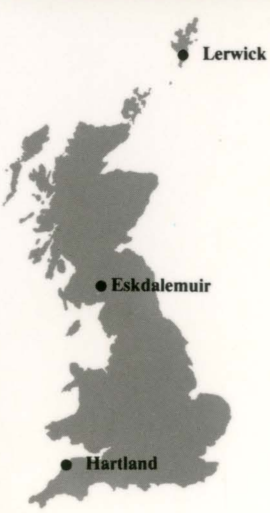
BRITISH GEOLOGICAL SURVEY

GEOMAGNETIC BULLETIN 22

Magnetic Results 1992

LERWICK, ESKDALEMUIR AND HARTLAND OBSERVATORIES



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1 INTRODUCTION

This bulletin is a report of the measurements made between 1 January and 31 December 1992 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 1st 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 1992 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°05'N
Longitude	358°49'E	89°27'E
Height above *msl*	85 m	

(Geomagnetic coordinates used in this report are relative to a geomagnetic pole position of 79°12'N, 71°14'W, computed from the 6th generation International Geomagnetic Reference Field (Langel, 1992) at epoch 1992.5.)

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 700 m 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 H Middleton were responsible for the general maintenance of the observatory during 1992. Mrs Middleton was replaced by Mrs M Scott at the end of September 1992.

Figure 2 is a site diagram of Eskdalemuir observatory. No major changes were made at the observatory during 1992. Routine building maintenance was carried out on the observatory buildings.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	55°19'N	57°57'N
Longitude	356°48'E	84°02'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 a seismic outstation in South Wales is 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 only member of BGS staff stationed at Hartland is the caretaker. Mr K G Johns retired from this post in July 1992, and was replaced by Mr C R Pringle who was formerly stationed at Eskdalemuir. During 1992 a large quantity of archive material was transferred from Edinburgh to Hartland for storage. This material consists of Observatory Yearbooks, magnetograms and survey records.

Figure 3 is a site diagram of Hartland observatory. Routine maintenance was carried out on all the observatory buildings during 1992.

The observatory coordinates are:

	Geographic	Geomagnetic
Latitude	51°00'N	54°05'
Longitude	355°31'E	80°20'
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 4. 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 minute mean 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 performs measurement of 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) is mounted at the centre of a set of coils which are used to apply bias fields to the magnetometer. 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 mounted at the centre of two orthogonal sets of Helmholtz coils in a "δD/δI" configuration. The coils are orientated initially so that one set provides a bias field approximately perpendicular to the geomagnetic field vector (F) in the magnetic meridian, and the other provides a bias field approximately perpendicular to F in the horizontal plane. If the resultant magnetic field is measured after applying the bias fields then vector algebra can be used to calculate the change in declination (δD) and the change in inclination (δI) relative to values of declination and inclination (D_0 and I_0) determined by the directions of the magnetic axes of the coils. The values of D_0 and I_0 can be determined by comparing the BRM measurements with absolute observations. This technique is described in full by Alldredge (1960).

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

3.4 Summary of Technical Specifications of the ARGOS Equipment

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

a) FM100C fluxgate magnetometer

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

b) ELSEC 820M proton precession magnetometer

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

c) System clock

Accuracy:	1 second per week

d) Datron 1061A digital voltmeter (DVM)

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

e) Time Electronics 9818 programmable current supply

Maximum current:	1A
Accuracy:	1μA

f) Thaler Corporation VRE 105CA precision reference supply

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

3.5 Back-up Systems

At each observatory an EDA FM 100B three-axis fluxgate magnetometer, completely independent of ARGOS, is maintained to provide back-up data in the event of a total ARGOS failure. The three fluxgate sensors are aligned with one along magnetic north to measure changes in the horizontal component (H), one along magnetic east to measure changes in declination (D) and one vertically to measure changes in the Z component. The analogue outputs of the magnetometer are input to a 12-bit A/D converter and sampled every 10 seconds. The 10-second samples are written to a DC300XL cartridge tape to ECMA 46 standard. The cartridge is changed every 14 days and sent by post to BGS, Edinburgh, for transcription. The dynamic range of the magnetometers at Lerwick is ±2000 nT, at Eskdalemuir and Hartland it is ±1000 nT.

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. (The PARIS link is still used to collect data manually each day. Since this link is via a different modem this provides a backup communication system in case the automatic collection system should fail.)

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

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

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

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

At the end of each month any gaps in the ARGOS data are filled using data from the back-up magnetometers. The 10-second back-up data are filtered in the same way as the ARGOS data to produce one-minute values. The resulting complete day files are archived on magnetic tape (two copies) on the VAX and also on data cartridge. The (unfiltered) back-up data are maintained as a high time-resolution data set. 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 monthly bulletin also contains a diary giving details of any changes made during the month at the observatory.

The number of missing minute values during 1992 at each observatory, resulting from failure of the ARGOS and back-up systems during the same periods of time, were as follows:

	No. of missing minute values	Date
Lerwick	48	13 Oct
	14	14 Oct (Z component only)
Eskdalemuir	0	-
Hartland	0	-

5 CORRECTION OF FLUXGATE VARIOMETER DATA TO ABSOLUTE VALUES

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

The zero-field offset corrections allocated for each observatory for 1992 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 correction adopted, 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.

Lerwick (Figure 5)

Absolute measurements were made by BGS staff during service visits to the observatory in February, May, August 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, 0.9 minutes of arc for D and 13 nT for Z. The main deviation in the Z corrections appears to be an annual effect and is probably related to an increase in temperature during the summer.

The comparison of BRMs with fluxgate measurements shows that between the end of May and the middle of October the the BRMs were subject to a varying drift. It is likely that this drift is related to changes in the outside air temperature causing mechanical deformation of the coils. In October new feet were installed on the δD/δI coils and the coils were relevelled. This appears to have substantially reduced the instrument drift.

The temperature variation in the variometer chamber was kept to within ±1°C over the year.

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

Year	H(nT)	D(min)	Z(nT)
1989	2.97 (19)	0.48 (18)	1.57 (19)
1990	1.69 (25)	0.37 (24)	1.95 (25)
1991	0.82 (19)	0.58 (19)	0.74 (20)
1992	1.70 (26)	0.36 (27)	1.21 (26)

Eskdalemuir (Figure 6)

Absolute measurements were made weekly by staff of the Meteorological Office at Eskdalemuir, supplemented by occasional measurements made by BGS staff.

At the end of 1991 the oscillator card for the fluxgate sensors failed and it was replaced on 7 January 1992. The initial drift in the zero-field offset corrections until the end of January is the result of the new oscillator card stabilising. During the rest of the year the ranges in the allocated zero-field offset corrections were 11 nT for H, 2 minutes of arc for D and 7 nT for Z.

The BRM - fluxgate comparison at Eskdalemuir agrees very well with the zero-field offset corrections. Drift in the BRMs was observed from the end of May to mid July. On 16 July a new set of δD/δI coils was installed in which all the polythene components had been replaced by Tufnol components. This appears to have reduced the drift in the BRMs.

In July a fault developed in the fluxgate-theodolite (inventory number ESK43) which was returned to the manufacturers for repair. The absolute observations made between 25 August and 7 October were made with the fluxgate-theodolite normally used for the magnetic survey of the UK (inventory number GM105). This instrument is fitted with an ELSEC 810 fluxgate magnetometer. Following the return of ESK43 a comparison between measurements made with this instrument and GM105 at Eskdalemuir showed that there is a constant difference in declination and inclination measured by the two instruments. Therefore the measurements made by GM105 between 25 August and 7 October had the following corrections added: +2.5 minutes of arc in D, +5.5 nT in H and -2.2 nT in Z. An investigation will be carried out to determine the cause of the difference in the measurements made by the two fluxgate-theodolites.

