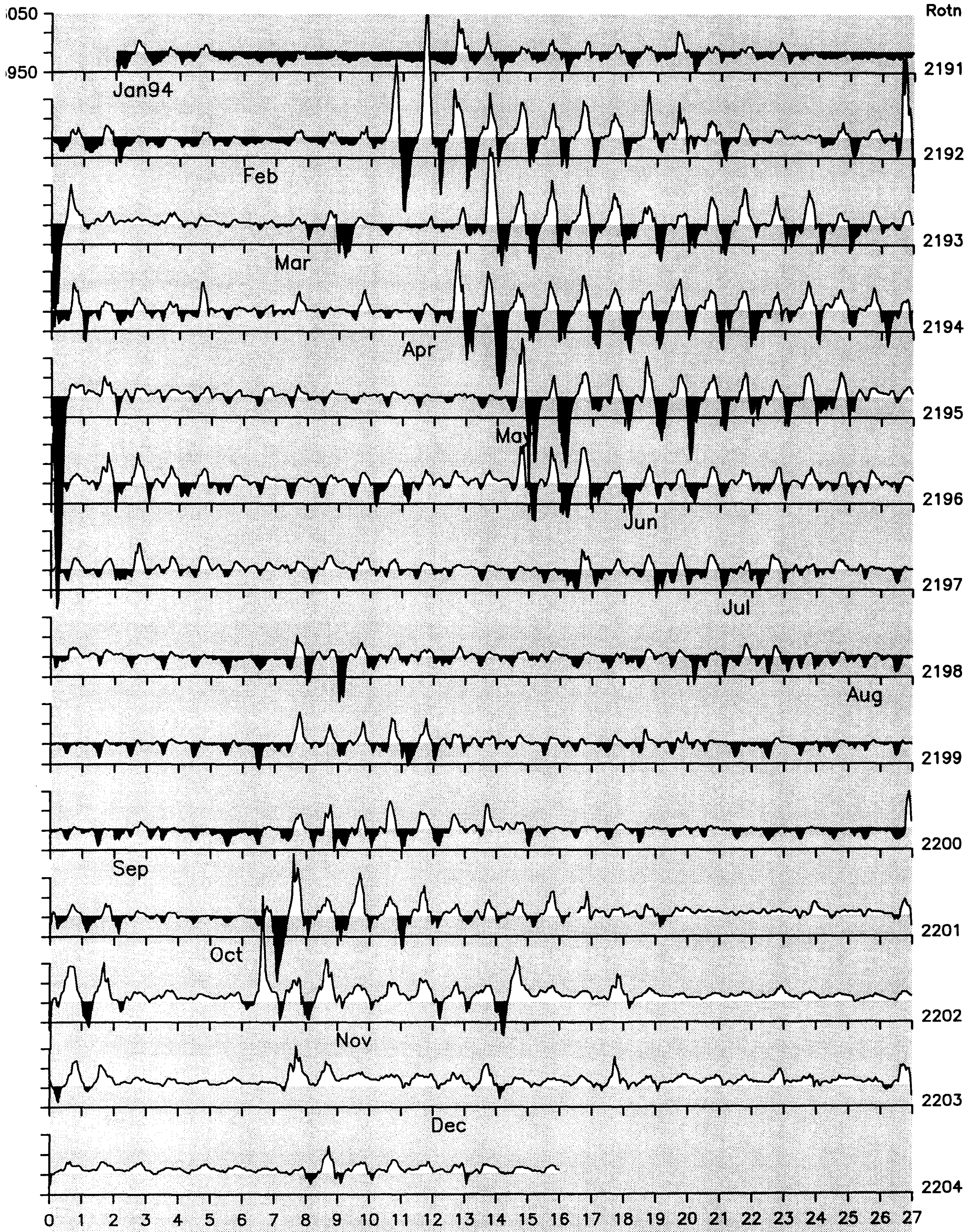
24
UT



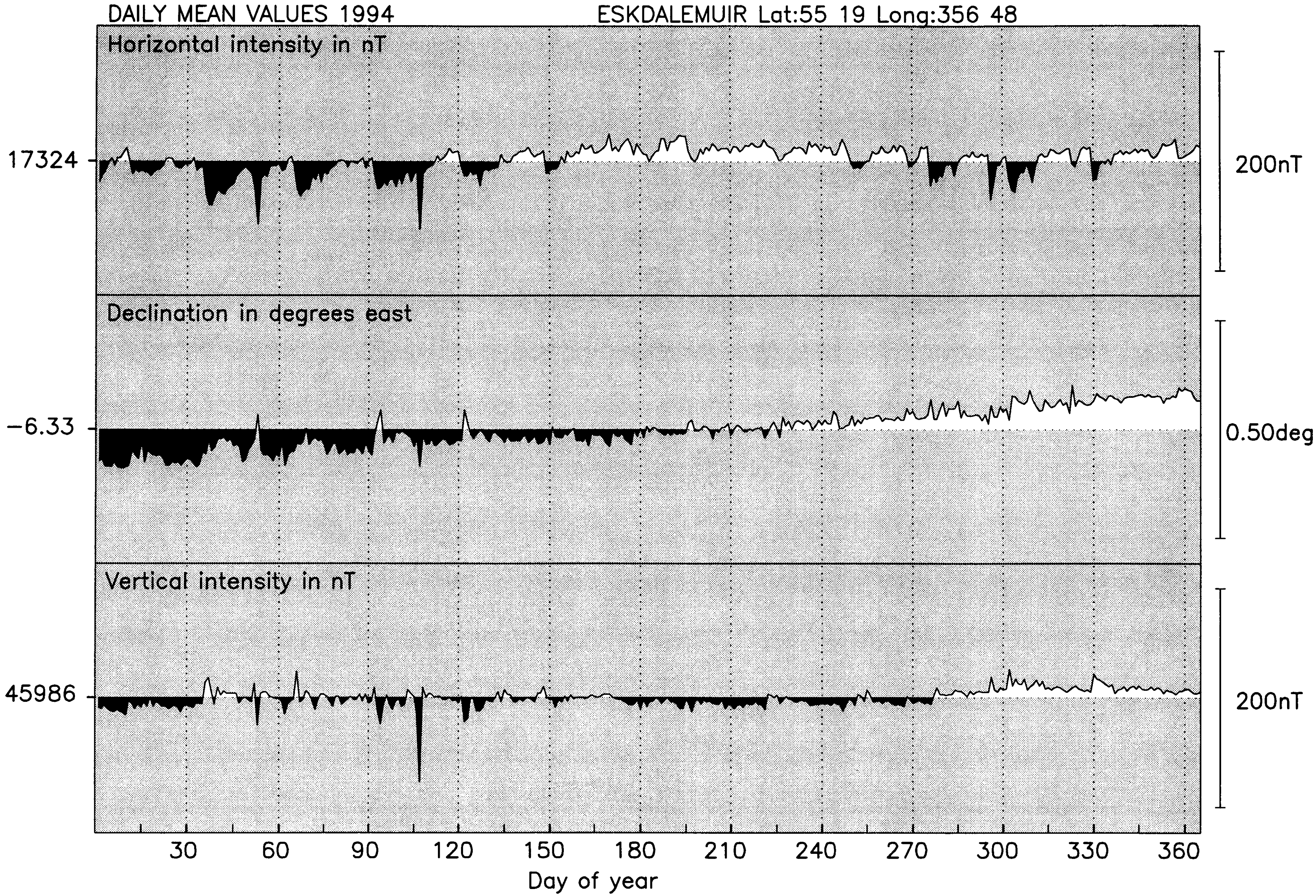
Eskdalemuir Observatory: Horizontal Intensity (nT)
7400
7250
Rotn
2191
Jan94
2192
Feb
2193
Mar
2194
Apr
2195
May
2196
Jun
2197
Jul
2198
Aug
2199
2200
Sep
2201
Oct
2202
Nov
2203
Dec
2204
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

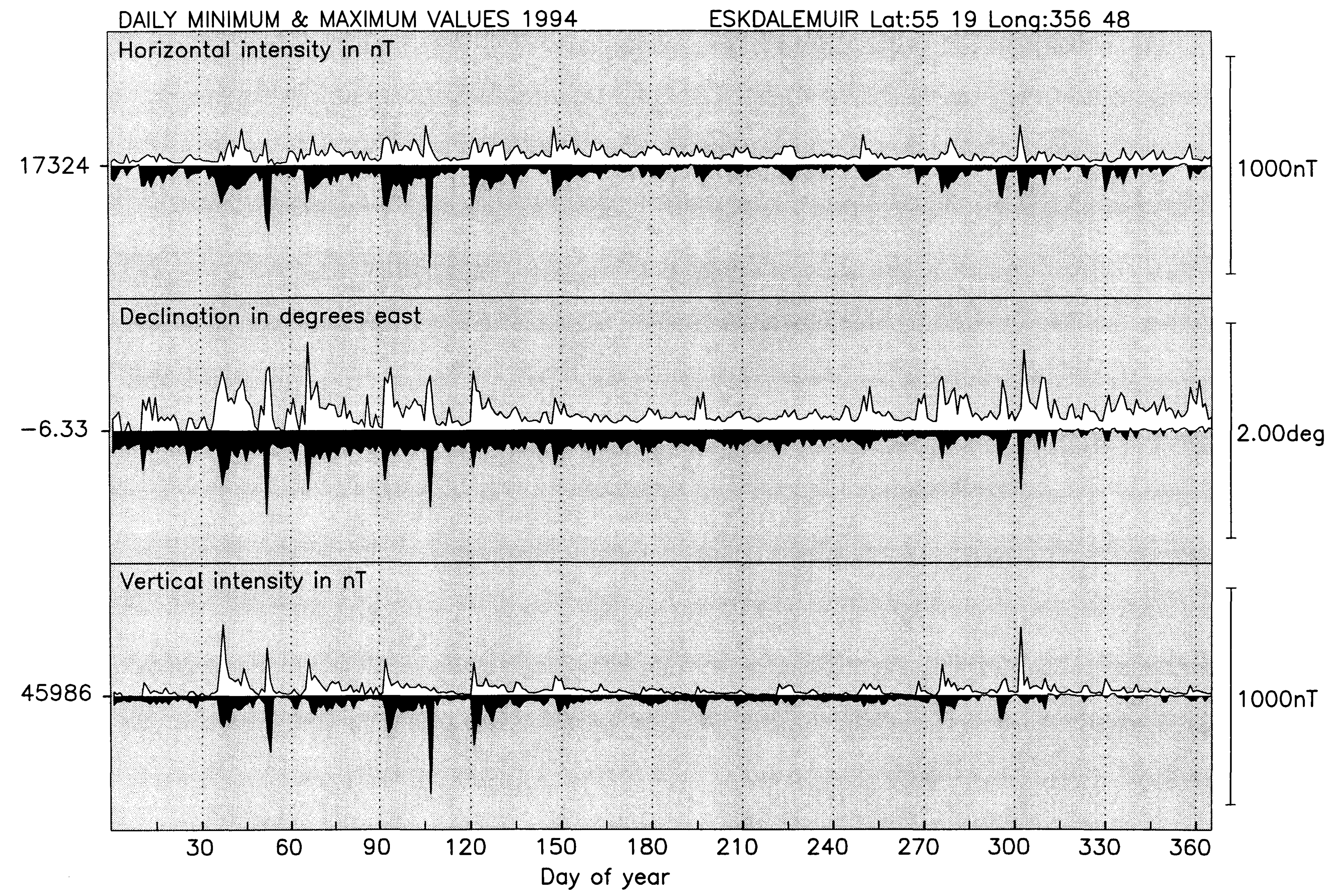

Eskdalemuir Observatory: Declination (degrees)
-6.20
-6.50
Rotn
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
Jan94
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

Eskdalemuir Observatory: Vertical Intensity (nT)



Hourly Mean Values Plotted by Bartels Solar Rotation Number


DAILY MEAN VALUES 1994
ESKDALEMUIR Lat:55 19 Long:356 48
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
17324
-6.33
45986
200nT
0.50deg
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year


DAILY MINIMUM & MAXIMUM VALUES 1994
ESKDALEMUIR Lat:55 19 Long:356 48
Horizontal intensity in nT
17324
1000nT
Declination in degrees east
-6.33
2.00deg
Vertical intensity in nT
45986
1000nT
30 60 90 120 150 180 210 240 270 300 330 360
Day of year

Monthly Mean Values for Eskdalemuir 1994

Month	D	H	I	X	Y	Z	F
Jan	-6 24.0	17320	69 21.5	17212	-1931	45978	49132
Feb	-6 22.4	17306	69 22.6	17199	-1921	45987	49136
Mar	-6 22.2	17316	69 21.9	17209	-1921	45985	49137
Apr	-6 21.1	17314	69 22.0	17208	-1915	45981	49133
May	-6 20.7	17322	69 21.5	17216	-1914	45984	49138
Jun	-6 20.7	17334	69 20.7	17228	-1916	45984	49143
Jul	-6 19.8	17336	69 20.5	17230	-1911	45981	49141
Aug	-6 19.3	17336	69 20.6	17231	-1909	45982	49141
Sep	-6 18.3	17330	69 21.0	17225	-1903	45983	49140
Oct	-6 17.3	17319	69 21.9	17215	-1897	45992	49145
Nov	-6 16.0	17325	69 21.7	17221	-1891	45997	49152
Dec	-6 15.2	17333	69 21.0	17230	-1888	45993	49151
Annual							
All days	-6 19.7	17324	69 21.4	17218	-1910	45986	49141
Q days	-6 20.2	17333	69 20.8	17227	-1913	45984	49142
D days	-6 19.2	17313	69 22.1	17208	-1906	45985	49136

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

Eskdalemuir Observatory K Indices 1994

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3333 3443	3011 1100	4232 1224	0111 2222	0222 4566	3343 3344	4333 3434	3311 1221	4301 2132	1111 1001	3322 2422	2322 3314
2	3233 4343	0233 3220	4212 2245	3233 4465	5432 4455	4233 3444	3443 3533	1100 1211	2201 1101	0001 2345	3222 3323	3222 4445
3	2223 3341	0111 3333	4443 2122	5554 5566	5543 4543	3333 4453	2222 2223	1101 1221	2211 2112	5554 5554	1221 3243	4222 3022
4	1210 1020	2111 2453	0012 1000	6534 4454	3332 4444	3233 3334	1212 3332	1000 2200	2001 2211	3333 4443	2423 2343	2111 1031
5	0000 1012	3234 2455	1002 1024	4333 5435	3433 4544	2223 4444	1110 1212	1211 1121	1223 3212	3334 3453	4212 3245	0111 1112
6	3121 2314	5334 5655	2311 1233	3344 4555	4433 3345	3223 3443	2111 2224	1111 1102	1314 2323	3334 4345	4544 3551	3243 3444
7	0000 2022	4544 5554	5334 5566	3444 4544	5344 4333	3223 3333	3423 3332	0111 2212	1334 4465	4343 3555	2211 1131	3322 2423
8	1121 2112	5444 5555	4444 4445	4443 4445	3334 4454	3222 3322	1110 2210	1000 0111	3333 3444	3323 1343	1001 1113	2222 2233
9	0000 1110	3233 4555	3454 4566	5445 4454	3433 4542	1222 2311	1100 3421	0110 1232	3342 4454	3221 2242	2111 3434	2112 2223
10	0000 1000	5433 4454	4333 4455	4333 4455	4343 4553	1222 3543	0111 1220	3122 3332	4333 3332	3221 2244	3332 2232	3212 1233
11	0122 2564	4424 4565	3444 4444	4444 3444	4433 4533	2233 2333	1100 3311	3423 3433	3332 3232	2322 3342	1122 1112	1111 1343
12	4333 4534	3333 4454	4343 4444	4333 3355	3321 1202	3334 4433	1100 1200	3322 3343	2113 2333	233* 1243	1100 0111	4222 2244
13	4323 4435	4323 3564	4423 3324	3333 4544	2221 1112	2212 3443	0120 1221	3433 4443	1321 2324	2212 2223	1112 1221	3331 2311
14	3323 5444	4333 3545	4433 4454	4223 3443	2432 4333	3223 4423	1113 5534	4343 3434	3211 3110	3102 2423	2121 1133	2101 1133
15	3222 2354	3232 3455	4433 4554	3313 2433	2344 4443	2111 2211	4222 3335	4221 3334	1110 2223	3322 2122	2111 2133	2221 4344
16	2333 3333	5433 3333	3332 3543	3422 3365	4323 4543	2000 2211	5324 3434	2212 1233	2322 2211	1122 1111	2100 1200	3323 3212
17	4432 3344	2221 2232	3444 3443	5765 4333	4333 3332	1211 3411	3223 3322	1221 2211	2111 2312	1011 2013	1211 1032	2121 1131
18	2223 4443	1112 1103	3432 3314	3233 3343	4322 4424	3421 2322	3322 3222	1111 2312	2111 2202	1001 1123	0001 2221	2010 1223
19	3332 3244	4333 4244	4333 2223	4222 2233	3333 3211	2233 3333	3222 2124	2110 1220	3100 1222	0000 2223	3332 2433	1311 1101
20	3231 3342	4322 2232	3212 2343	2222 2212	1211 2211	3322 4333	1010 2211	1221 2232	1111 1112	3011 2323	2333 3223	2121 2223
21	2101 1242	2337 6666	2333 3443	2211 1123	0002 3321	2222 2222	2222 3222	3100 3311	2111 2123	1001 0000	2211 1012	2121 1111
22	4200 1122	6533 4222	4323 4223	2112 3123	1101 2232	3211 3222	3111 2110	3102 3324	3110 0122	0023 3335	0100 1232	2200 1000
23	2111 1212	3322 2233	3332 3333	0013 3234	1103 3323	0100 1111	0211 2322	2211 1211	1200 0112	5443 4354	0001 0102	3111 1213
24	2001 1000	1111 1110	3324 3223	1111 2311	3423 3432	1101 2110	1112 2223	0100 1323	3200 1101	3432 3544	0110 0211	3333 3545
25	1210 0013	2233 2231	4212 3443	3222 1222	4323 2324	0020 2211	3312 4322	2222 3320	1010 2354	2331 1120	0100 0011	3222 2323
26	3343 4343	3211 2200	3213 1221	1011 2211	1222 3223	3334 4443	1100 2111	0111 1223	3332 3322	3101 1132	1245 4432	3222 2333
27	3332 2334	0112 3200	1111 2135	1211 2111	2100 1311	4332 3222	2421 1233	3222 2232	3322 2324	0100 1001	3233 4443	1211 2154
28	4223 3223	1022 2024	1212 3323	2000 2100	0001 4754	2112 2345	3333 3334	2311 1120	3323 1212	1001 1013	2123 2331	3101 2212
29	1222 3222		1111 1112	0211 1113	4434 5433	3443 4444	3222 2323	1011 1212	2110 1113	3234 5632	1111 1333	3233 2200
30	3111 2432		1112 4443	0100 1110	4444 5555	3333 4434	3212 2223	0000 2212	0000 1112	2454 4464	3333 3333	2212 1110
31	3111 1213		2112 2110		3333 4344		2112 2224	1001 2313		4324 3343		0110 1023

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	1	11	48	SSC*	B	-10	3.6	4
25	1	21	52	SSC	C	15	3.2	
21	2	09	01	SSC*	A	-212	6.4	19
22	3	11	51	SSC	C	33	-3.6	
2	4	11	45	SSC	B	20	-1.6	-3
16	4	11	51	SSC*	B	25	-3.0	-2
28	5	13	56	SSC*	A	50	-4.1	-3
14	7	10	24	SSC*	B	13	-1.3	-2
27	7	17	57	SI	B	22	-1.5	-2
6	8	21	50	SSC*	C	6	-1.2	
10	8	12	36	SSC*	B	15	-0.5	
24	8	17	51	SSC*	A	-38	2.4	3
25	8	09	00	SI*	B	+9/-12	-2.2	+3/-3
29	8	06	59	SSC*	C	6	-2.1	
29	8	22	33	SSC*	B	20	3.5	-3
18	9	12	10	SSC*	C	15	-1.5	
19	10	14	52	SSC*	B	22	-1.6	
22	10	08	50	SSC*	B	17	-1.2	-2
29	10	00	26	SSC	B	48	-4.6	-7
26	11	07	24	SSC*	B	-14/+9	2.9	
5	12	21	05	SSC*	C	15	0.6	-2
10	12	10	08	SI*	B	-15	2.1	2