The temperature variation in the variometer chamber was kept to within ±0.25°C over the year.

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

Year	H(nT)	D(min)	Z(nT)
1989	1.77 (15)	0.61 (21)	1.06 (15)
1990	2.63 (38)	0.81 (38)	1.59 (38)
1991	1.67 (42)	0.44 (43)	1.09 (42)
1992	1.43 (36)	0.55 (36)	0.83 (36)

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 4 nT for H, 0.5 minutes of arc for D and 9 nT for Z. The drift in the Z fluxgate, which appears to be similar to that observed at Lerwick, is probably related to the increase in temperature during the summer.

Severe drift was observed in the BRMs from the end of March to the end of May. At the beginning of June the δD/δI coils were refurbished by removing all polythene components and replacing them with Tufnol components, which immediately removed the drift in the BRMs. At the beginning of November new feet were installed on the δD/δI coils and since then a slight drift has been observed. It is assumed that this is due to settlement of the coils on the new feet, and that the drift should decrease with time.

The temperature variation in the variometer chamber was kept to within ±1.25°C over the year.

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

Year	H(nT)	D(min)	Z(nT)
1989	1.24 (44)	0.24 (5)	1.03 (44)
1990	1.88 (55)	0.49 (57)	1.11 (56)
1991	1.03 (48)	0.17 (49)	1.09 (47)
1992	1.11 (48)	0.36 (49)	1.69 (49)

6 PRESENTATION OF RESULTS

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

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

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

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

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

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

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

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

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

7 DATA AVAILABILITY

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

Data Services
Geomagnetism Group
British Geological Survey
Murchison House
West Mains Road
Edinburgh EH9 3LA
Scotland UK

☎: 031 667 1000
Fax: 031 668 4368
Telex: 727343 SEISED G

8 GEOMAGNETISM GROUP STAFF LIST 1992

Edinburgh

Group Manager (Grade 7)	Dr D J Kerridge
PSec	Mrs M Milne
Grade 7	D R Barraclough J C Riddick
HSO	Dr T D G Clark S 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
ASO	F J Campbell
Craftsman	J McDonald
Casual	N C Davidson (April - September) C B Turbitt

Eskdalemuir

Craftsman	W E Scott
Cleaner	Mrs H Middleton (until September) Mrs M Scott (from October)

Hartland

PGS E	C R Pringle

Staff changes during 1992

At the end of July Mr K G Johns retired after 27 years service at Hartland. Mr C R Pringle transferred to Hartland in August, having been stationed at Eskdalemuir for 10 years. Mrs M Scott replaced Mrs H Middleton, who had been at Eskdalemuir for 10 years.

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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.

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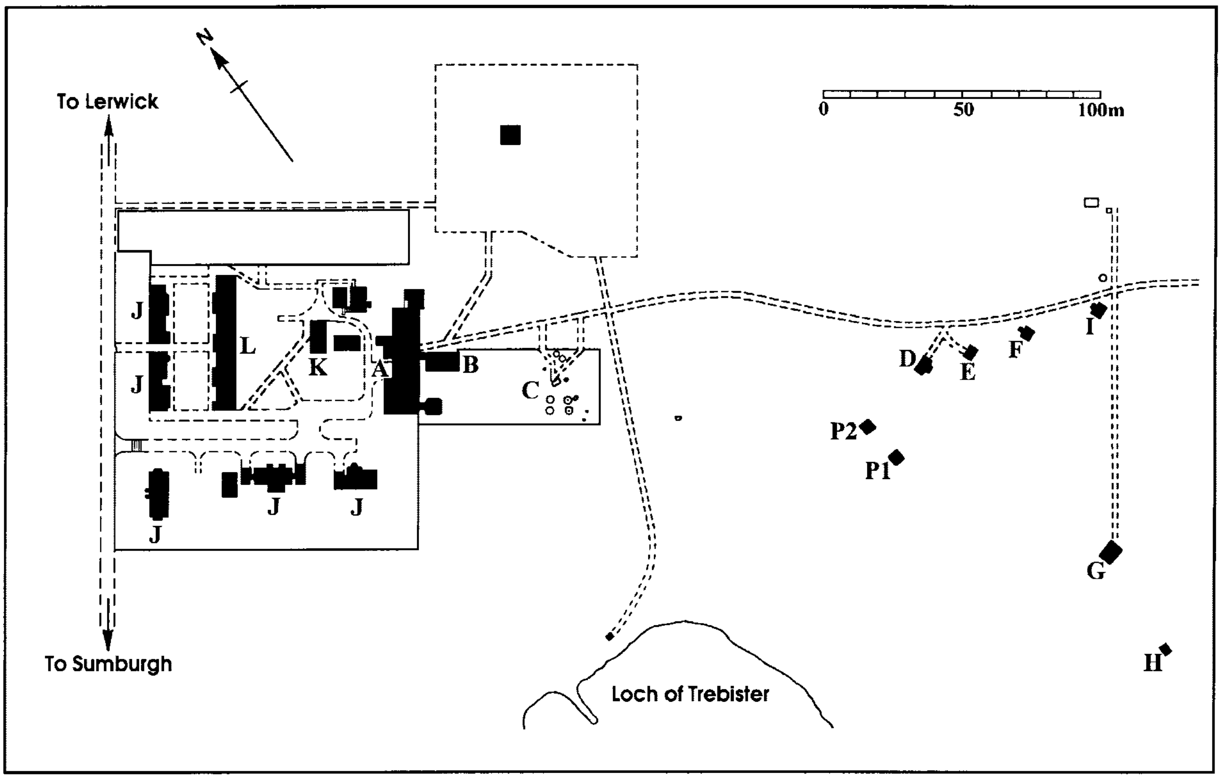
Robinson, P R. 1982. Geomagnetic observatories in the British Isles. *Vistas in Astronomy*, **26**, 347-367.

Lerwick Observatory



Observatory Layout

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

Instrument Deployment

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

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

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

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

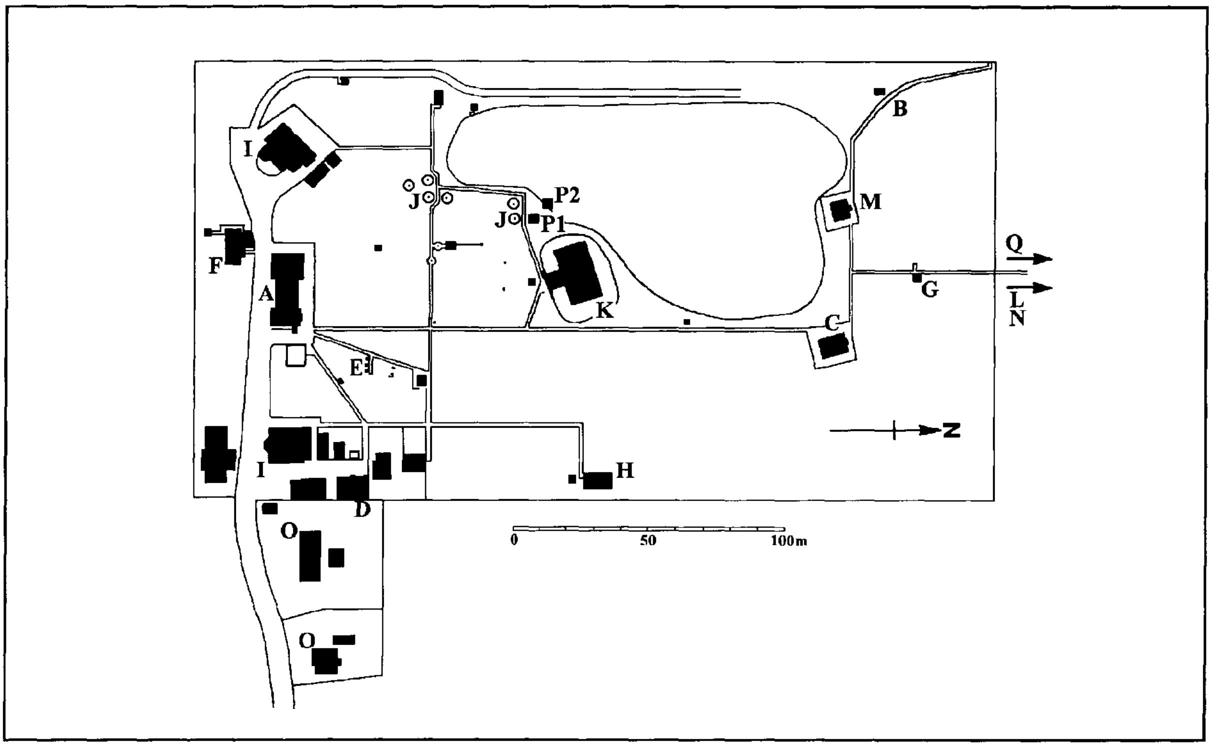
The Variometer House is constructed from non-magnetic concrete and has internal dimensions of 4.9 by 3 metres. The roof is semi-circular in cross section. The temperature of the house is controlled to a diurnal range of $\pm$1°C. The meridian at the time of construction is defined on the north and south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

Previous descriptions

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

Figure 1. Lerwick observatory site diagram

Eskdalemuir Observatory



Observatory Layout

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

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

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

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

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

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

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

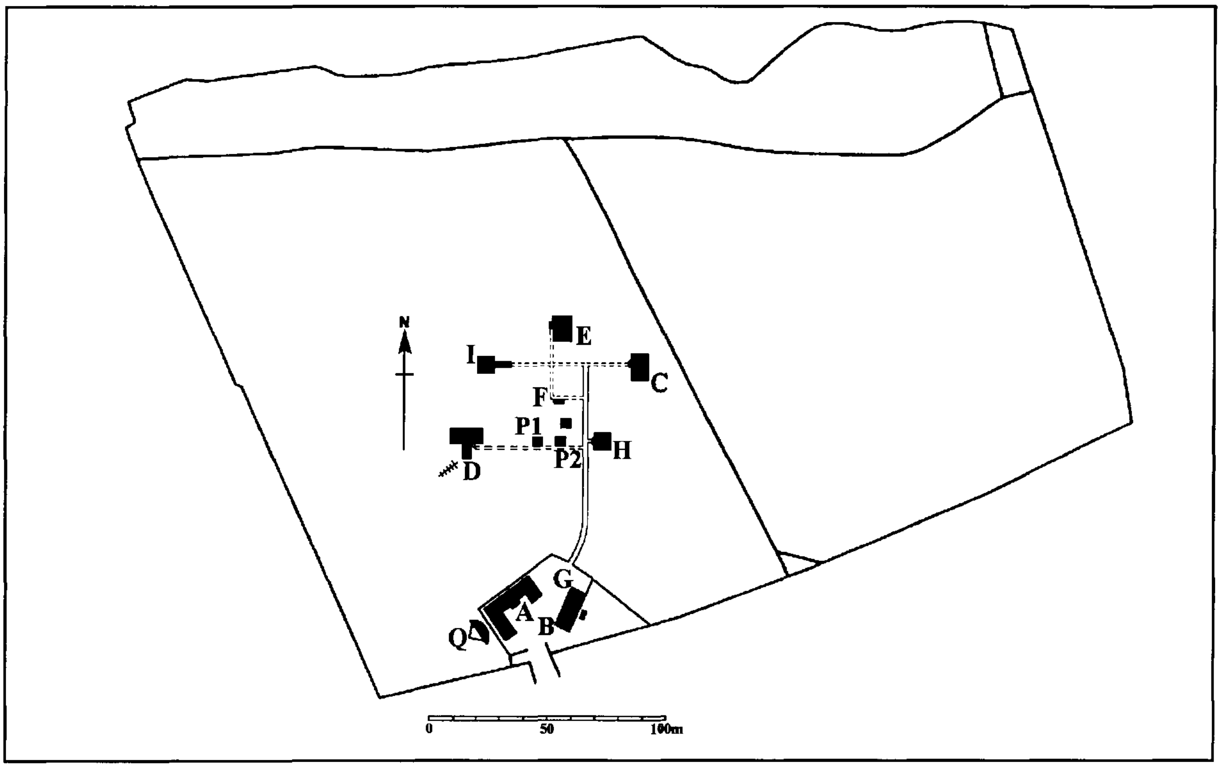
The Non-Magnetic Laboratory
The laboratory is used for instrument development and testing. It contains two rooms, a sensor room with three piers and a larger instrument room with a single pier.