Notes

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

The quality of the event is classified as follows :

A = very distinct
B = fair, ordinary, but unmistakable
C = doubtful

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

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
4	3	11	26	11	33	11	44	22	-3.4	

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

Annual Values of Geomagnetic Elements

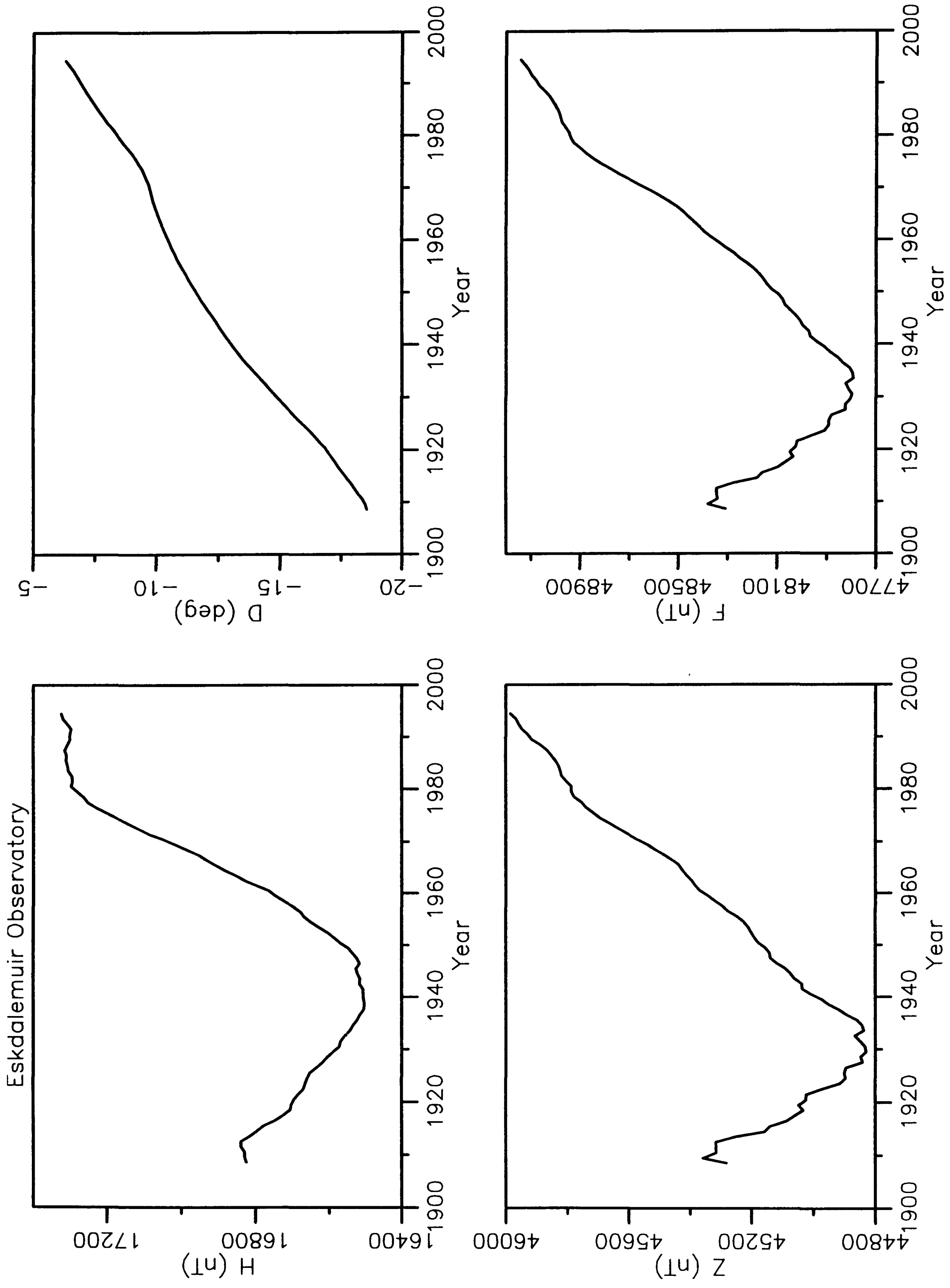
Eskdalemuir

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

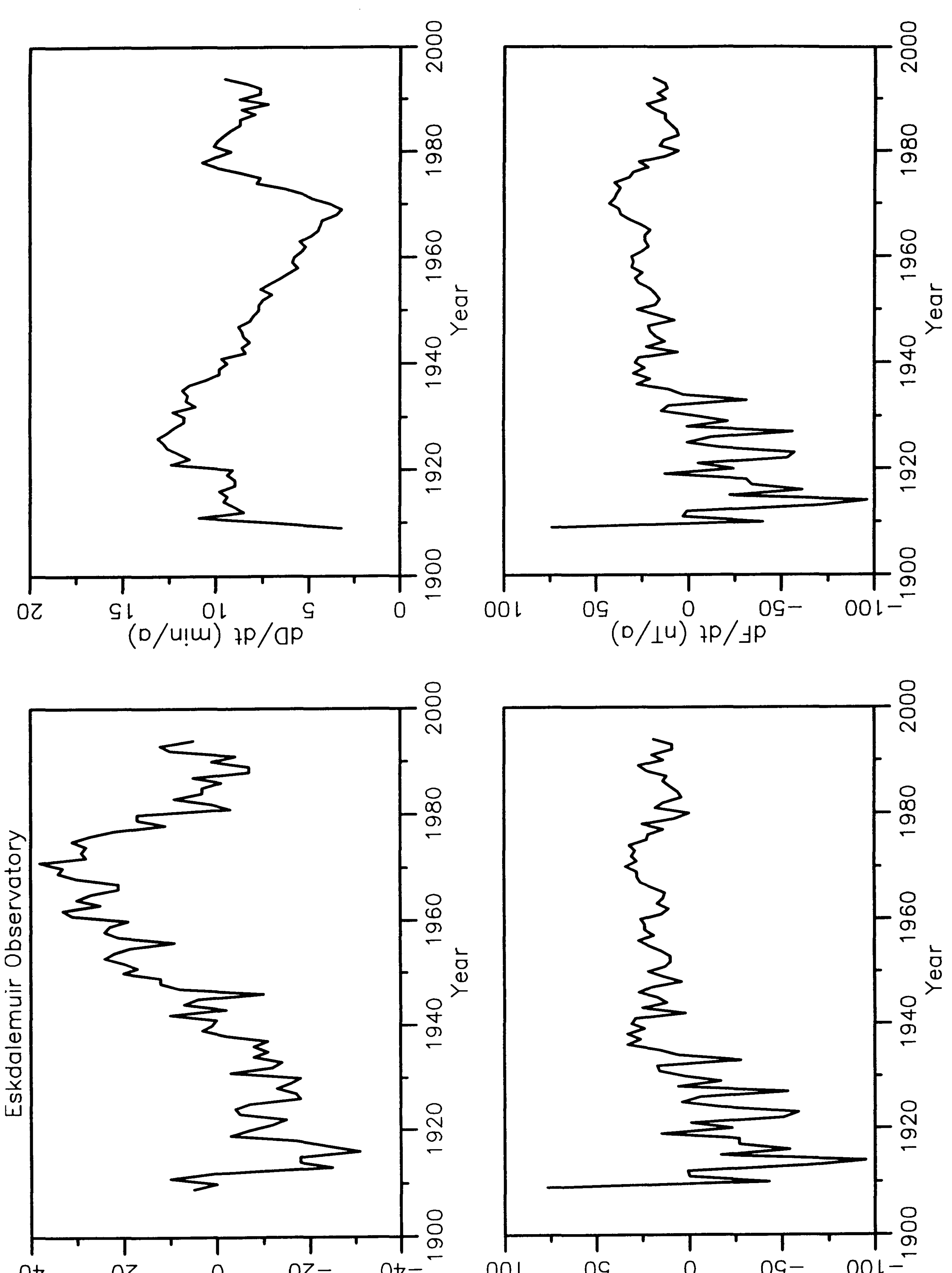
	Year	D	H	I	X	Y	Z	F
	1970.5	-9 41.6	17046	69 29.6	16803	-2870	45576	48659
	1971.5	-9 36.8	17084	69 27.8	16844	-2853	45604	48699
	1972.5	-9 31.5	17112	69 26.7	16876	-2832	45635	48738
	1973.5	-9 25.2	17141	69 25.5	16910	-2805	45664	48775
	1974.5	-9 17.4	17169	69 24.5	16944	-2772	45696	48815
	1975.5	-9 9.8	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 1.4*	*17297*	*69 21.5*	*17167*	*-2115*	*45916*	*49066*
	1989.5	-7 0.2	17297	69 21.5	17168	-2109	45916	49066
Note 1		0 0.0	11	0 -0.2	11	-1	22	25
	1990.5	-6 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