Previous descriptions

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

Figure 2. Eskdalemuir observatory site diagram

Hartland Observatory



Observatory Layout

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

Instrument Deployment

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

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

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

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

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

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

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

Test Hut 2
Auxiliary measurement position

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

Previous descriptions

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

Figure 3. Hartland observatory site diagram

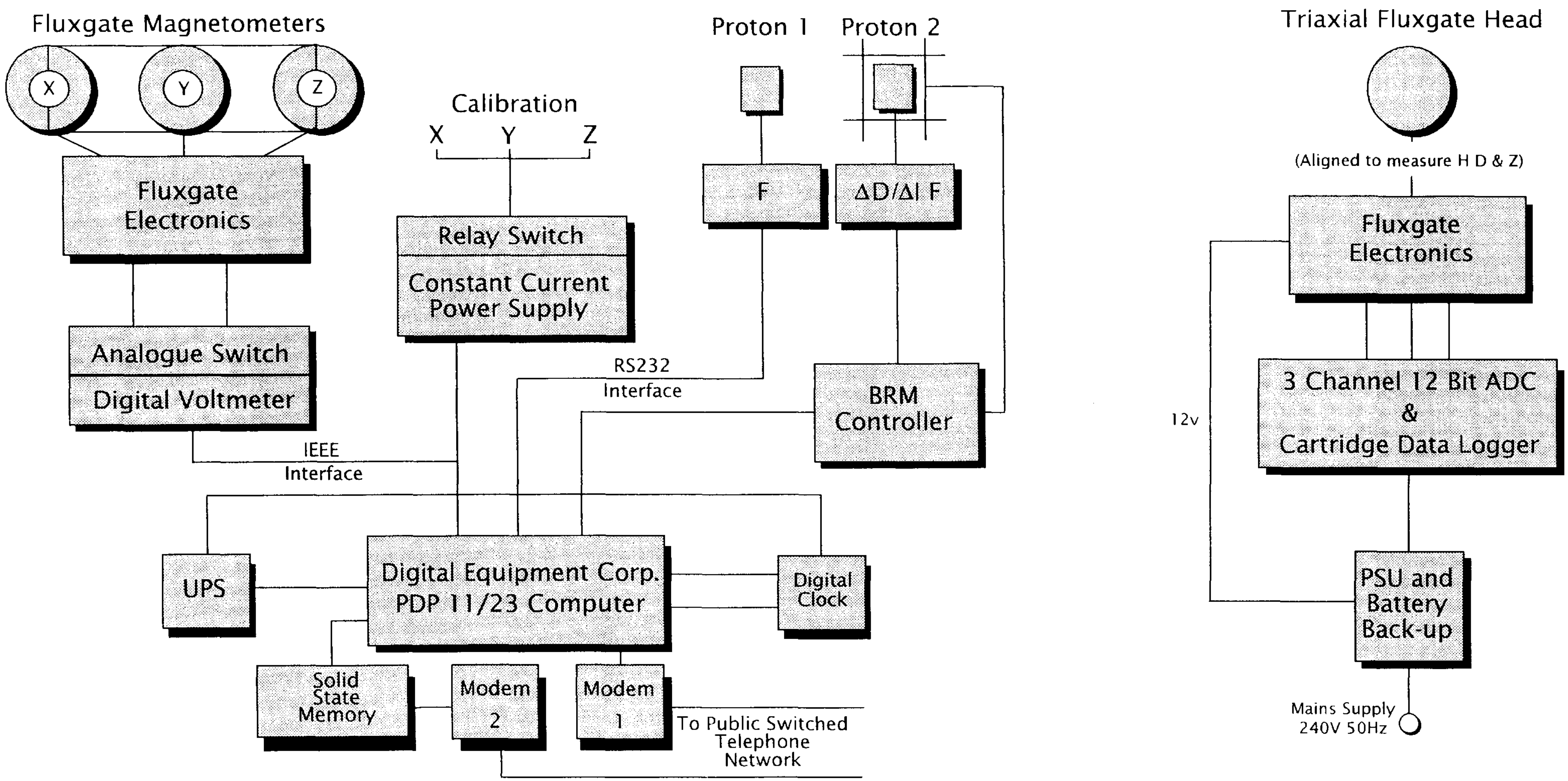
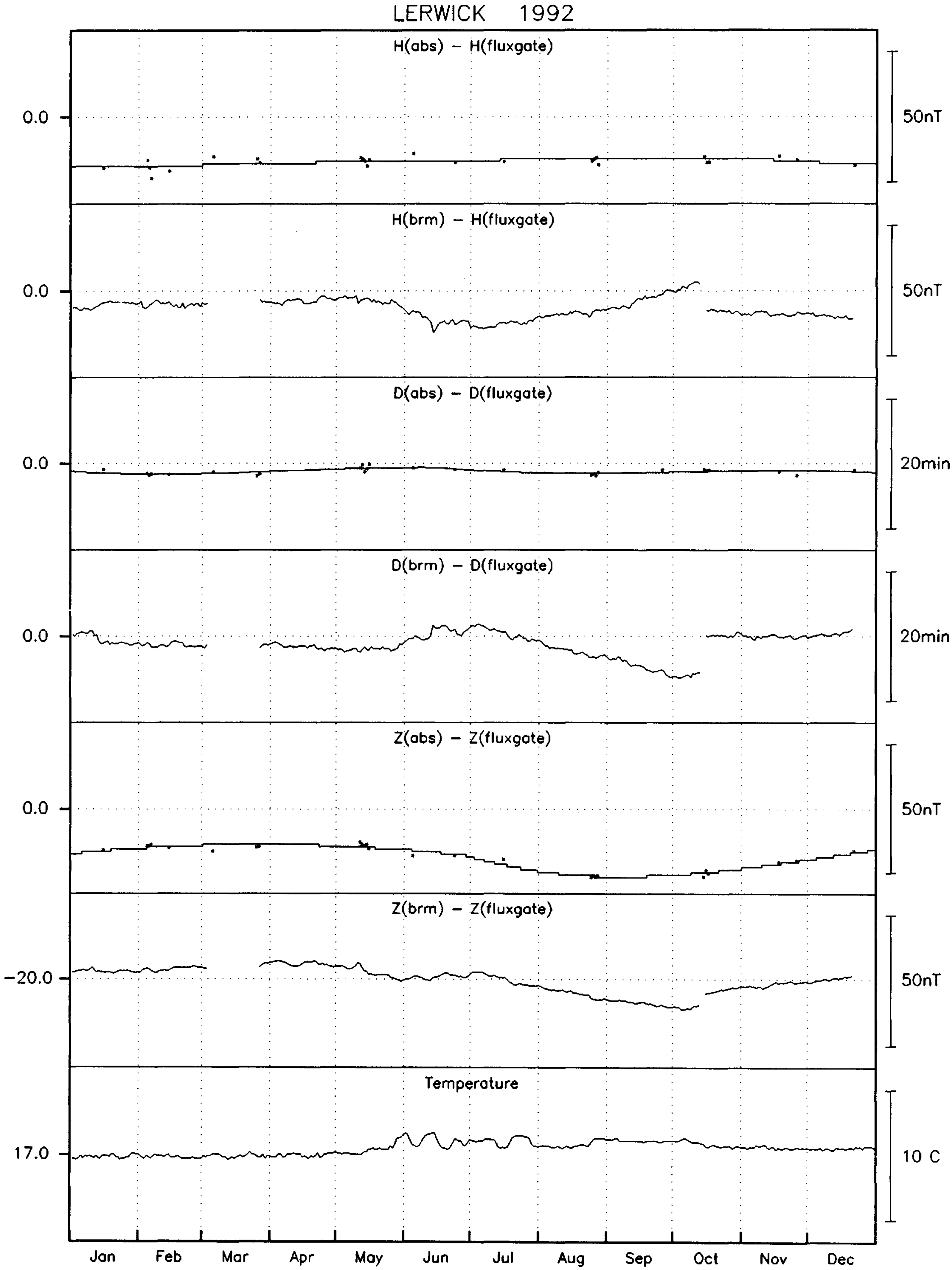