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

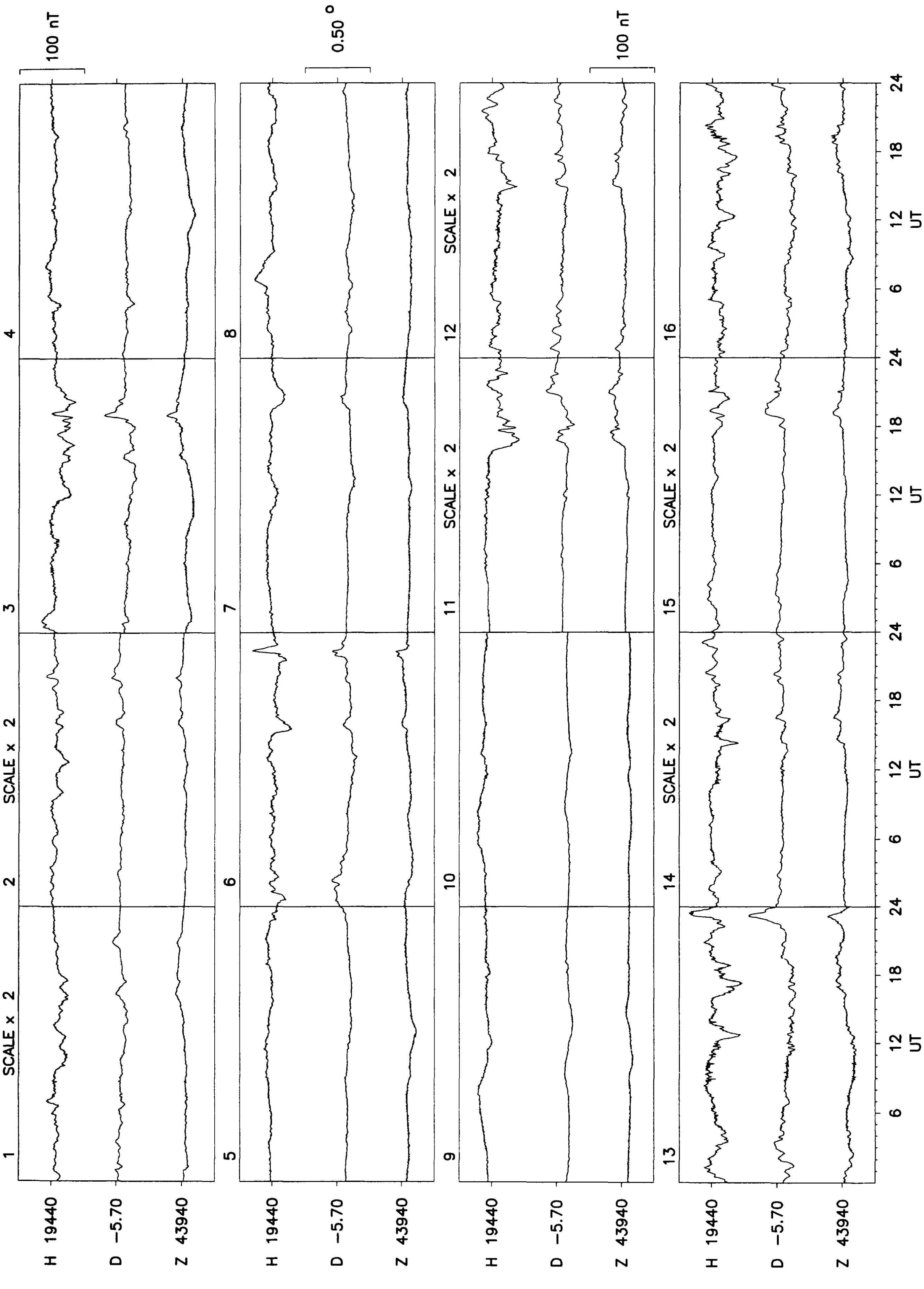


Annual mean values of H, D, Z & F at Eskdalemuir

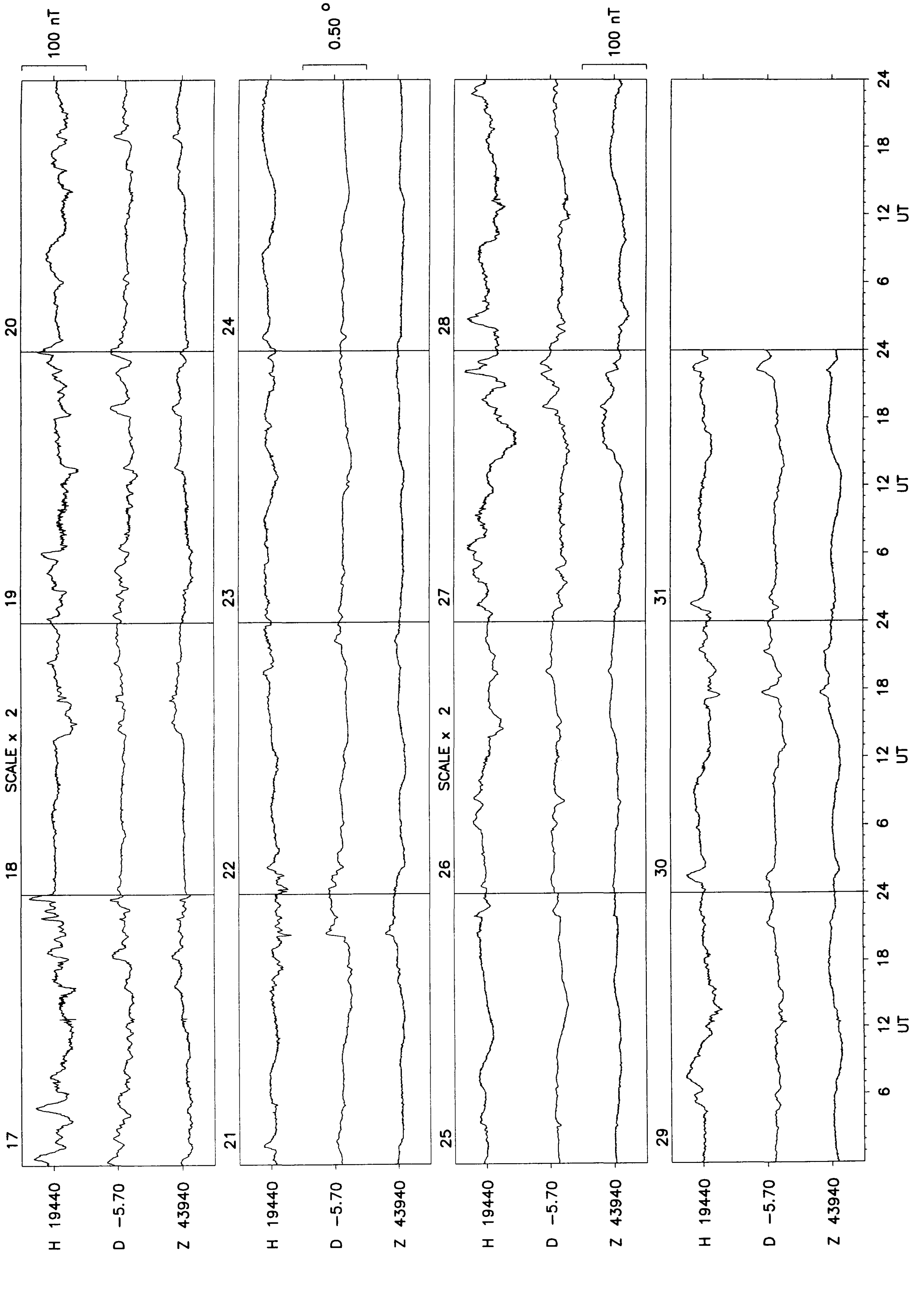


Rate of change of annual mean values of H, D, Z & F at Eskdalemuir

Hartland 1994



Hartland January 1994


100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 2
17
18
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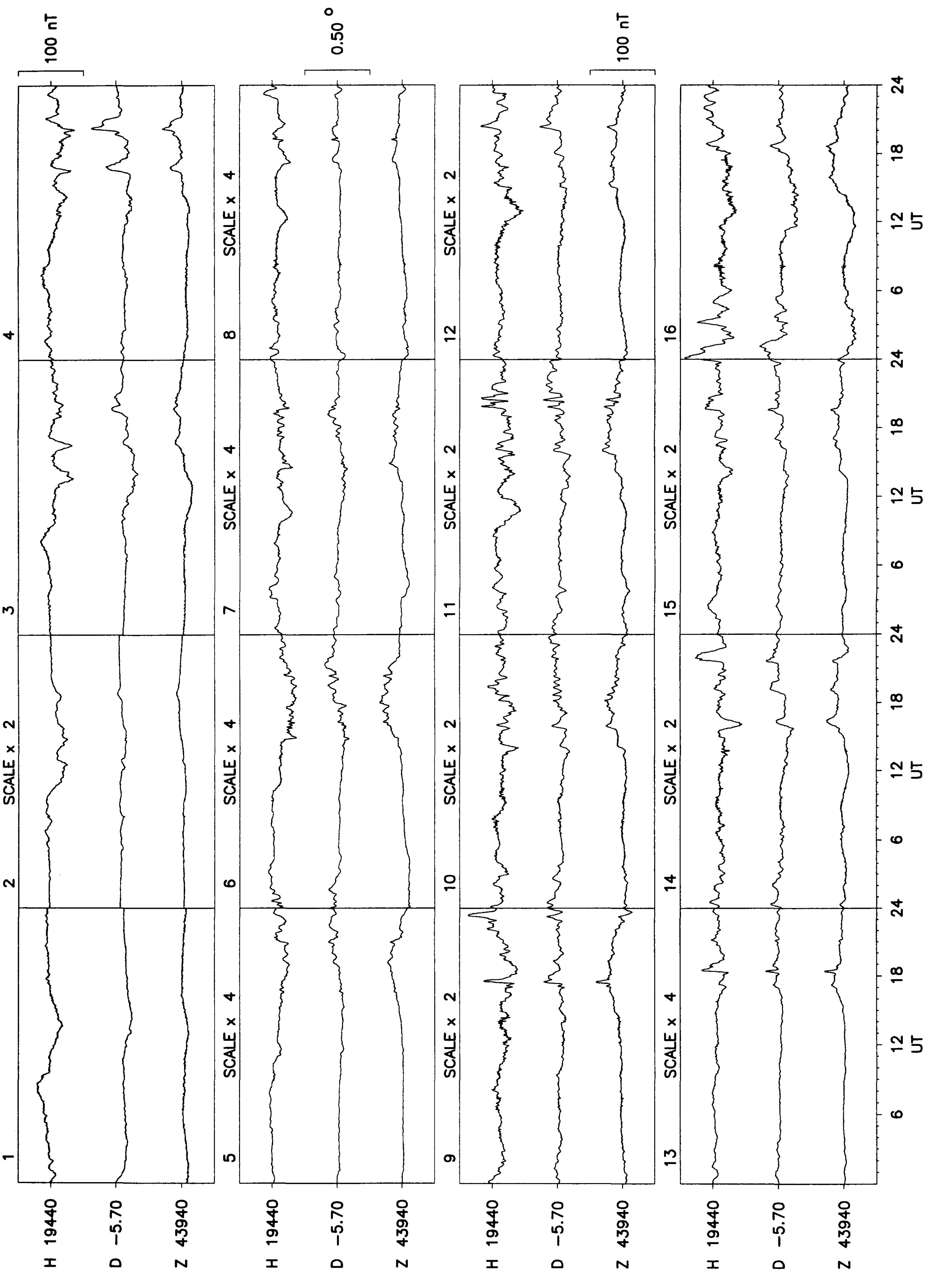
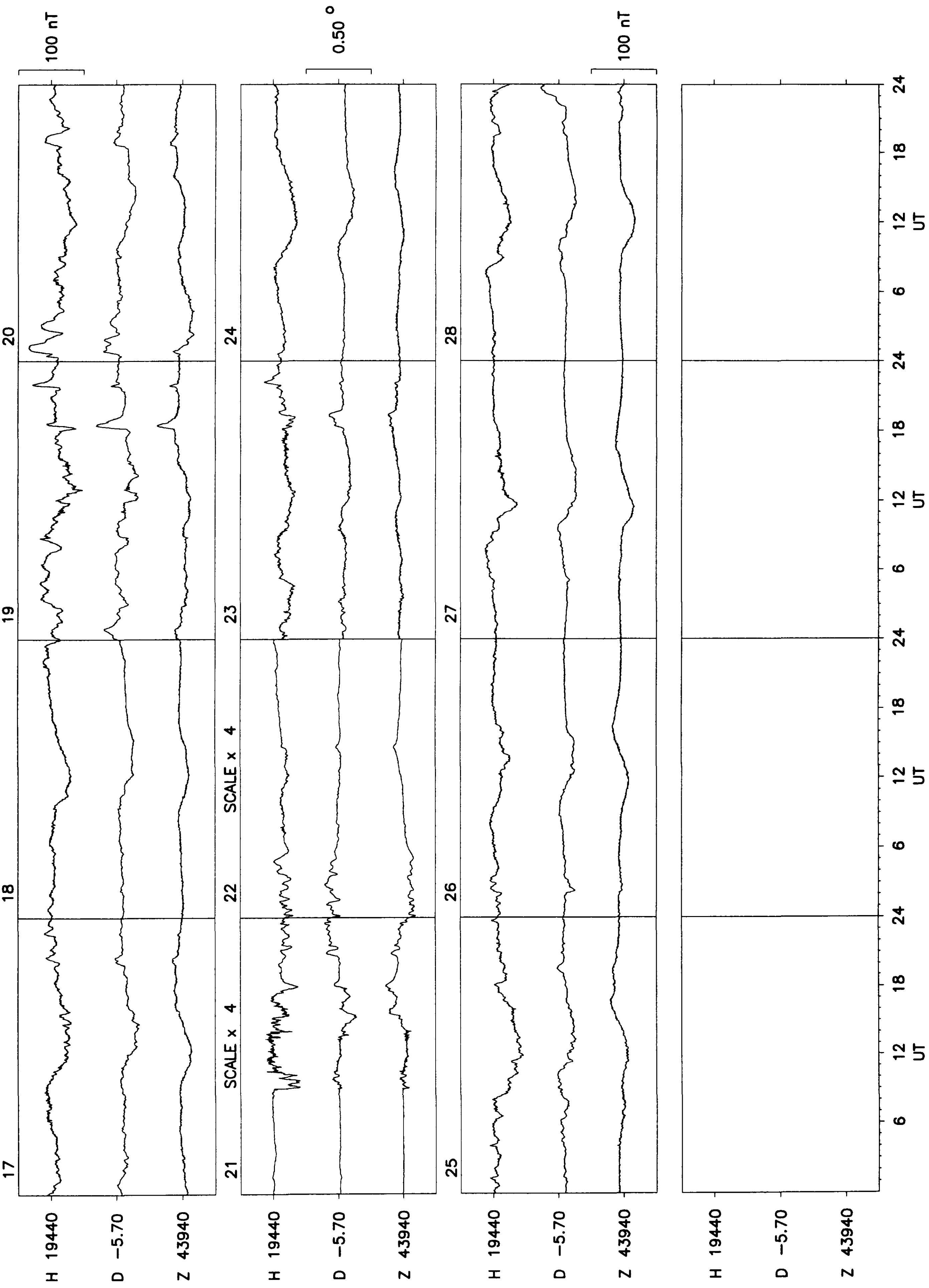
26
27
28
29
30
31
H 19440
D −5.70
Z 43940
6
12
18
24
UT



Hartland February 1994



100 nT
0.50 °
100 nT
17
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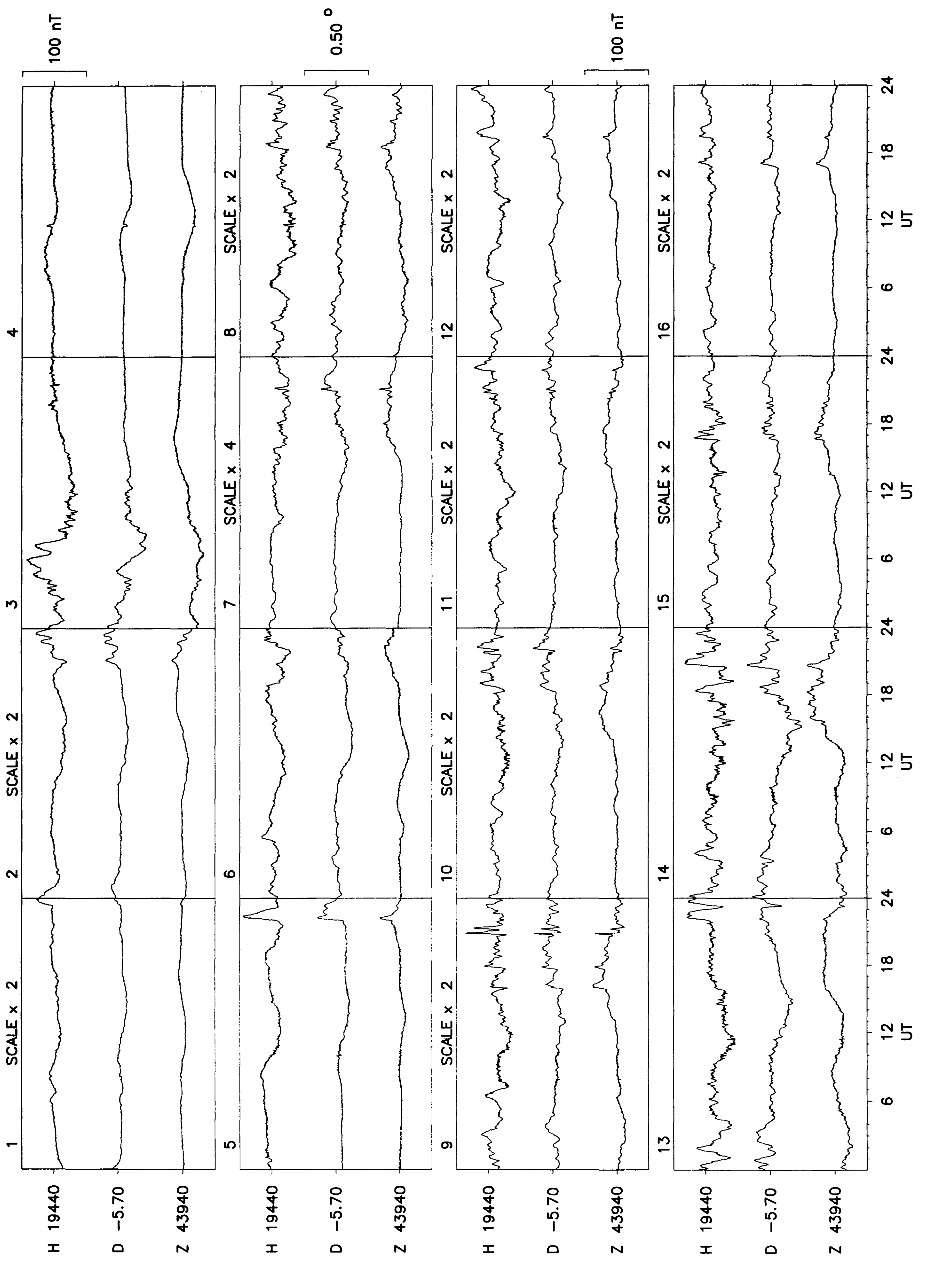
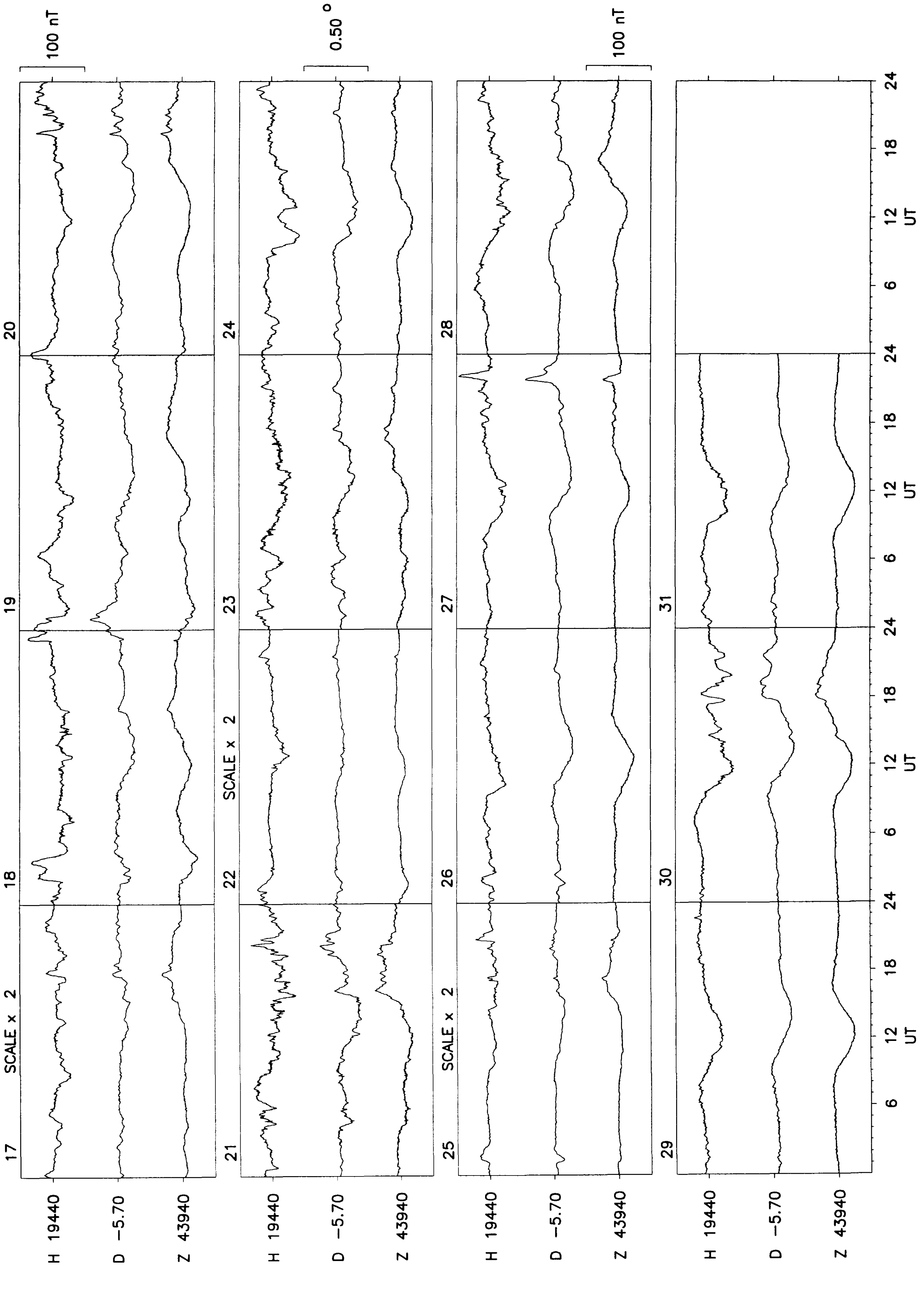
23
24
25
26
27
28
SCALE x 4
SCALE x 4
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
6
12
18
24
UT



Hartland March 1994


100 nT
0.50 °
100 nT
17
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22
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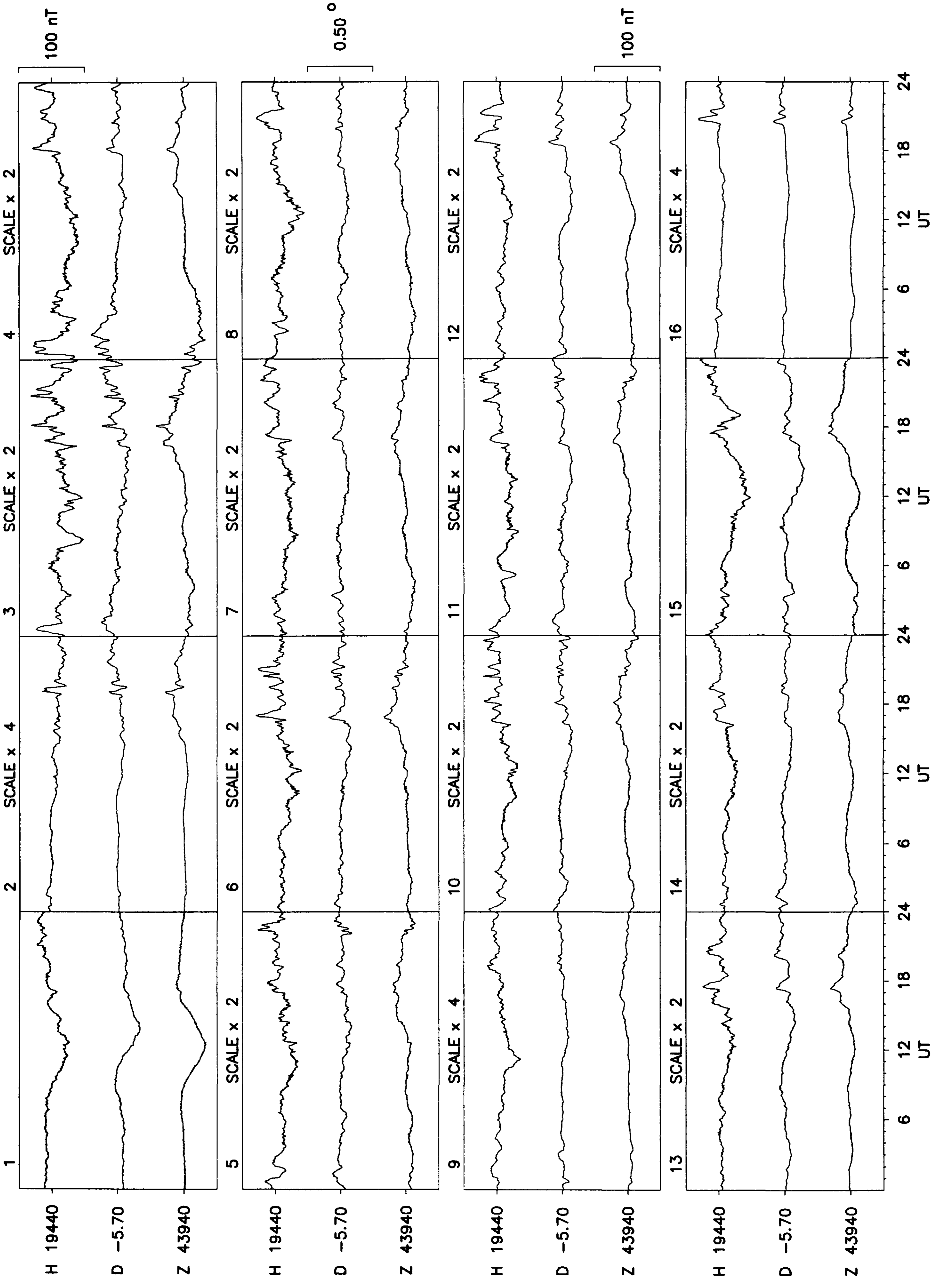
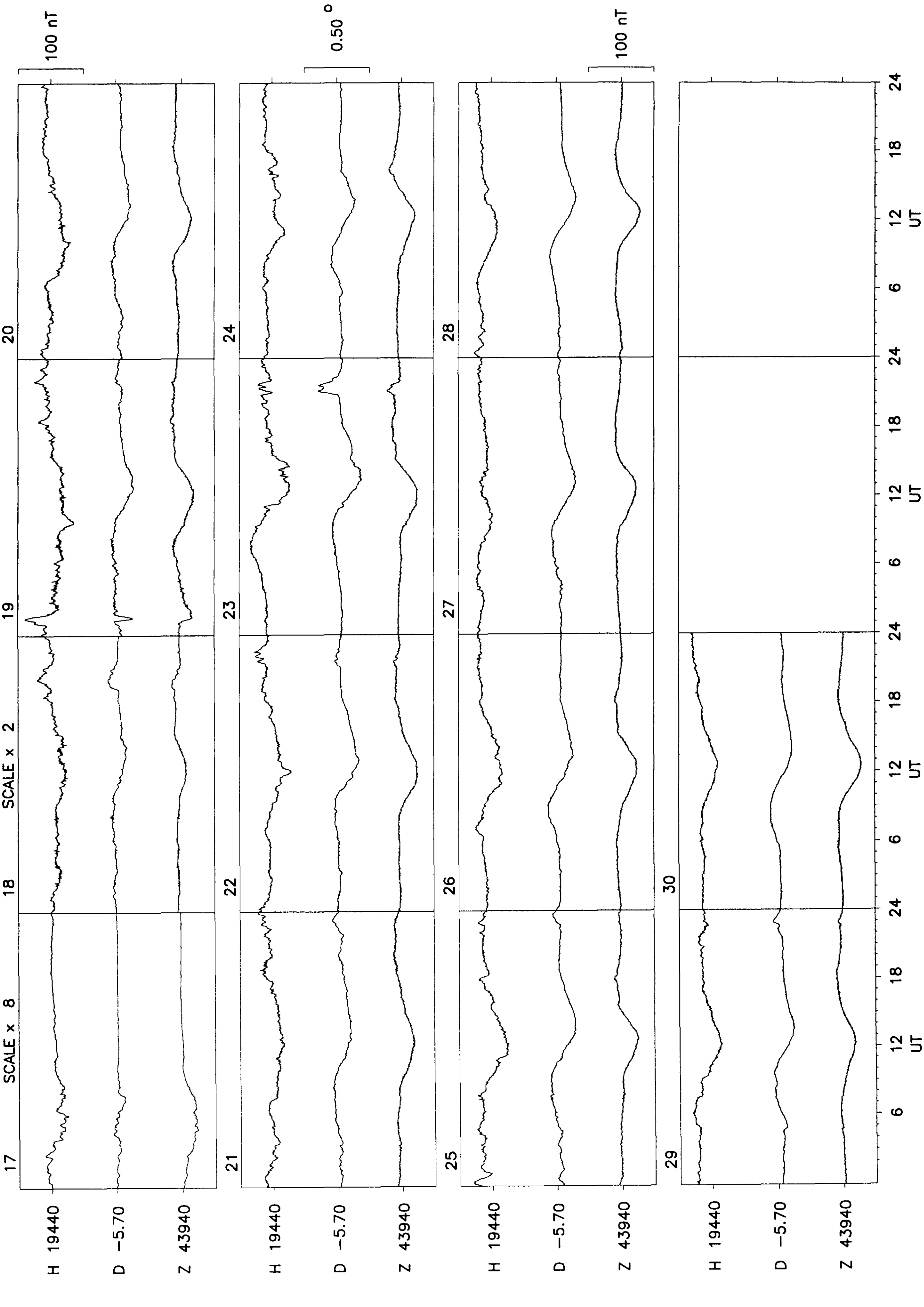
24
25
26
27
28
29
30
31
SCALE x 2
SCALE x 2
SCALE x 2
H 19440
D -5.70
Z 43940
H 19440
D -5.70
Z 43940
H 19440
D -5.70
Z 43940
H 19440
D -5.70
Z 43940
6
12
18
24
UT