Figure 4. Block diagram of ARGOS and backup system


LERWICK 1992
H(abs) – H(fluxgate)
0.0
50nT
H(brm) – H(fluxgate)
0.0
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D(abs) – D(fluxgate)
0.0
20min
D(brm) – D(fluxgate)
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20min
Z(abs) – Z(fluxgate)
0.0
50nT
Z(brm) – Z(fluxgate)
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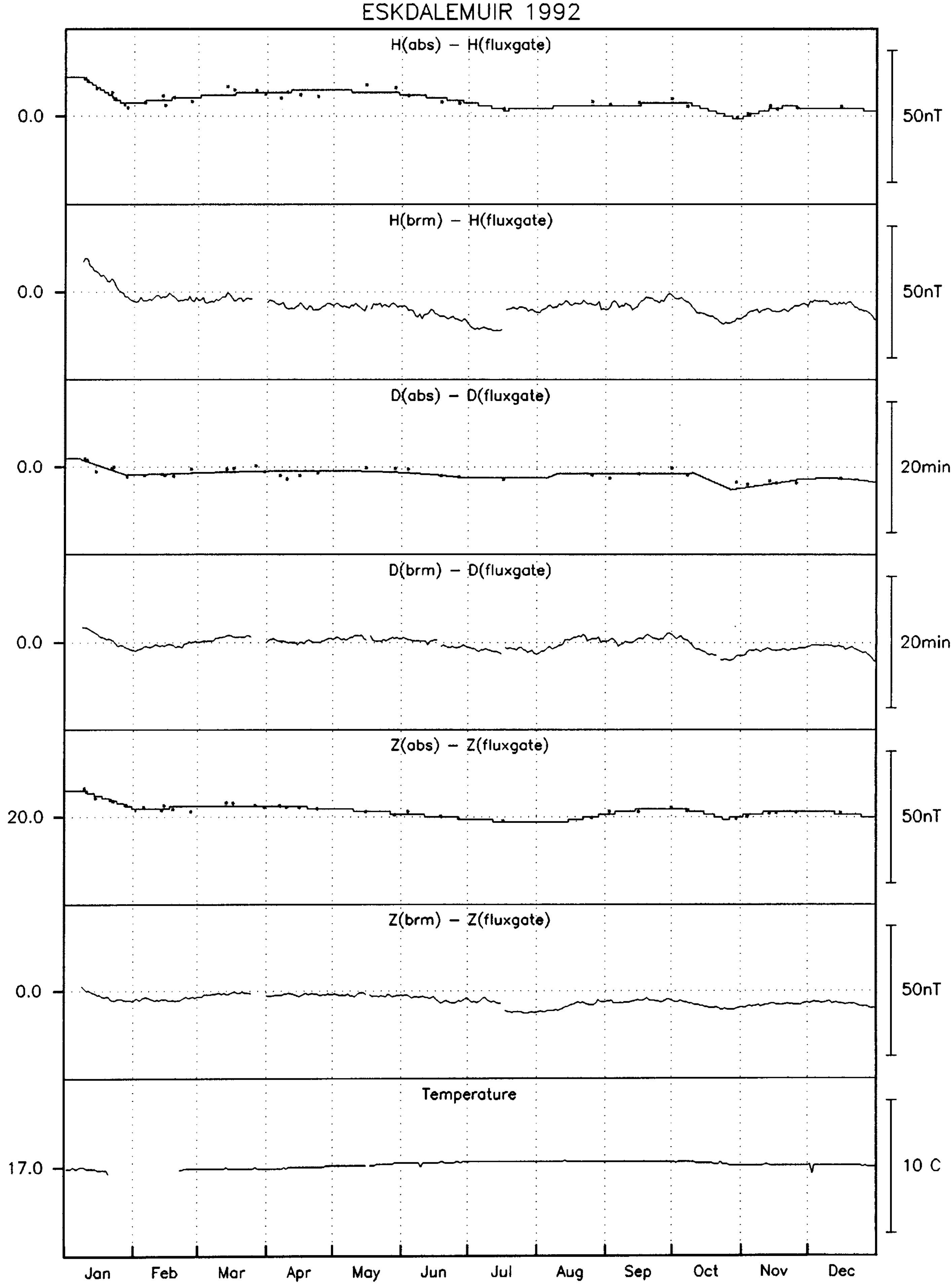
Figure 5.


ESKDALEMUIR 1992
H(abs) – H(fluxgate)
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D(brm) – D(fluxgate)
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Z(abs) – Z(fluxgate)
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Z(brm) – Z(fluxgate)
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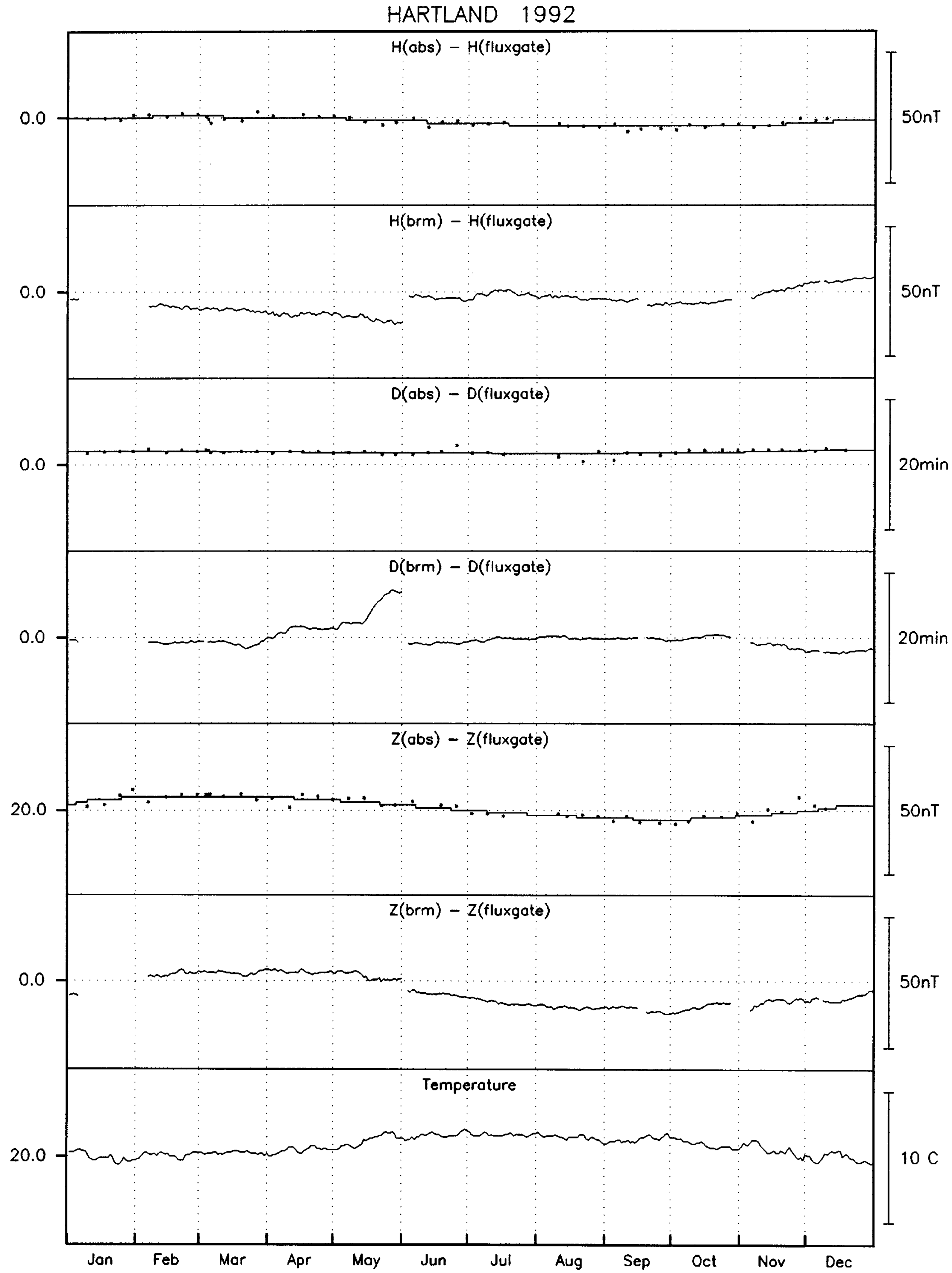

HARTLAND 1992
H(abs) – H(fluxgate)
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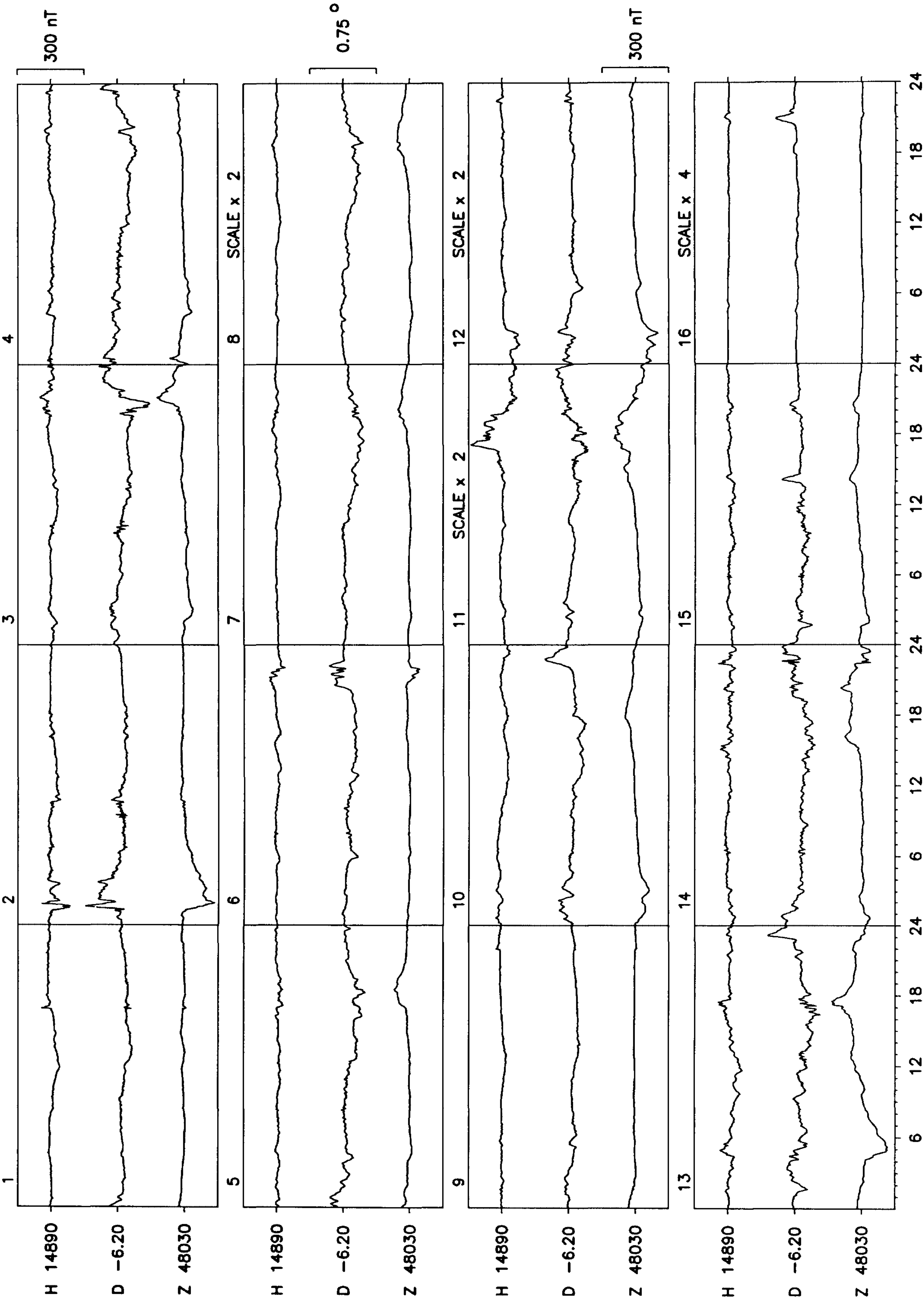
Figure 7.