Hartland April 1994



SCALE x 8
SCALE x 2
100 nT
0.50 °
100 nT
H 19440
D −5.70
Z 43940
17
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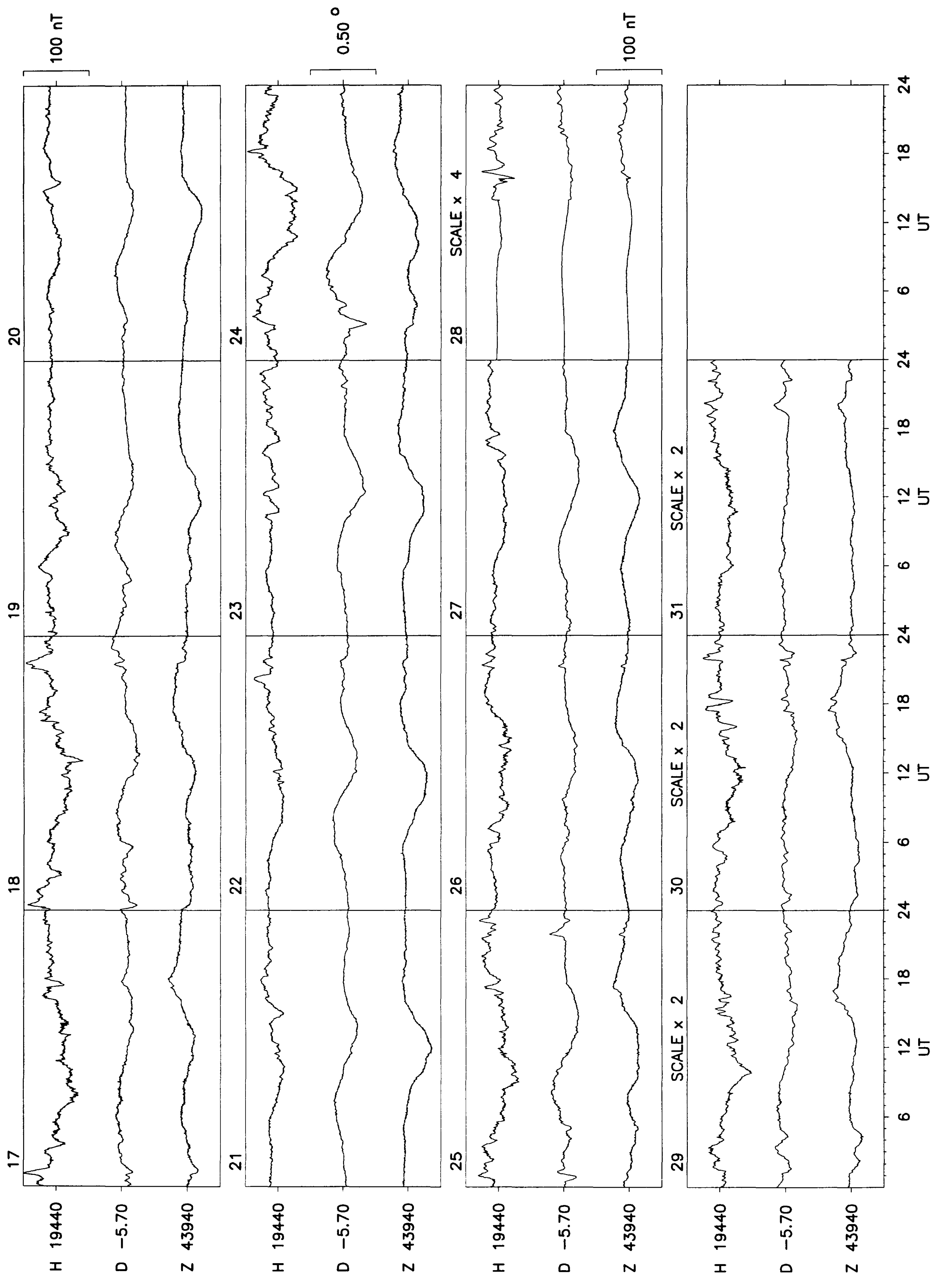
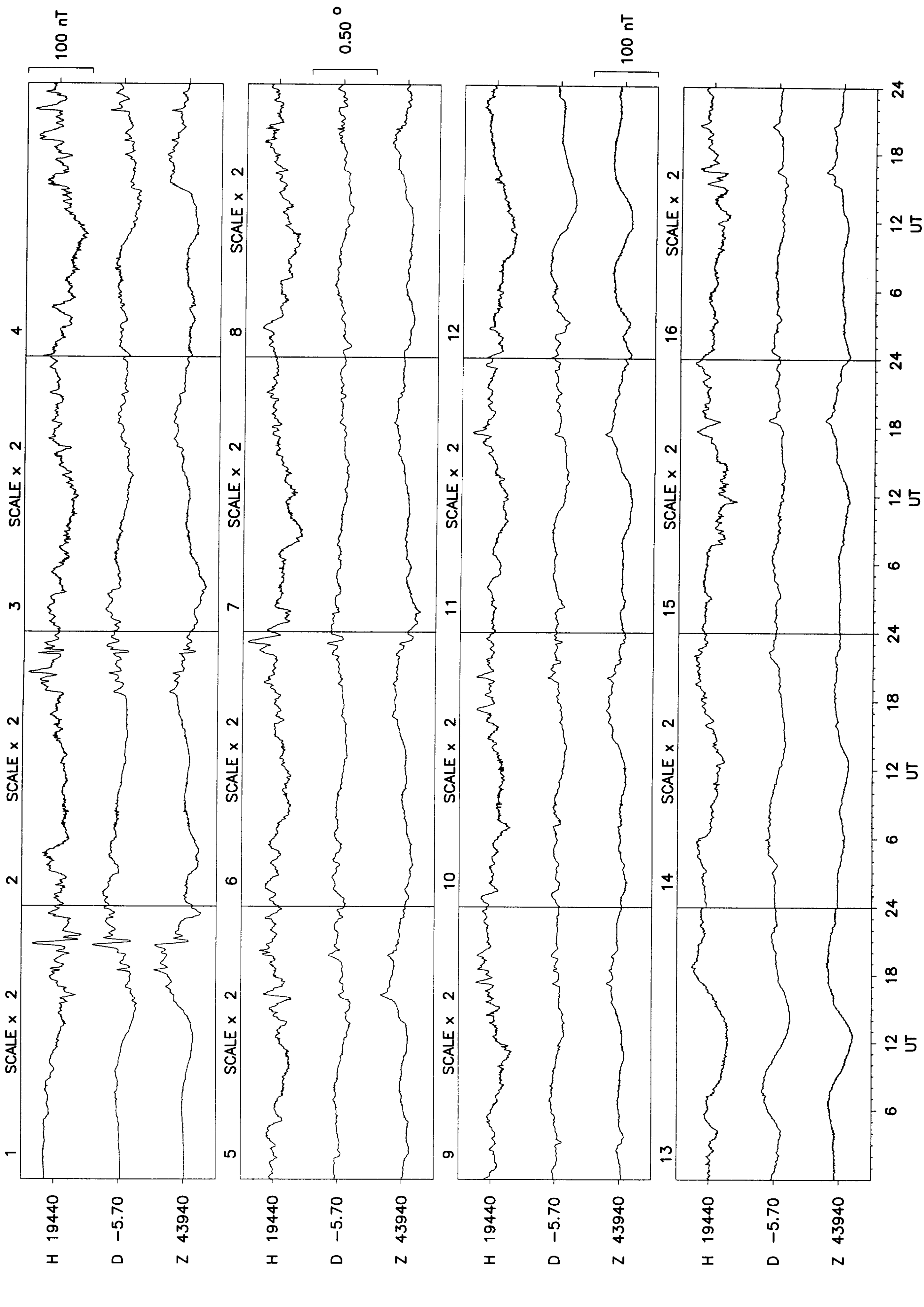
29
30
UT



Hartland May 1994


100 nT
0.50 °
100 nT
1
2
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4
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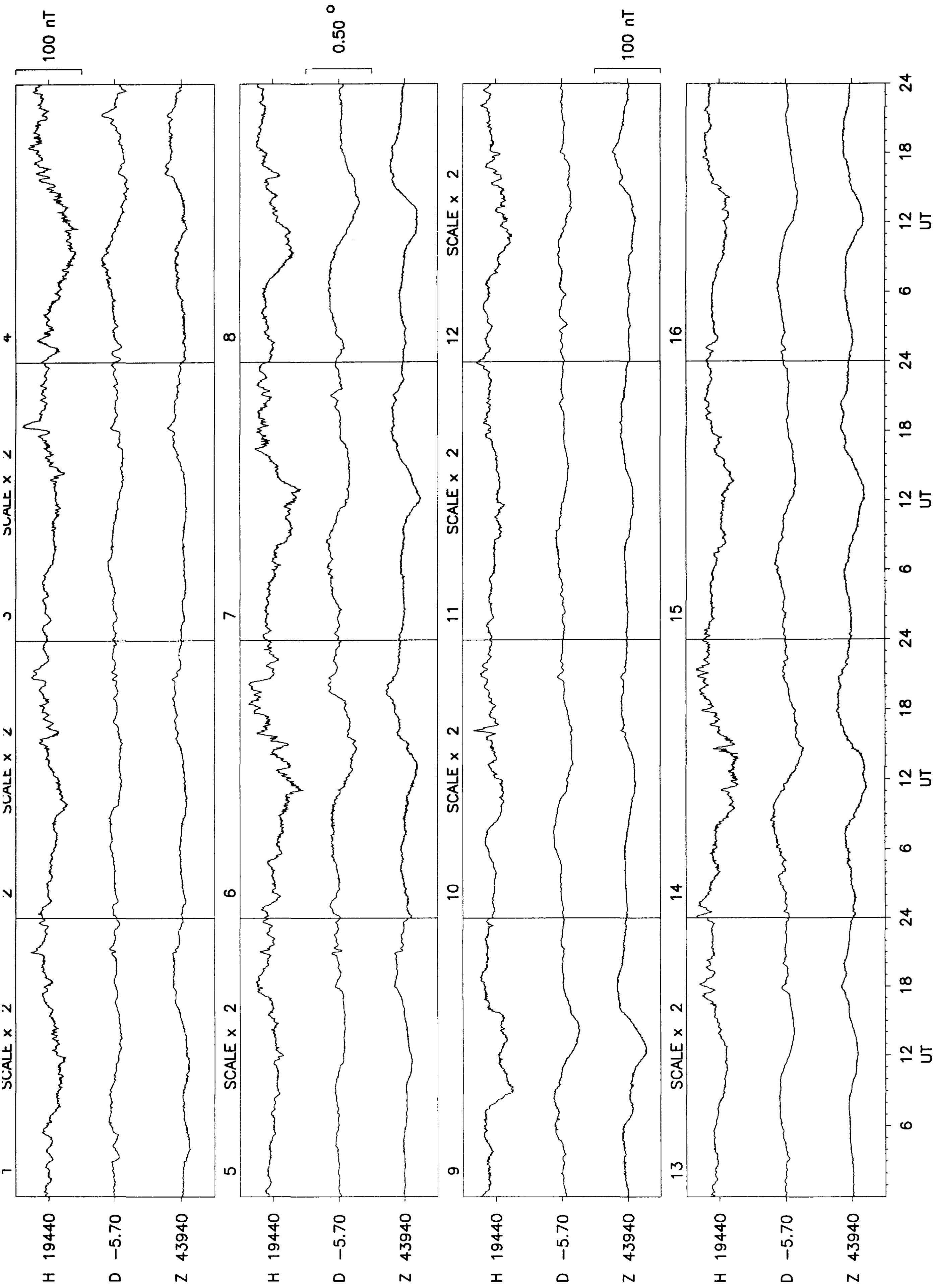
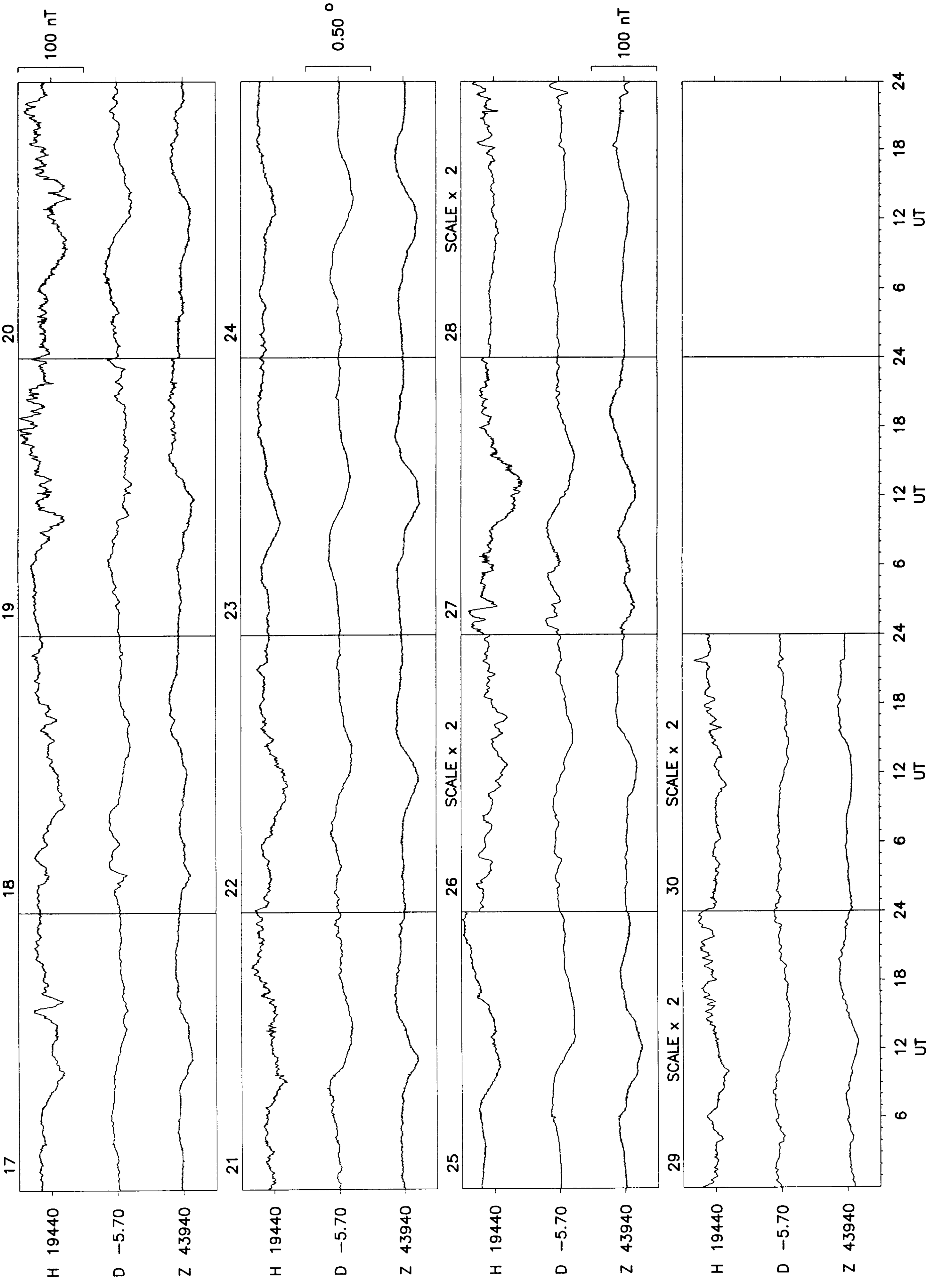
13
14
15
16
SCALE x 2
H 19440
D −5.70
Z 43940
6
12
18
24
UT



Hartland June 1994


100 nT
0.50 °
100 nT
17
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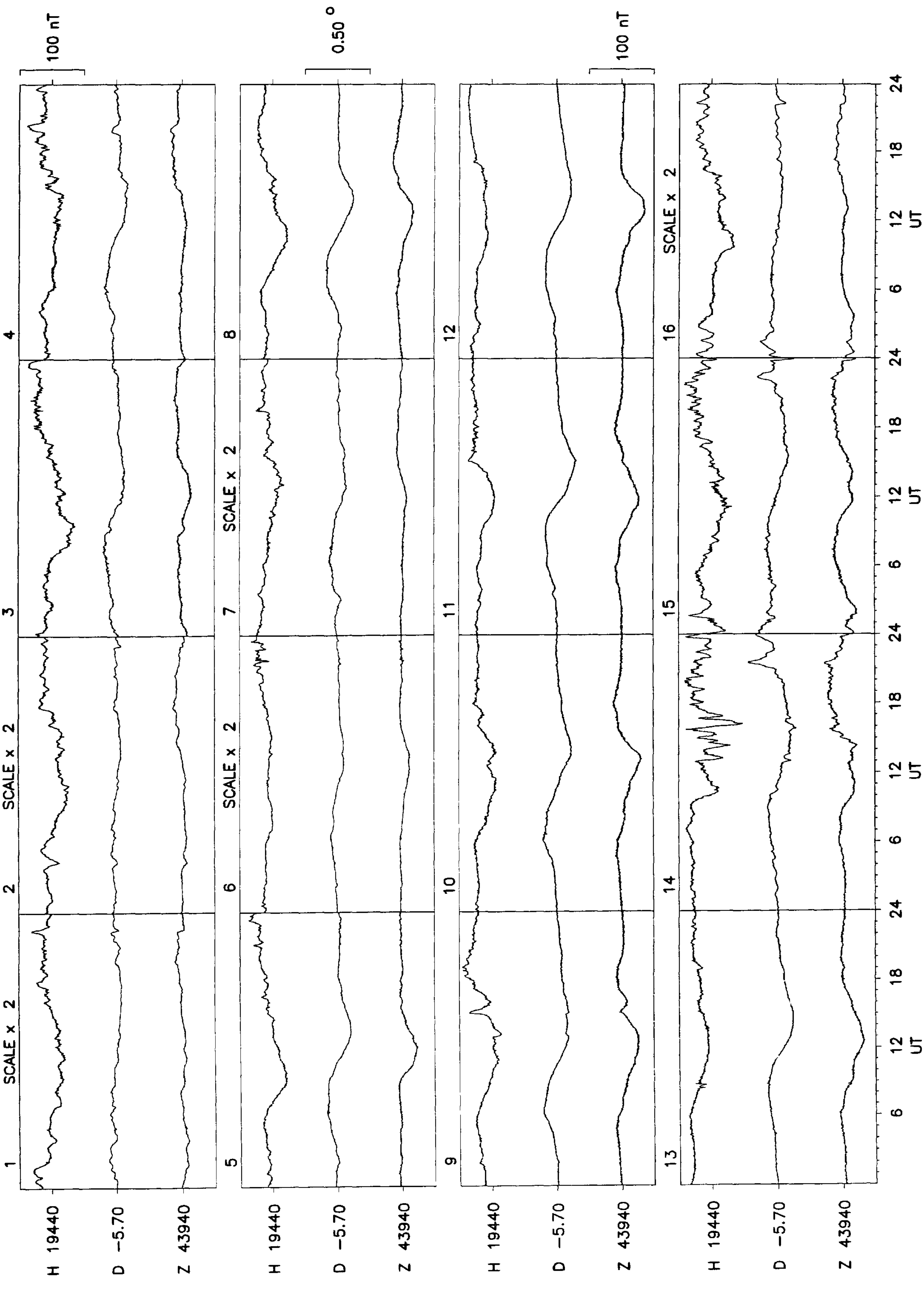
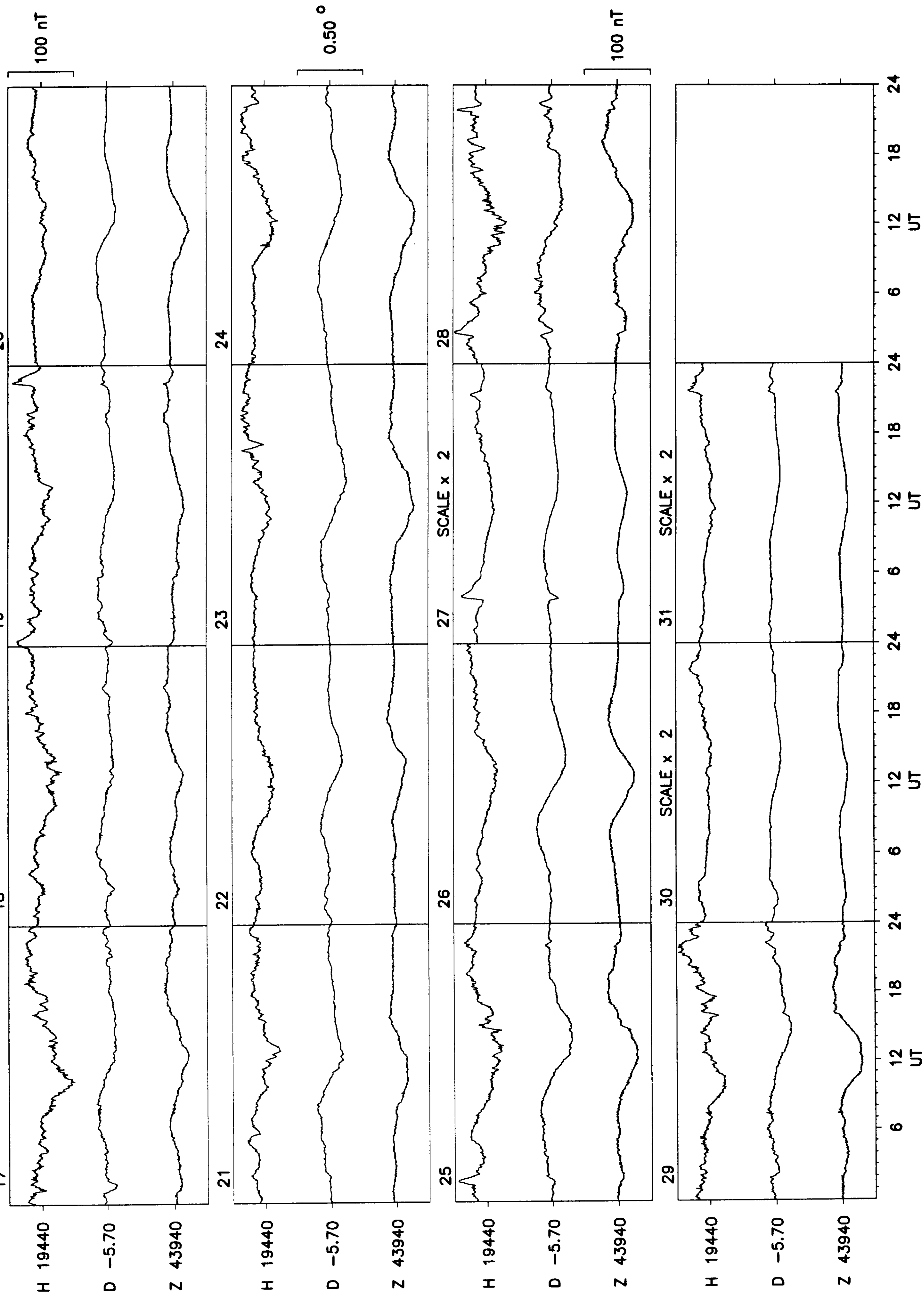
27
28
29
30
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
6
12
18
24
UT



Hartland July 1994



100 nT
0.50 °
100 nT
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31
SCALE x 2
SCALE x 2
SCALE x 2
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
H 19440
D −5.70
Z 43940
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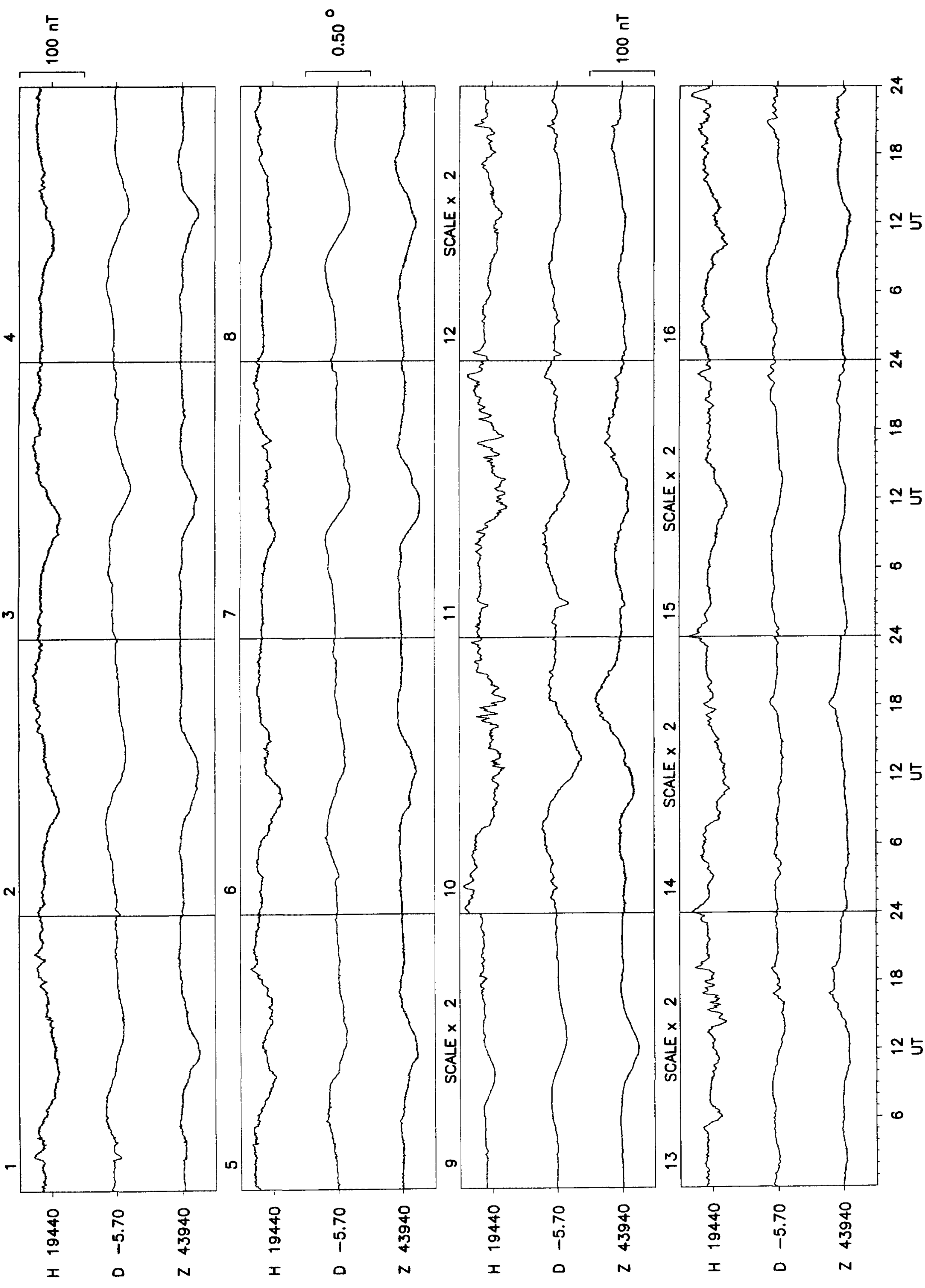
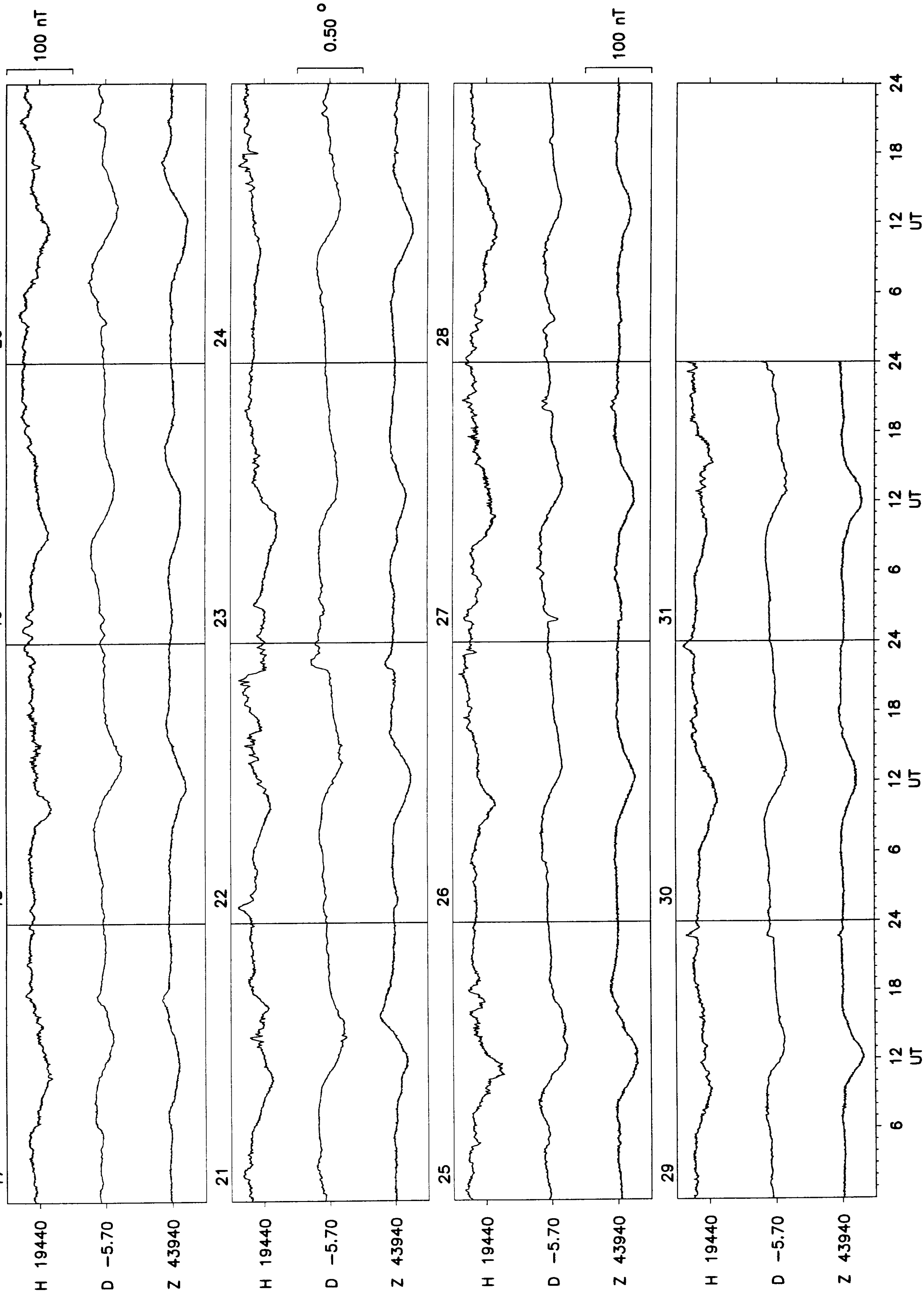
UT



Hartland August 1994


100 nT
0.50 °
100 nT
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H 19440
D −5.70
Z 43940
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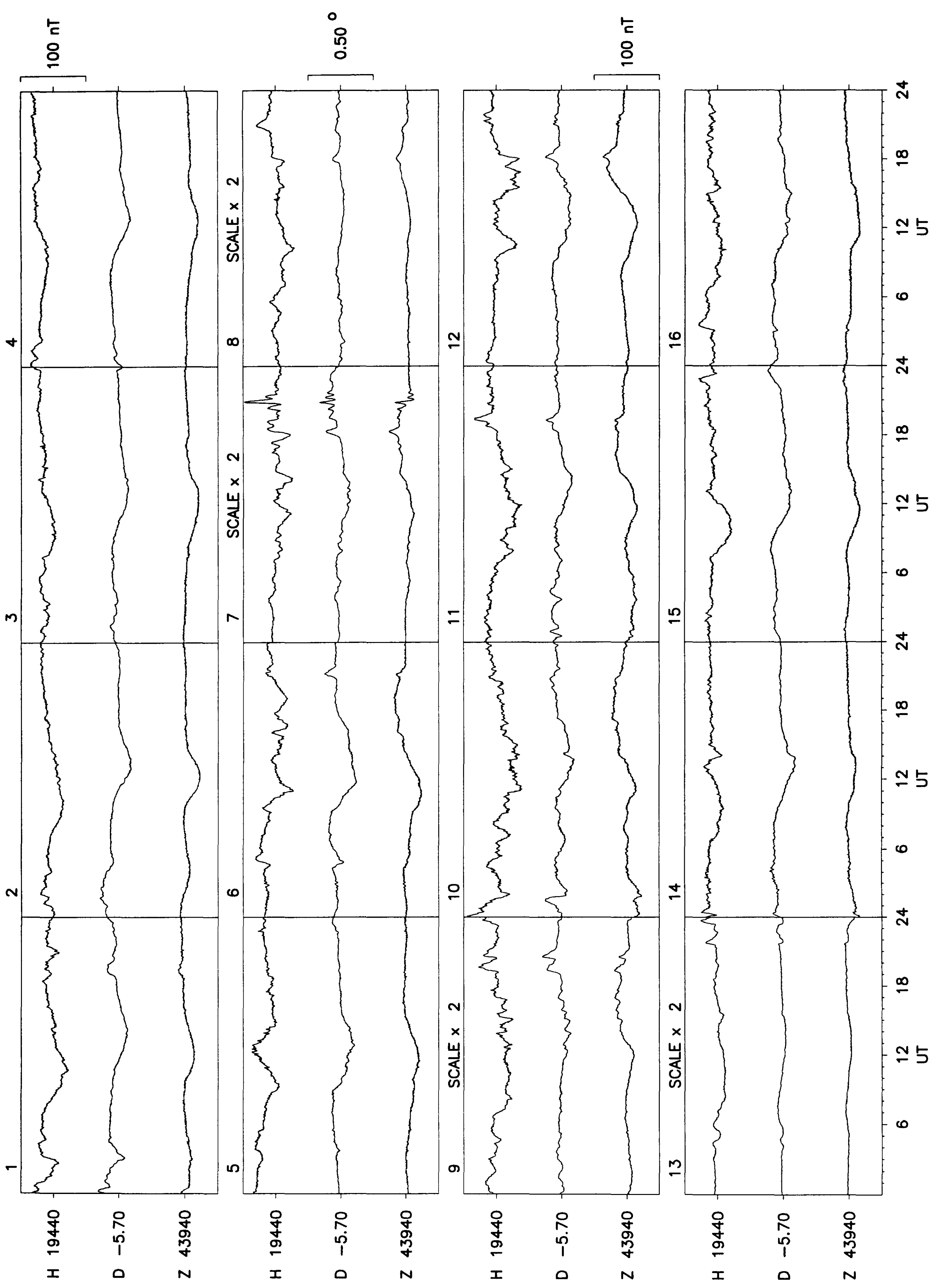
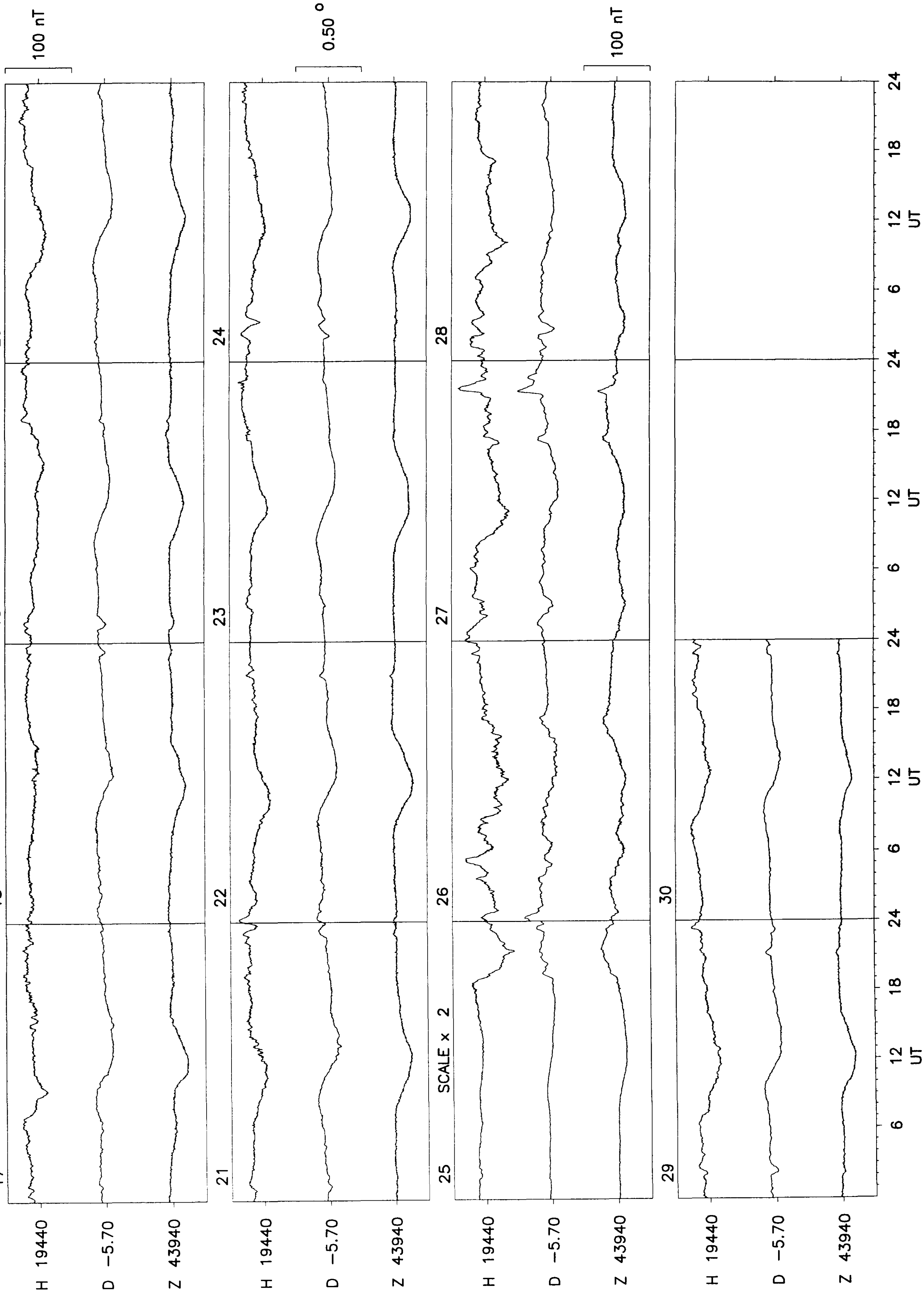
UT