Lerwick 1992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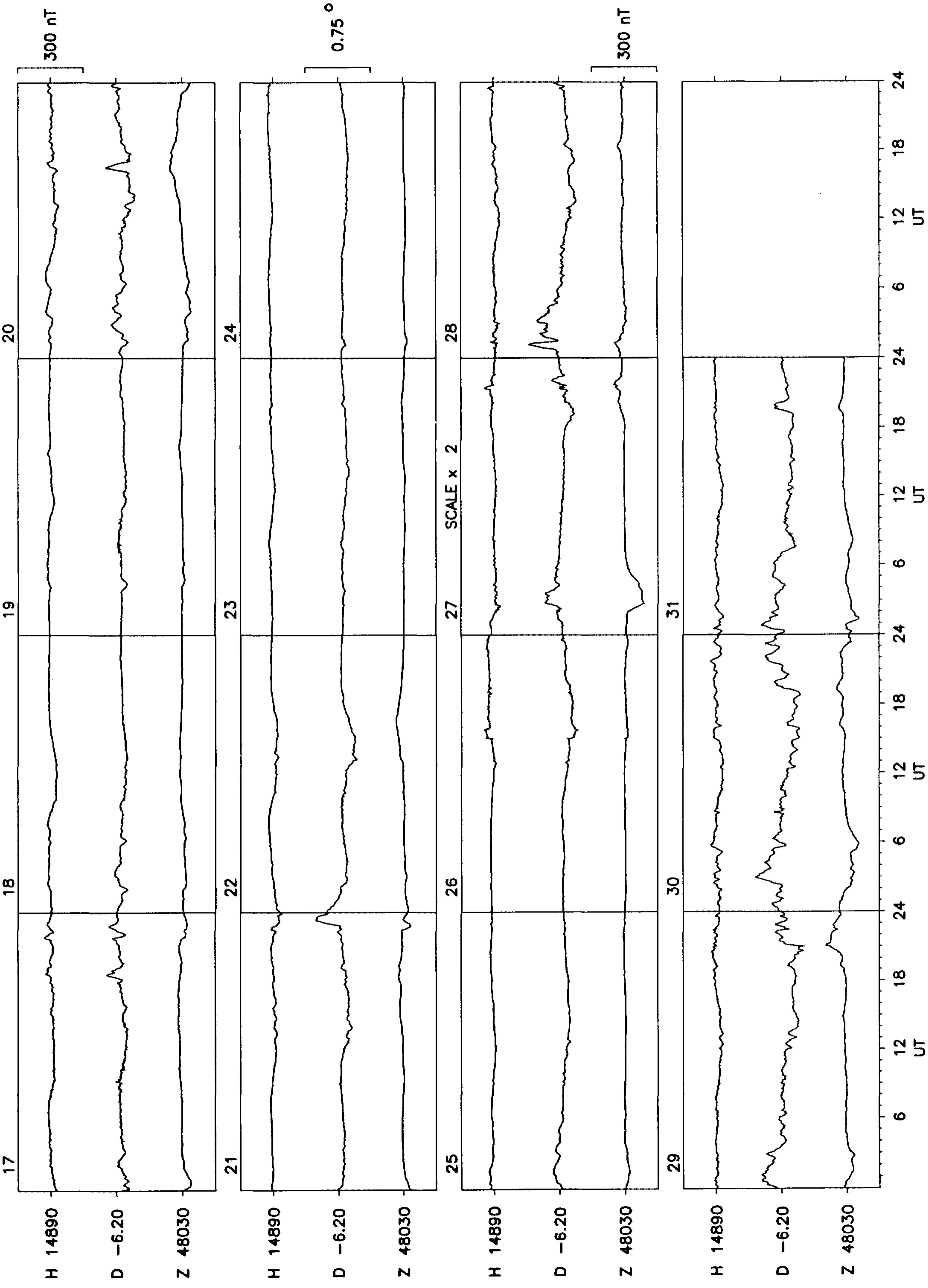
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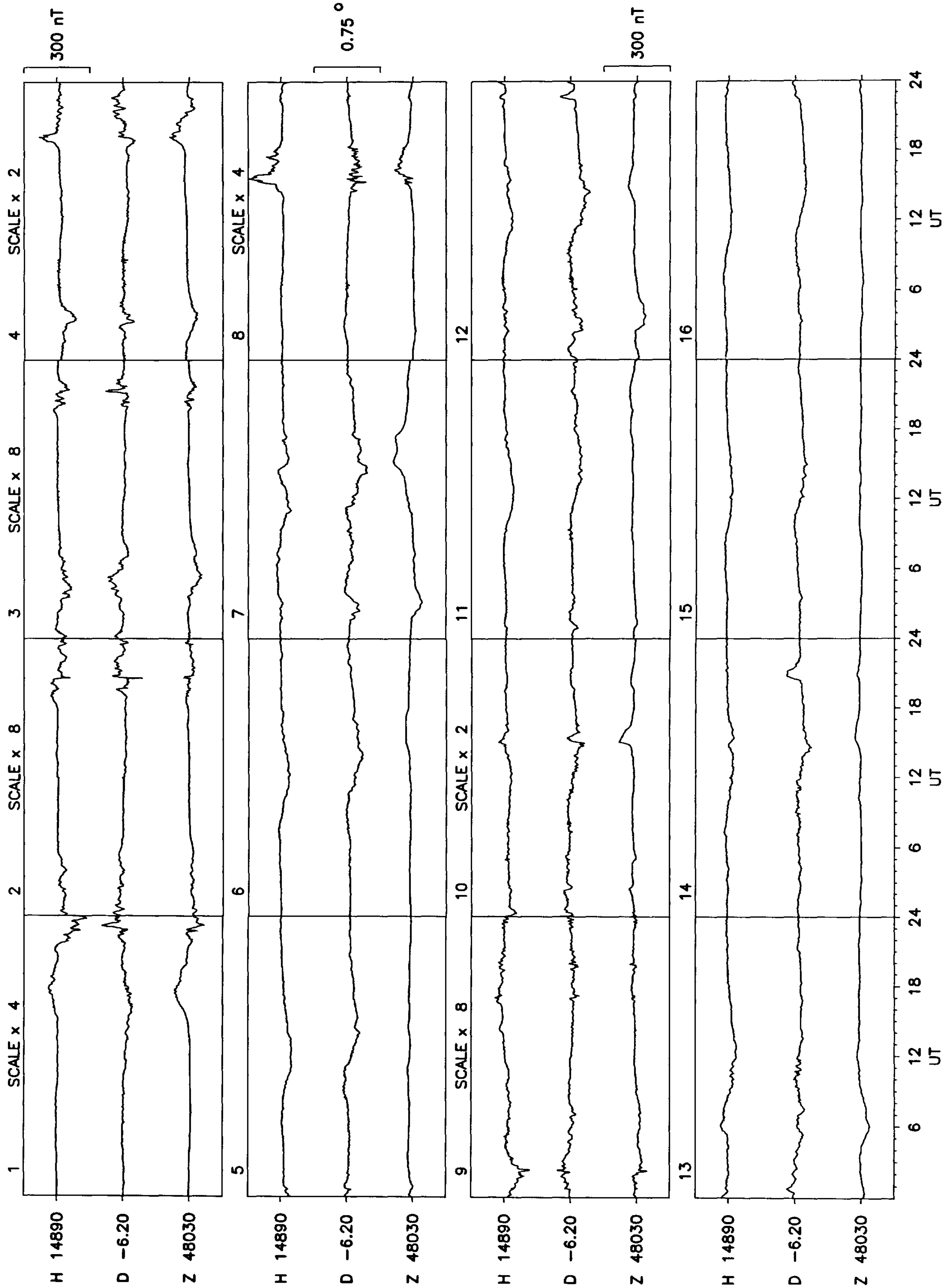
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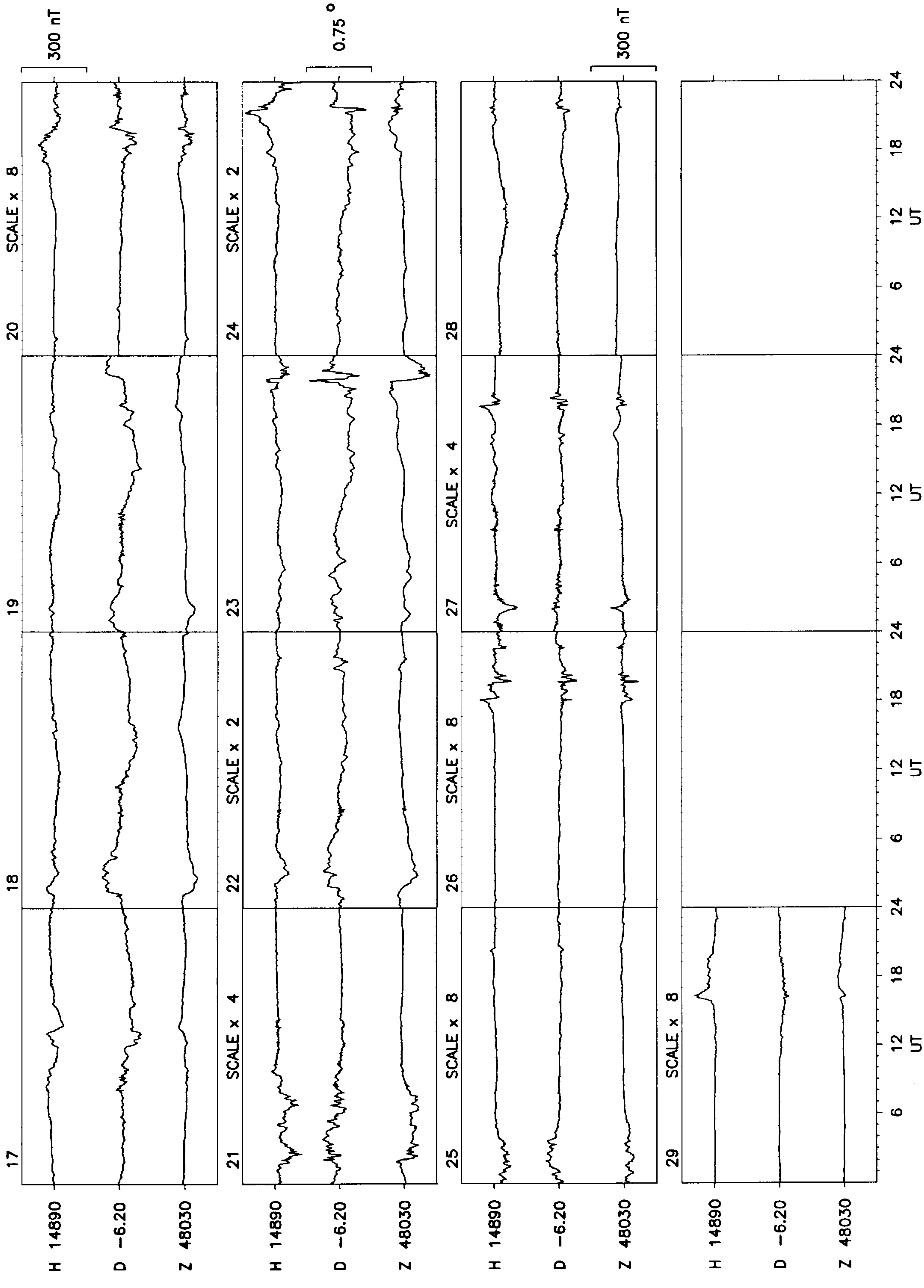