Hartland September 1994


H 19440
D −5.70
Z 43940
100 nT
0.50 °
100 nT
SCALE x 2
17
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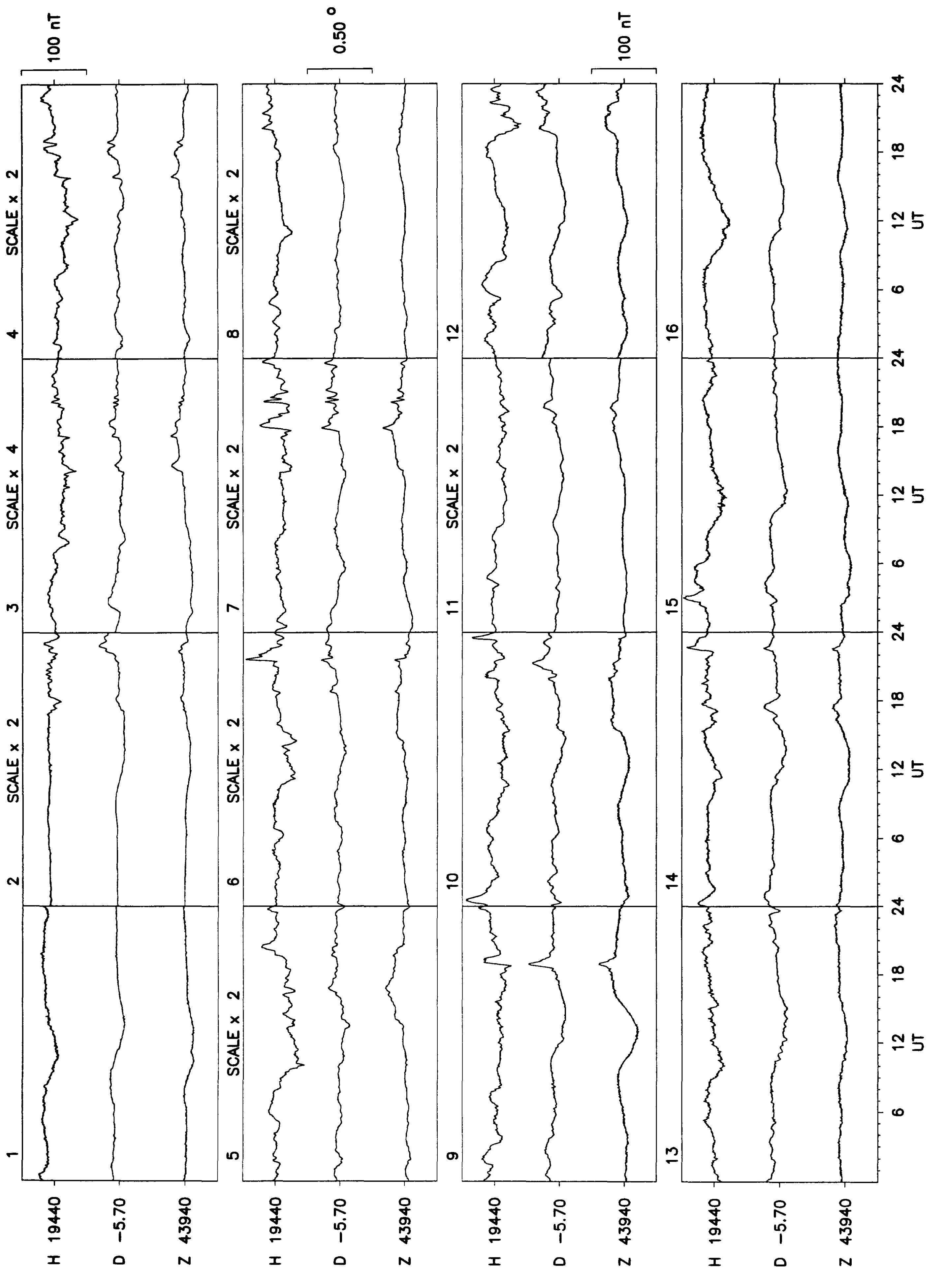
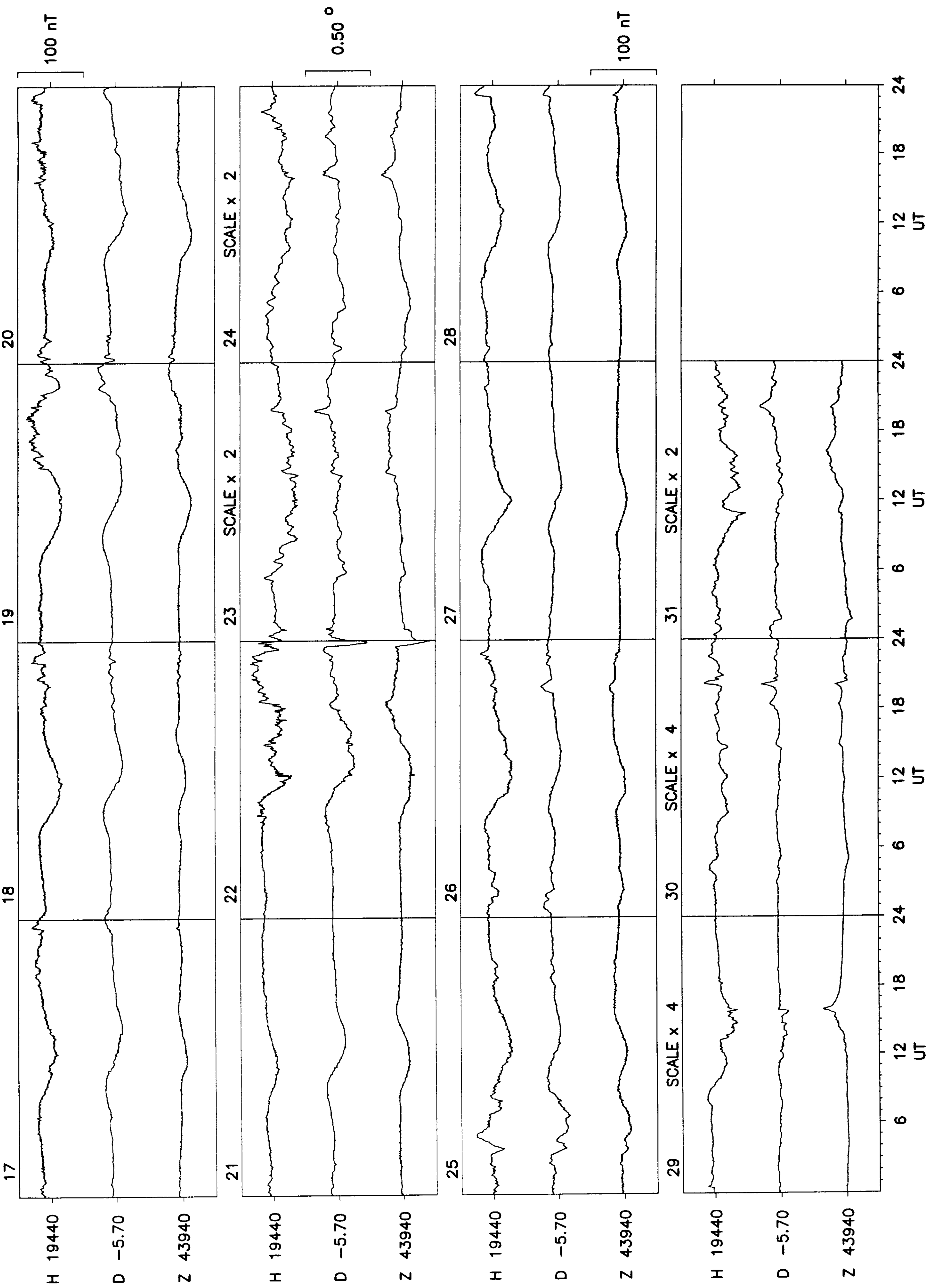
12
18
24
UT



Hartland October 1994


100 nT
0.50 °
100 nT
H 19440
D −5.70
Z 43940
17
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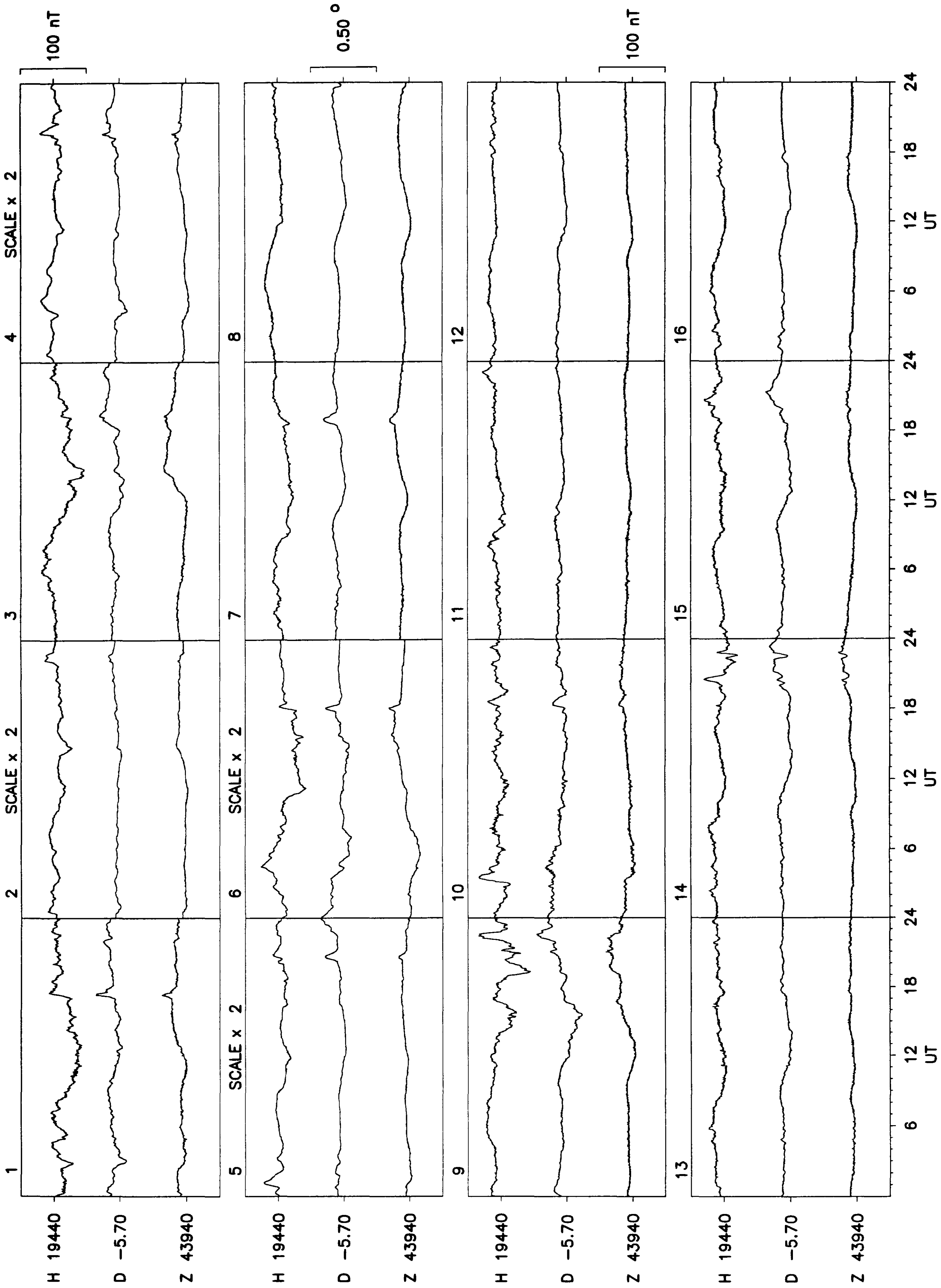
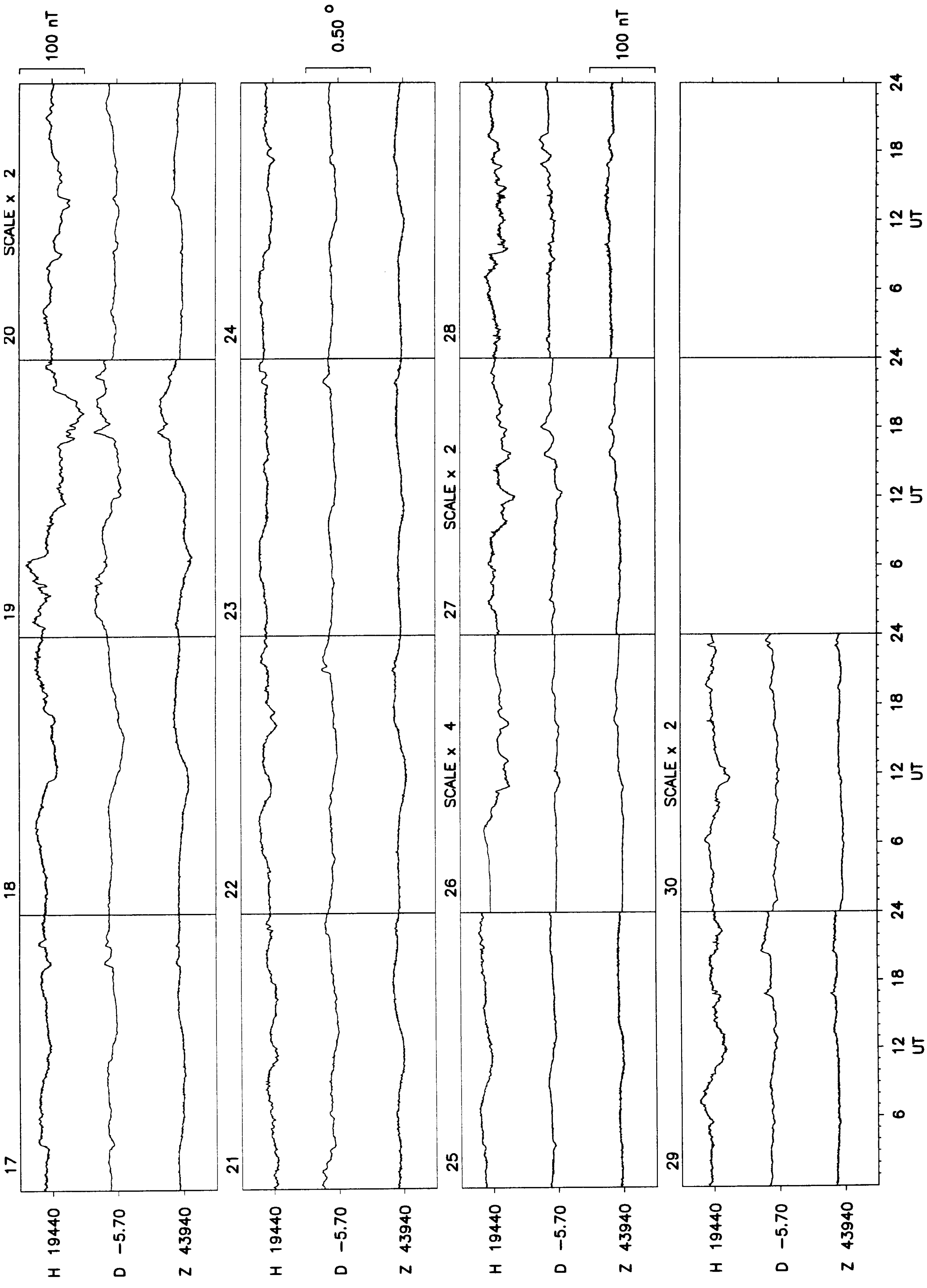
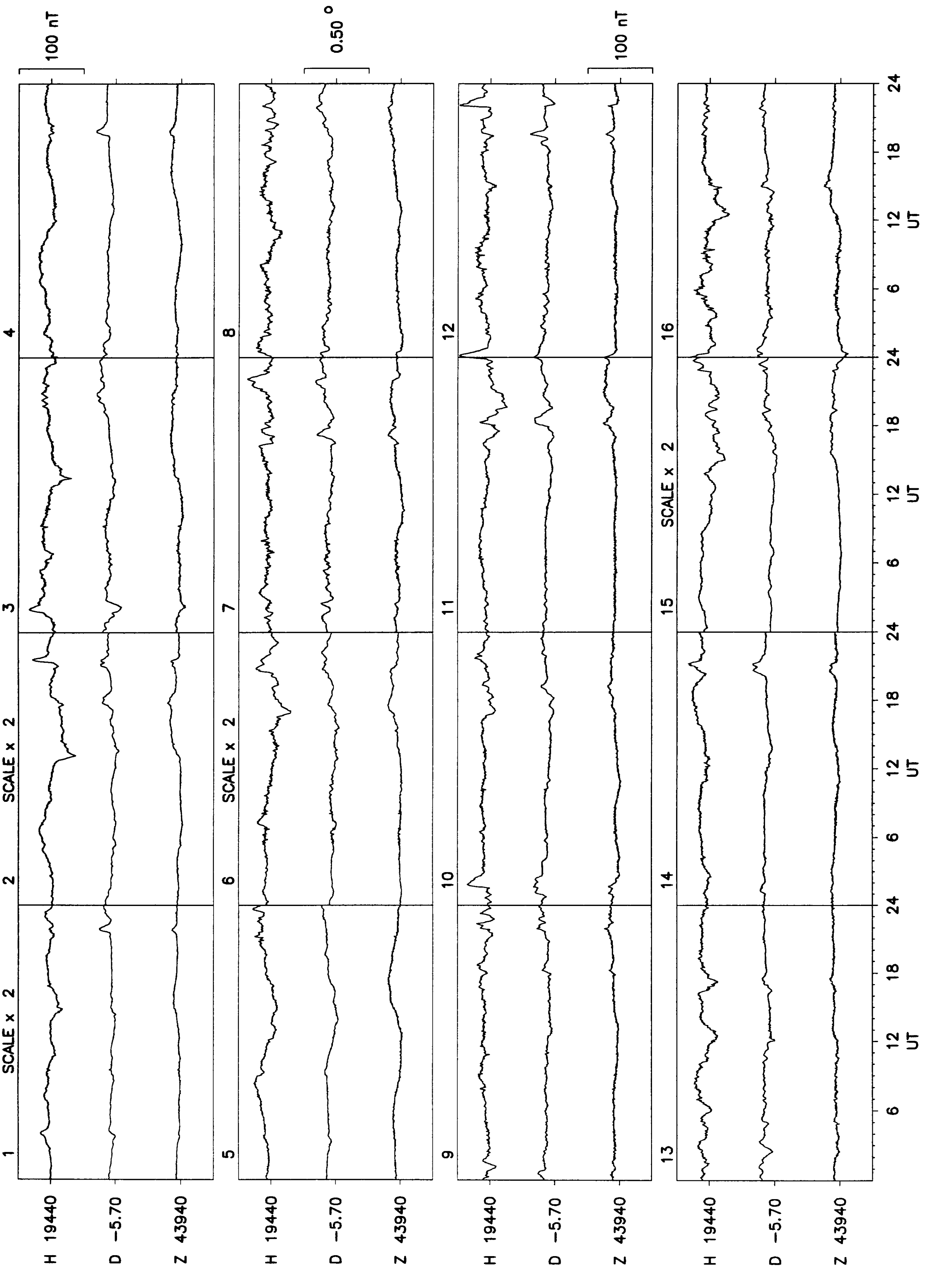
29
30
31
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 4
6
12
18
24
UT

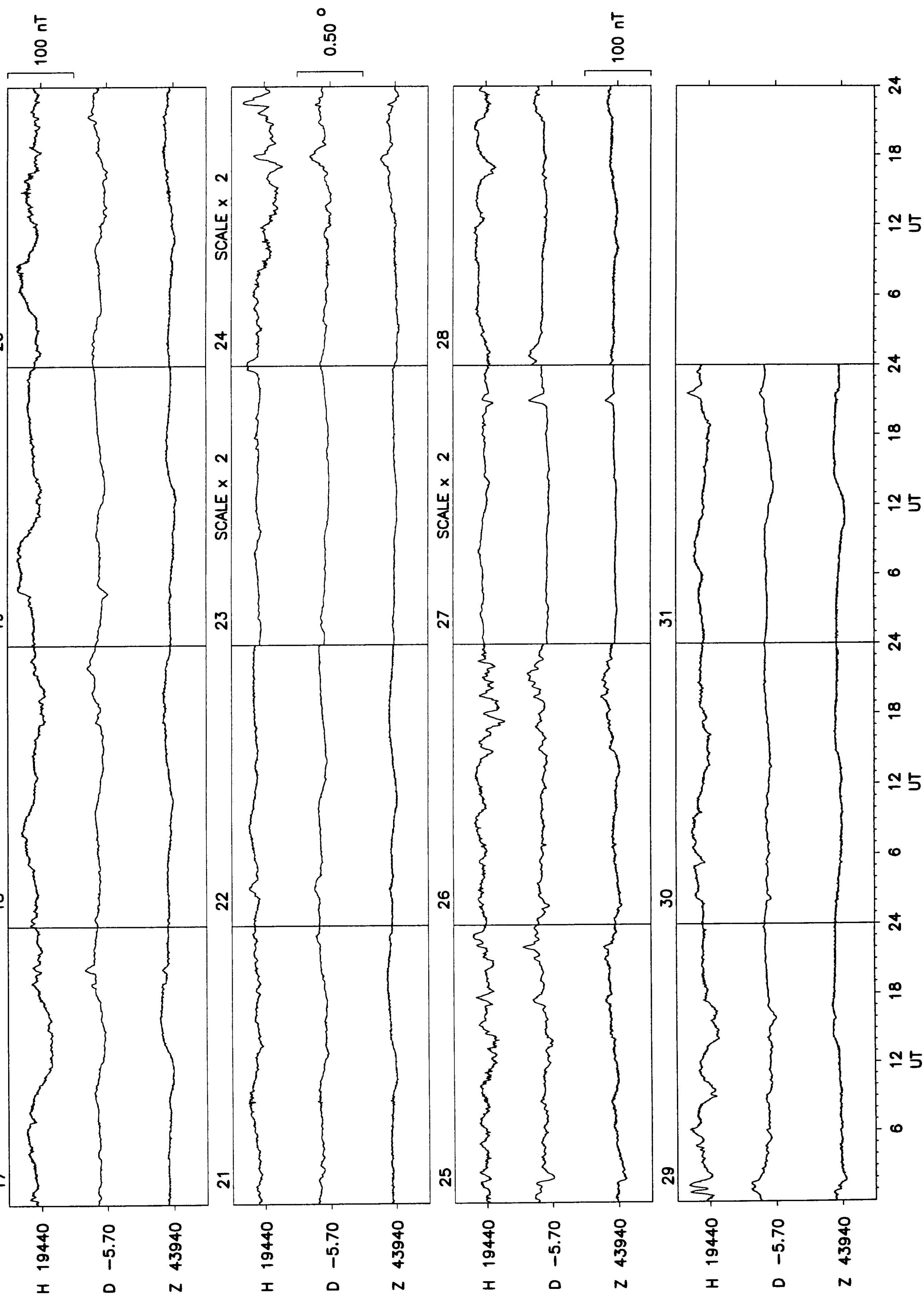


Hartland November 1994


100 nT
0.50 °
100 nT
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 2
17 18 19 20
21 22 23 24
25 26 27 28
29 30
H 19440
D −5.70
Z 43940
6 12 18 24
UT



Hartland December 1994



17
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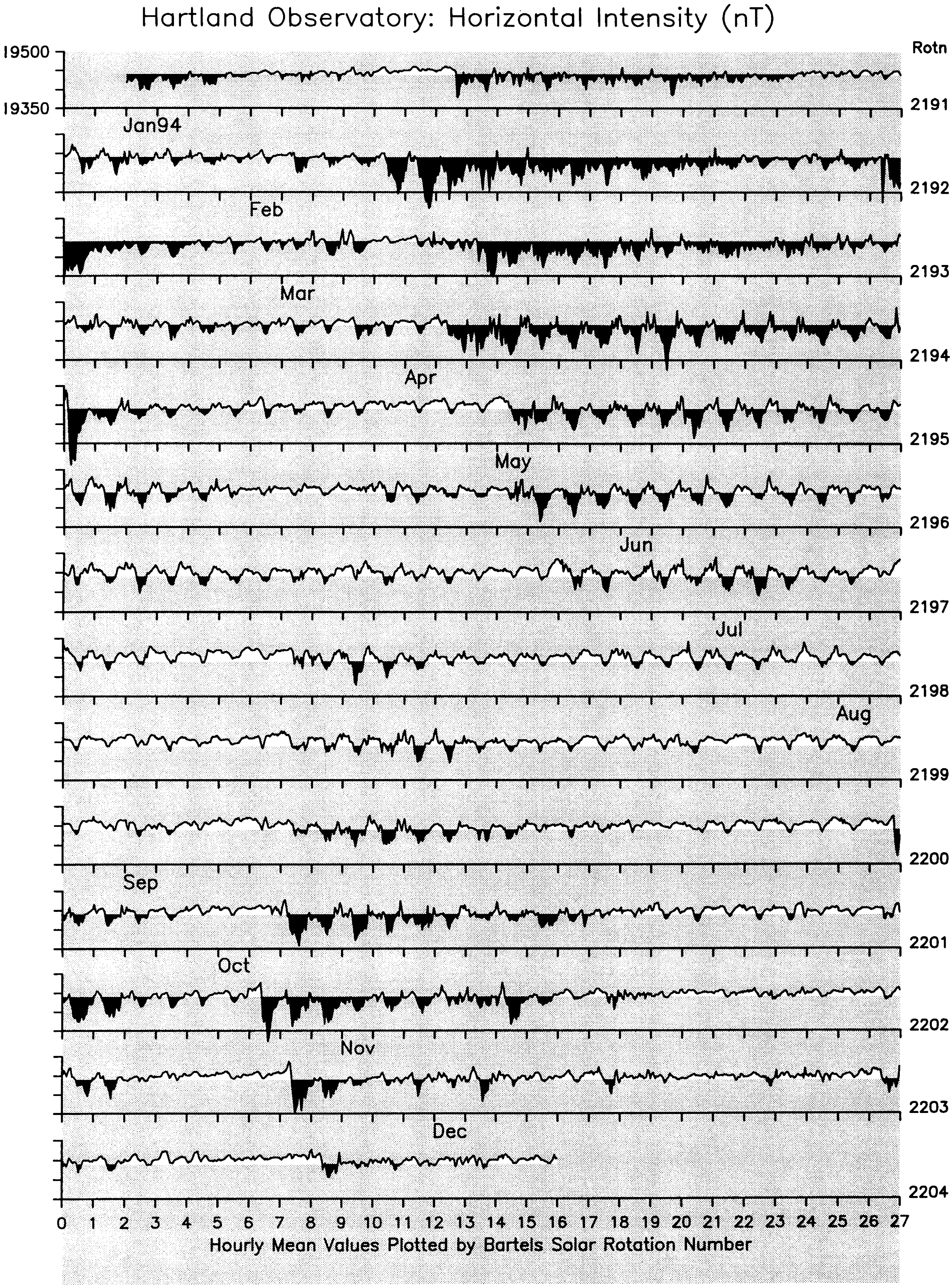
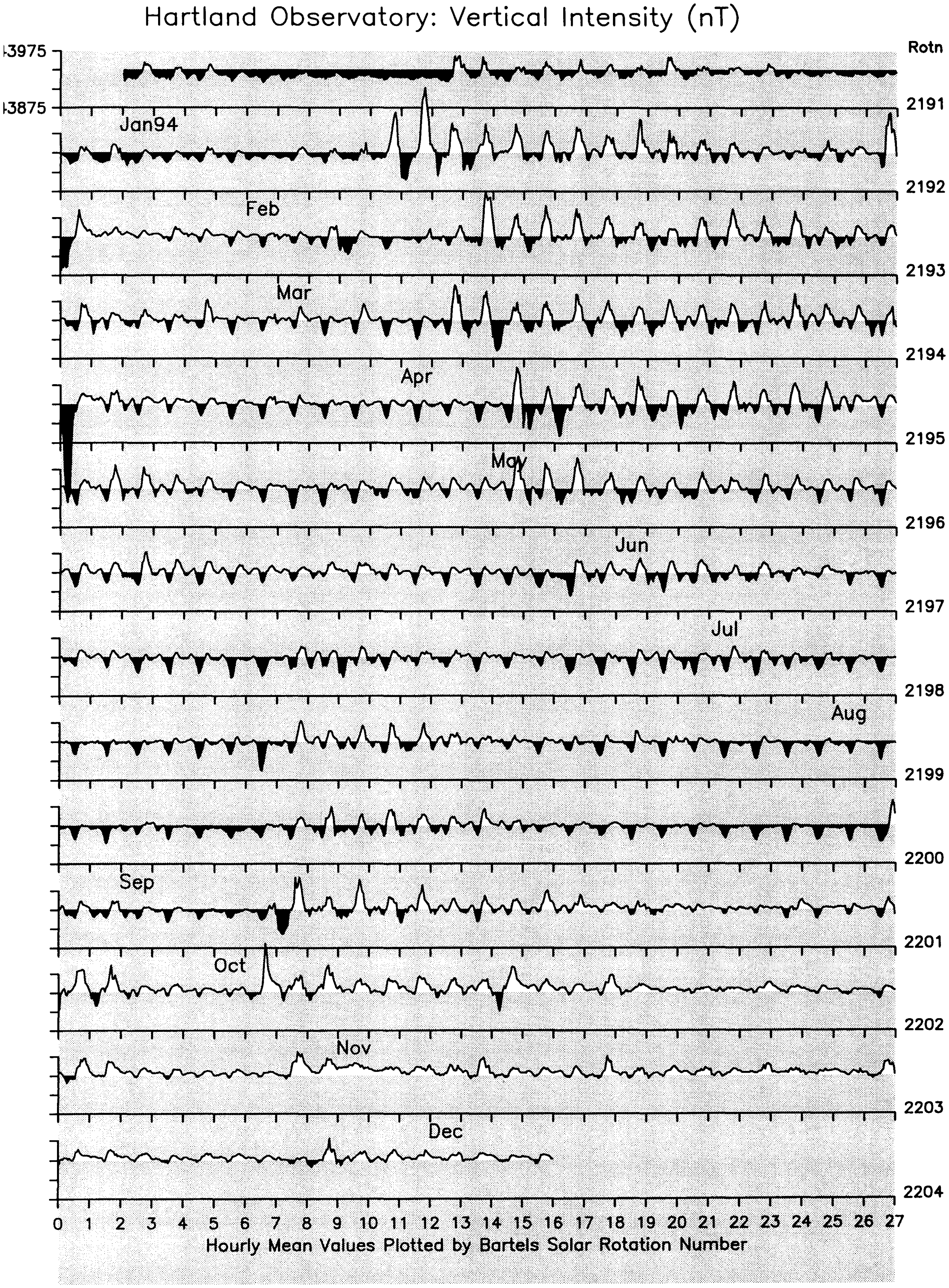
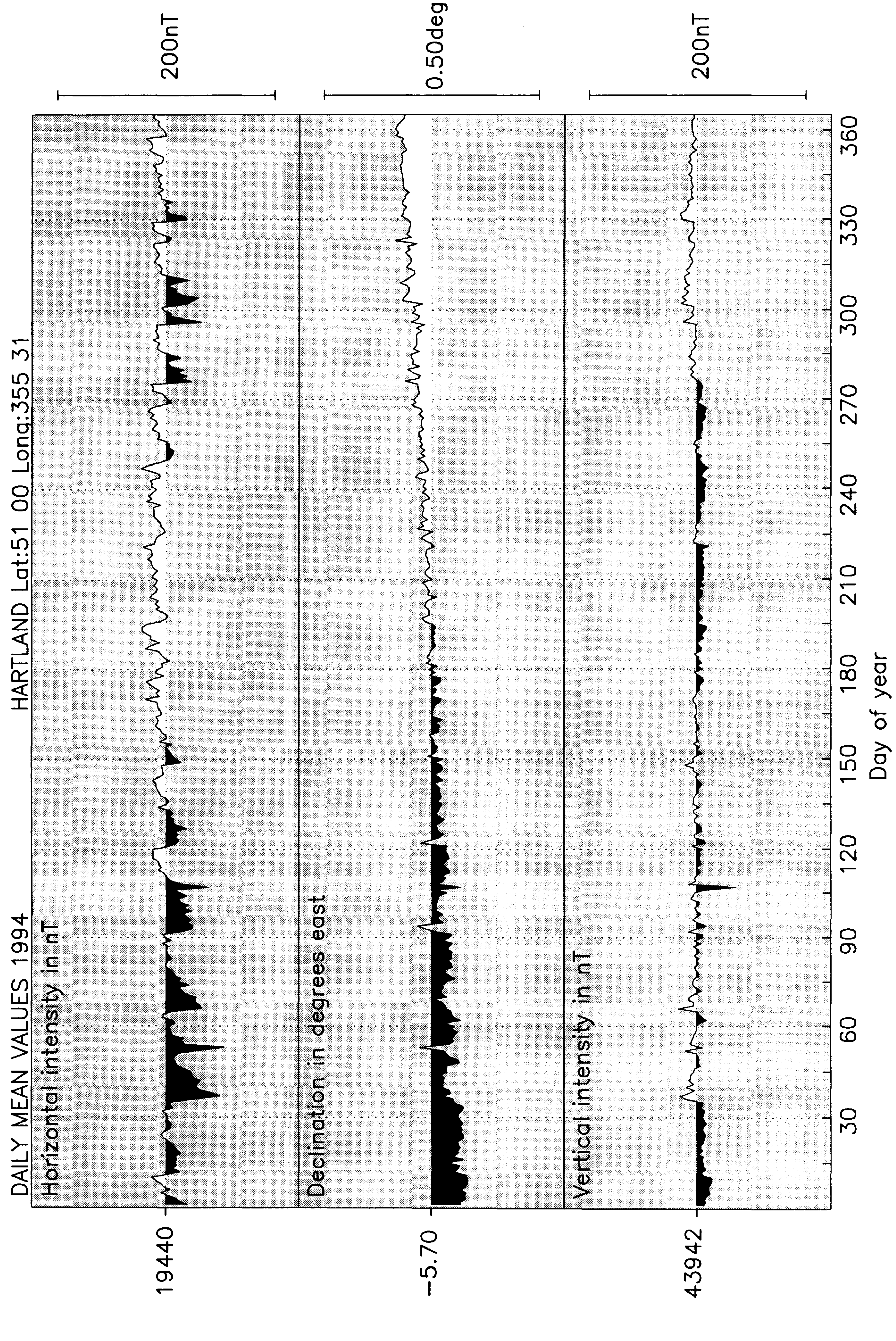
23
24
25
26
27
28
29
30
31
H 19440
D −5.70
Z 43940
100 nT
0.50 °
SCALE x 2
6
12
18
24
UT


Hartland Observatory: Horizontal Intensity (nT)
19500
19350
Rotn
2191
Jan94
2192
Feb
2193
Mar
2194
Apr
2195
May
2196
Jun
2197
Jul
2198
Aug
2199
2200
Sep
2201
Oct
2202
Nov
2203
Dec
2204
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

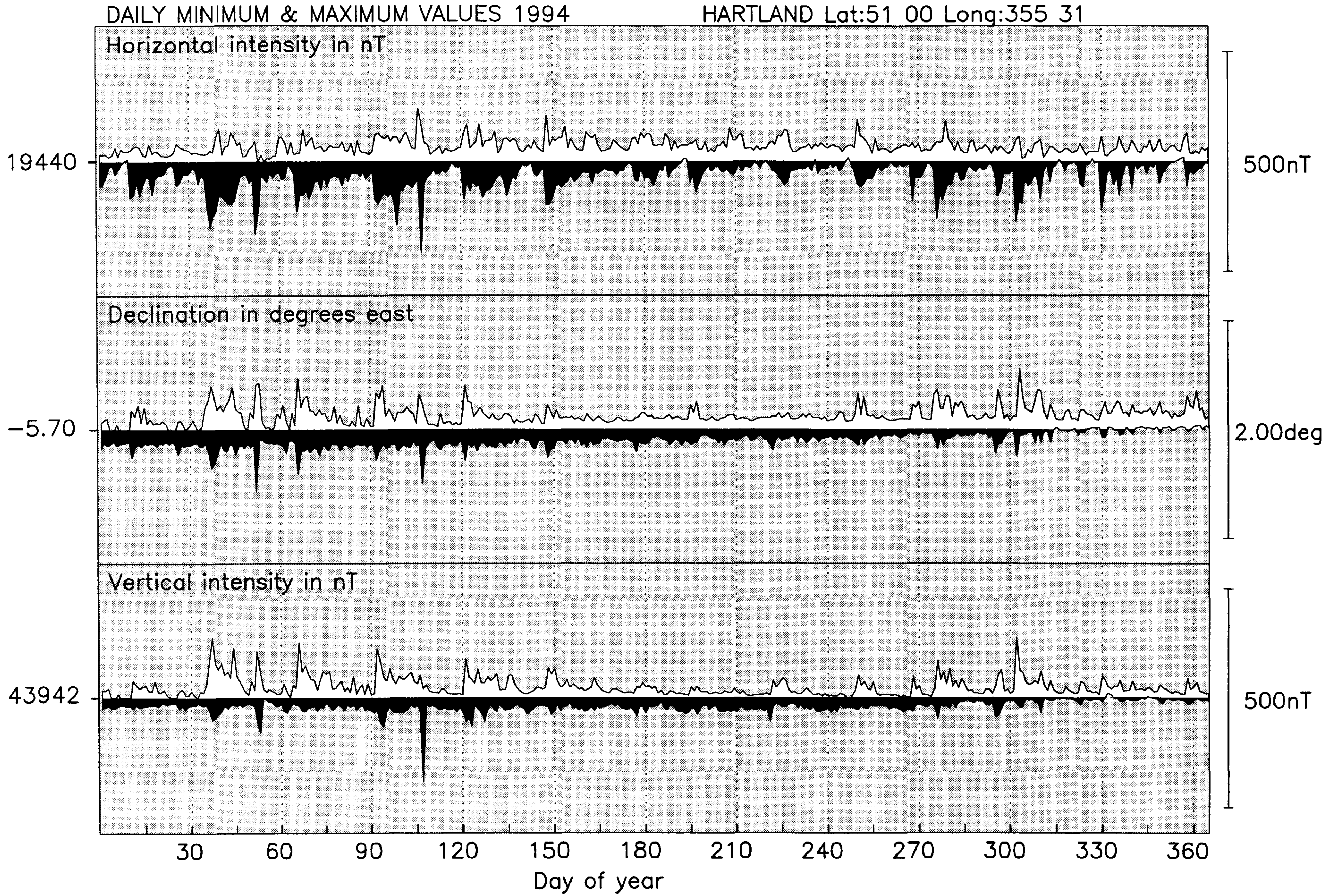
Hartland Observatory: Declination (degrees)
-5.60
-5.90
Rotn
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
Jan94
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number



Hartland Observatory: Vertical Intensity (nT)
43975
43875
Rotn
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
Jan94
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 1994
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
19440
-5.70
43942
200nT
0.50deg
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year



DAILY MINIMUM & MAXIMUM VALUES 1994
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
19440
-5.70
43942
500nT
2.00deg
500nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly Mean Values for Hartland 1994

Month	D	H	I	X	Y	Z	F
Jan	-5 46.3	19436	66 8.2	19337	-1955	43935	48042
Feb	-5 44.7	19421	66 9.4	19323	-1944	43944	48044
Mar	-5 44.6	19431	66 8.7	19333	-1945	43943	48047
Apr	-5 43.7	19432	66 8.6	19335	-1940	43940	48045
May	-5 43.2	19438	66 8.3	19341	-1937	43942	48049
Jun	-5 42.8	19446	66 7.7	19349	-1936	43941	48052
Jul	-5 42.0	19450	66 7.4	19354	-1932	43939	48051
Aug	-5 41.4	19451	66 7.3	19355	-1928	43938	48051
Sep	-5 40.7	19446	66 7.6	19351	-1924	43938	48049
Oct	-5 39.9	19436	66 8.5	19341	-1919	43946	48052
Nov	-5 38.9	19441	66 8.3	19347	-1913	43950	48058
Dec	-5 38.1	19447	66 7.8	19353	-1910	43947	48058
Annual							
All days	-5 42.2	19440	66 8.1	19344	-1932	43942	48050
Q days	-5 42.6	19448	66 7.5	19352	-1935	43940	48052
D days	-5 41.7	19428	66 9.0	19332	-1928	43944	48047

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

Hartland Observatory K Indices 1994

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3334 3443	3122 1111	4232 1224	1211 2322	0232 3566	3343 3344	4333 3434	3311 1222	4411 1133	2111 1111	4422 2433	3333 3324
2	2333 4443	0233 3331	4222 2245	3334 4465	5532 4355	4233 3444	3443 3533	2111 1211	3301 1111	1111 1445	3322 4324	3333 5445
3	3223 2352	0122 3343	4443 2222	5455 5556	5543 4543	3333 4453	3222 2223	2111 1221	2221 2212	6554 5554	1222 3243	4223 3133
4	1311 1120	2121 2453	1112 1111	6533 4454	4332 4334	3232 2334	2222 3333	1111 1111	3011 1211	4343 4543	3433 2354	3111 1131
5	1111 1112	3234 2455	1012 1135	4334 4545	3433 4554	2233 3444	2111 1212	1221 1121	2223 3212	4344 4554	4223 3355	1121 2223
6	3211 2324	5334 5556	2311 1234	4344 4555	5443 3345	3323 3443	2221 2224	1211 2211	2324 2333	3344 4445	4545 3552	3233 3454
7	1001 2133	4545 5564	5434 5556	4444 4544	5354 4343	3232 3333	3432 3343	1111 2212	2334 4465	4442 4555	2221 1241	3332 2434
8	2231 1222	6544 5555	4454 4555	4443 4455	4444 4444	3122 2322	1111 2211	1110 0111	3334 3454	3334 1343	1011 1113	3232 2333
9	1011 1110	4333 4555	4454 4565	5445 4454	4444 3543	2233 2322	1111 3321	1110 1232	3343 4554	3221 2242	2112 3444	3122 2223
10	1111 1100	5433 4554	4344 4455	5433 4445	4343 4444	1332 3543	1121 2221	3222 3343	4333 3322	4222 2344	3432 2232	3212 1333
11	1222 3564	4435 4555	3344 4445	4444 3545	4433 4533	3233 2334	1110 2311	4423 3433	3332 3232	2333 3352	1222 1113	2111 1344
12	4333 4534	3334 4455	4344 4455	4333 3355	4421 1212	4344 3433	2110 1200	4332 3343	2123 2343	3332 1243	2111 1111	4222 2344
13	4323 4445	4433 3564	4423 3334	3332 4554	2321 1112	3411 2443	1120 1222	3432 4444	1331 2324	3222 2223	1211 1222	3333 3322
14	3323 5444	4333 3555	4433 4454	4233 3443	2442 3434	3323 3423	1223 4534	4444 2444	3211 3111	3112 1424	2221 1234	2111 1133
15	3322 3353	4332 4454	4434 4544	3323 2443	3444 3544	2121 2211	4322 3335	4222 2234	2211 2223	4323 2122	2112 2244	3232 4445
16	3333 3343	5434 3233	4332 3543	3422 2365	4333 4542	2011 2221	5434 3434	2212 2233	3322 2322	2112 1111	2111 1210	3333 3312
17	4432 3344	3222 3232	4444 3543	5765 4434	4333 2322	1211 2421	3223 3333	1221 2211	2222 1222	1111 1112	1211 1132	2121 1231
18	3323 4443	1112 2203	3432 3314	3334 3343	4322 4324	3432 2322	3422 3222	1112 2212	2111 2212	1011 1123	1112 1222	2111 1223
19	4342 3244	4333 4354	5333 2223	4223 2233	2333 3221	2234 3334	3222 3134	2110 1221	3110 1222	1111 2323	3332 2433	1311 1111
20	4232 3342	4322 2232	3211 2343	2222 2112	2221 2311	3322 4433	1111 2221	1221 1233	1111 1222	3111 2333	3343 4323	2222 2323
21	2211 1243	3337 6766	3432 3544	2221 1133	1112 3321	2232 2322	2322 3222	2211 3321	2111 2223	2101 1111	2221 1112	2221 2212
22	4211 2123	6544 4233	4333 4223	2112 3123	1212 2232	3221 2222	3212 2111	3111 2334	3211 1122	1123 4445	1211 1233	2211 1000
23	2212 2222	2322 2243	3432 3433	1113 3244	1113 3323	1110 1121	1221 2322	2211 2221	2211 1112	5554 4454	1111 1113	3222 1224
24	2111 1001	2111 1111	3324 3323	1222 2221	4533 2433	2211 1110	2112 2223	1111 1333	3311 1211	4433 3544	1111 1221	4343 4555
25	1220 1113	2233 2332	4222 3444	3322 1222	4323 2324	0120 1212	3322 3322	2233 2321	2110 1355	2431 1121	1110 1111	4222 3324
26	3343 4443	3211 2211	3223 1222	1121 2111	2232 2323	3434 4443	1110 1221	1211 1213	4332 3422	3211 1132	1245 5532	3222 3444
27	3332 3344	1213 3210	1111 2135	1211 2111	2111 1321	4332 3222	2421 1234	3222 1232	4322 2424	1111 2111	3334 4542	2221 2255
28	4323 3223	1132 2124	1212 3423	2110 2111	1011 4754	2222 2345	3333 3333	2312 1121	4323 1312	1111 1113	2223 2332	3111 2323
29	1232 3223		2121 1112	0221 1113	5434 4434	4443 4444	3321 2323	1111 1112	3121 1113	3335 5532	1121 2333	3233 3311
30	3111 2433		1113 3443	0110 1111	4444 5555	4323 3434	3211 2223	1111 1212	1011 1112	3454 4465	3344 3334	2212 1211
31	3211 1224		2112 2111		3433 4354		2212 2224	1111 2313		4334 4453		1121 1123

DAILY aa INDICES

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	40	12	23	17	55	42	43	13	20	9	33	31
2	36	25	33	60	58	39	43	7	9	26	29	45
3	29	25	36	98	61	43	27	8	11	97	24	24
4	11	26	9	64	36	33	19	6	8	54	34	13
5	8	49	18	60	60	41	10	9	18	59	34	18
6	25	85	21	73	57	34	17	8	25	51	54	50
7	10	86	91	58	60	31	35	8	59	58	15	28
8	14	93	67	66	55	18	7	4	43	29	12	28
9	6	57	76	67	51	18	9	10	55	19	30	17
10	7	58	63	58	51	35	9	24	29	30	29	18
11	49	68	57	70	47	27	8	29	25	33	15	21
12	49	51	66	46	20	42	6	32	22	24	9	29
13	44	55	36	55	12	25	7	45	19	21	12	28
14	41	56	57	41	35	27	37	51	15	19	19	13
15	34	44	61	32	61	12	32	28	12	25	22	40
16	37	35	39	45	45	9	49	17	17	11	10	25
17	43	17	52	97	28	16	26	11	16	9	12	13
18	36	16	33	33	33	21	21	13	9	8	14	14
19	43	42	27	28	22	31	24	9	10	16	34	13
20	25	25	23	15	12	28	11	14	9	16	41	21
21	16	123	47	14	11	17	17	18	12	6	11	12
22	18	58	34	14	11	14	11	20	10	44	12	6
23	15	22	33	23	16	6	13	11	7	75	8	19
24	7	9	30	15	35	7	12	13	11	43	11	65
25	10	24	36	16	30	6	21	17	29	19	7	28
26	47	14	15	10	24	46	9	12	31	15	66	32
27	37	14	19	10	11	30	24	15	27	8	42	28
28	26	18	23	8	60	32	29	13	21	10	21	20
29	23		11	11	61	49	24	9	12	67	15	24
30	20		26	4	75	37	21	8	9	77	34	11
31	18		11		51		18	11		53		10
Monthly Mean Value	26.5	43.1	37.9	40.2	40.2	27.2	20.6	15.9	20.1	33.3	23.6	24.1

Annual mean valuefor 1994 = 29.3

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
11	1	11	49	SSC	B	-4	2.2	5
25	1	21	53	SSC	C	11	1.9	4
21	2	09	01	SSC*	A	-150	7.0	-44
17	3	05	58	SSC*	C	-14	-1.2	-5
22	3	11	50	SSC*	C	17	-2.3	3
2	4	11	42	SSC*	C	15		
16	4	11	51	SSC*	B	11	-1.6	
28	5	13	56	SSC*	A	35	-3.0	6
27	7	17	58	SI	C	12	-0.7	3
10	8	12	36	SSC*	B	9	-0.3	4
24	8	17	51	SSC*	B	-24	1.0	-7
25	8	09	01	SI	C	-6	-0.9	
29	8	06	59	SSC*	C	4	-1.2	
29	8	22	33	SSC*	B	13	1.8	4
18	9	12	10	SSC*	C	8	-0.8	
25	9	18	04	SSC*	C	10	-0.8/+0.9	7
19	10	14	52	SSC*	C	15	-0.9	2
22	10	08	50	SSC*	C	11	-0.9	
26	11	07	24	SSC*	B	-14/+11	1.8	8
5	12	21	05	SSC*	C	13	0.6	3
10	12	10	07	SI*	C	-8	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 Start		Maximum		End		H(nT)	D(min)	Z(nT)
4	3	11	26	11	33	11	46	9	-2.3	-3

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

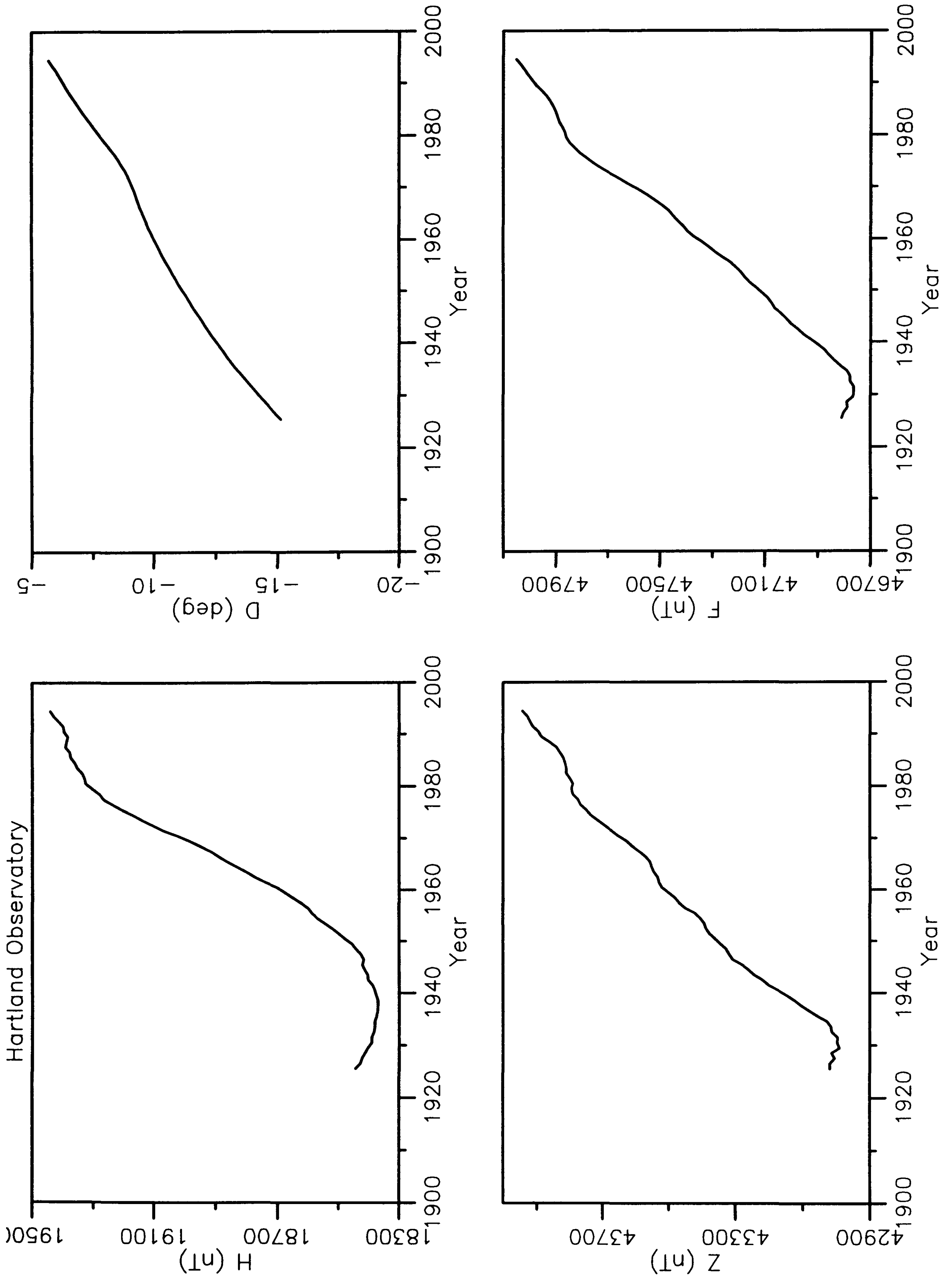
Hartland

	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

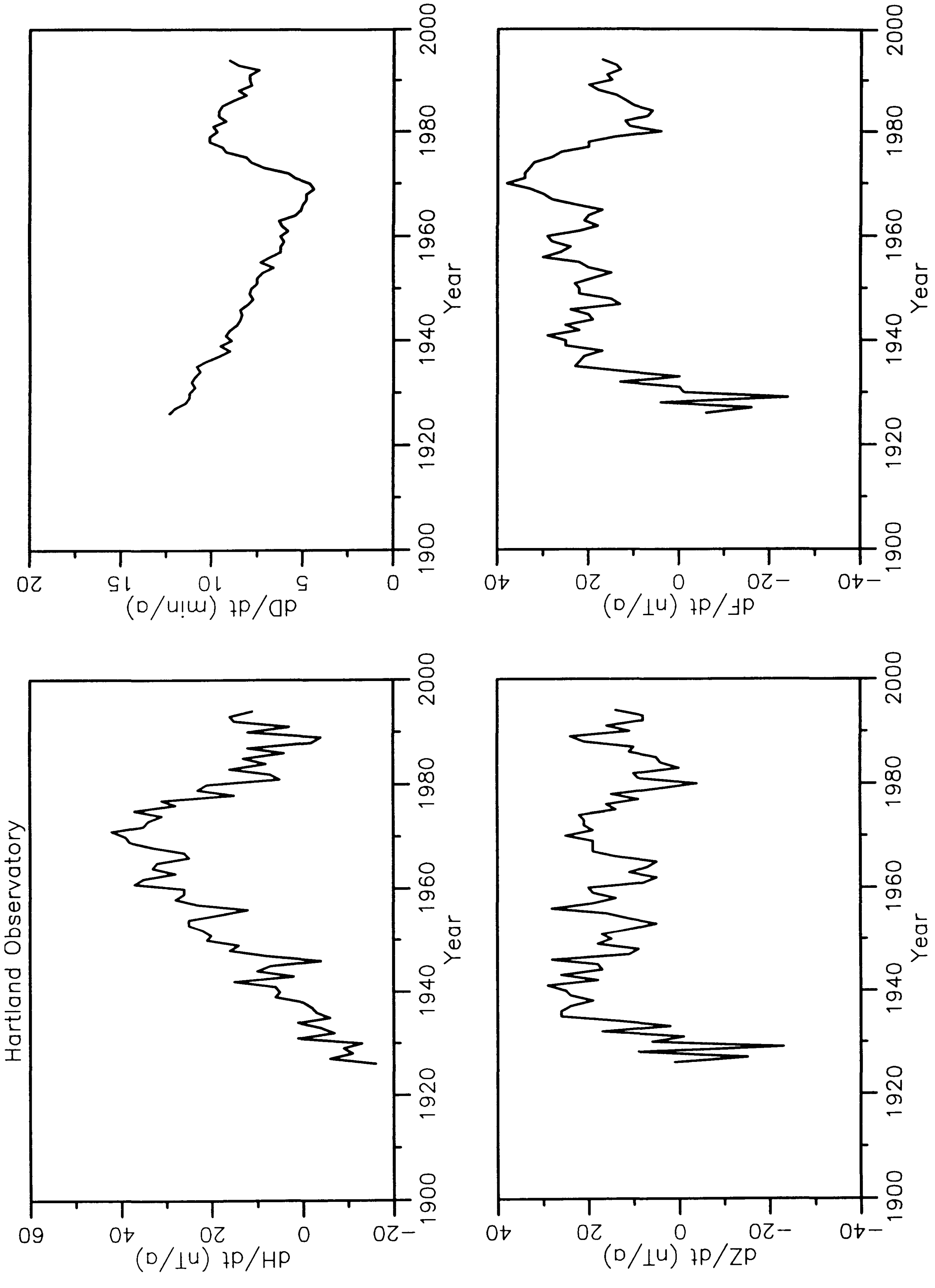
	Year	D		H	I		X	Y	Z	F
	1981.5	-7	33.9	19335	66	10.2	19167	-2546	43777	47857
	1982.5	-7	24.7	19342	66	10.1	19180	-2495	43787	47869
	1983.5	-7	15.1	19358	66	9.0	19203	-2443	43787	47876
	1984.5	-7	5.5	19366	66	8.6	19218	-2391	43791	47882
	1985.5	-6	56.1	19379	66	7.9	19237	-2340	43796	47892
	1986.5	-6	47.3	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

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 of H, D, Z, &F at Hartland

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Cover photos

Front
Lerwick Observatory
(Photo: A J Gair)

Back
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1985–94

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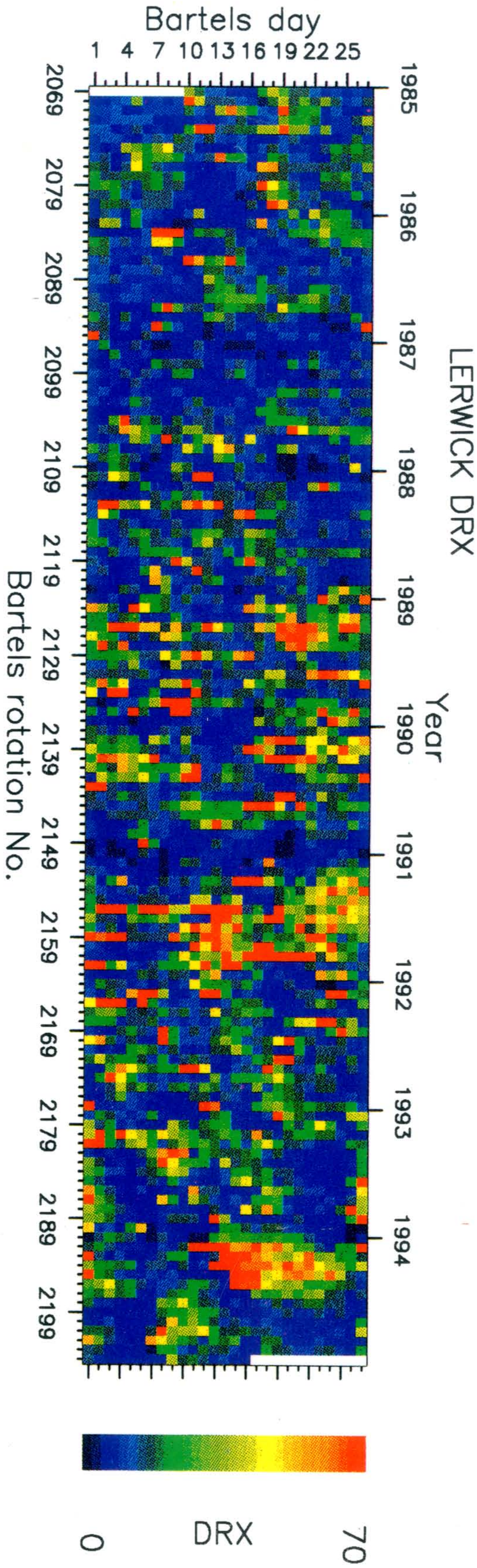

GEOMAGNETIC BULLETINS

1 Hartland Observatory magnetic results 1965, 1966 and 1967

2 Magnetic results 1968 Eskdalemuir, Hartland and Lerwick observatories

3 Magnetic results 1969 Eskdalemuir, Hartland and Lerwick observatories

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6 Annual mean values of the geomagnetic elements since 1941

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12 A bibliographic guide to the production of local and regional magnetic charts

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23 Magnetic results 1993 Lerwick, Eskdalemuir and Hartland observatories

24 Magnetic results 1994 Lerwick, Eskdalemuir and Hartland observatories

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