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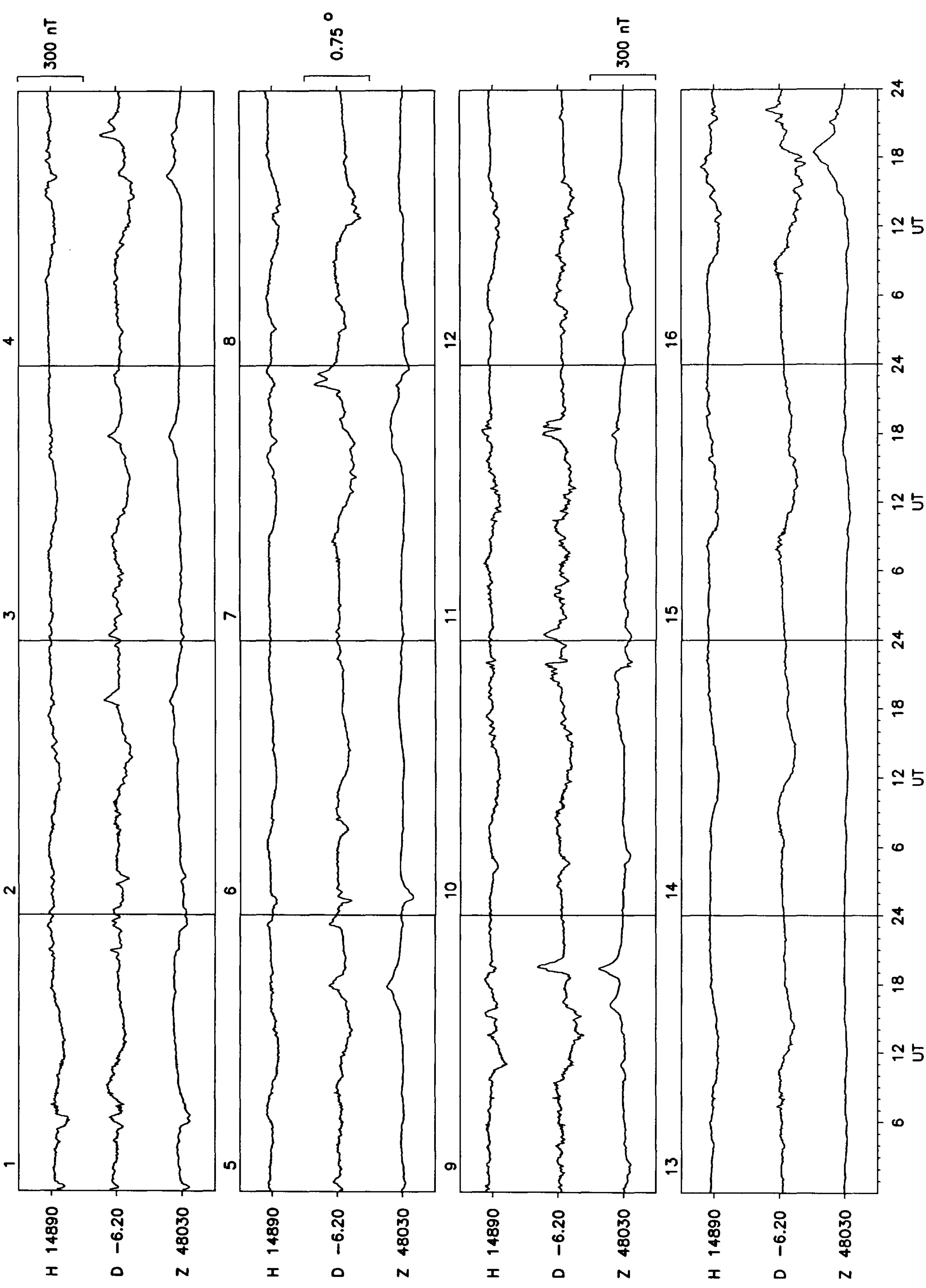
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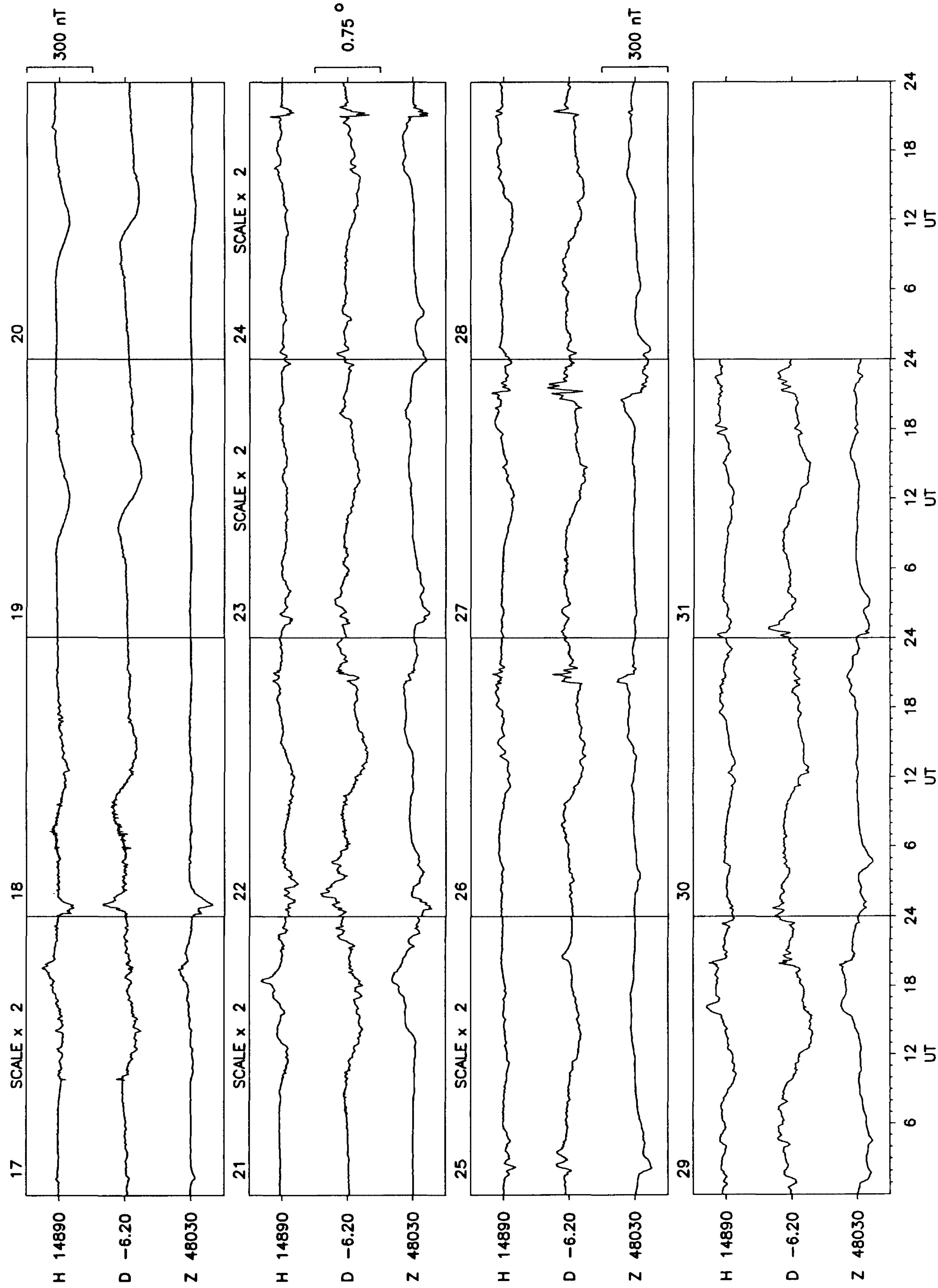

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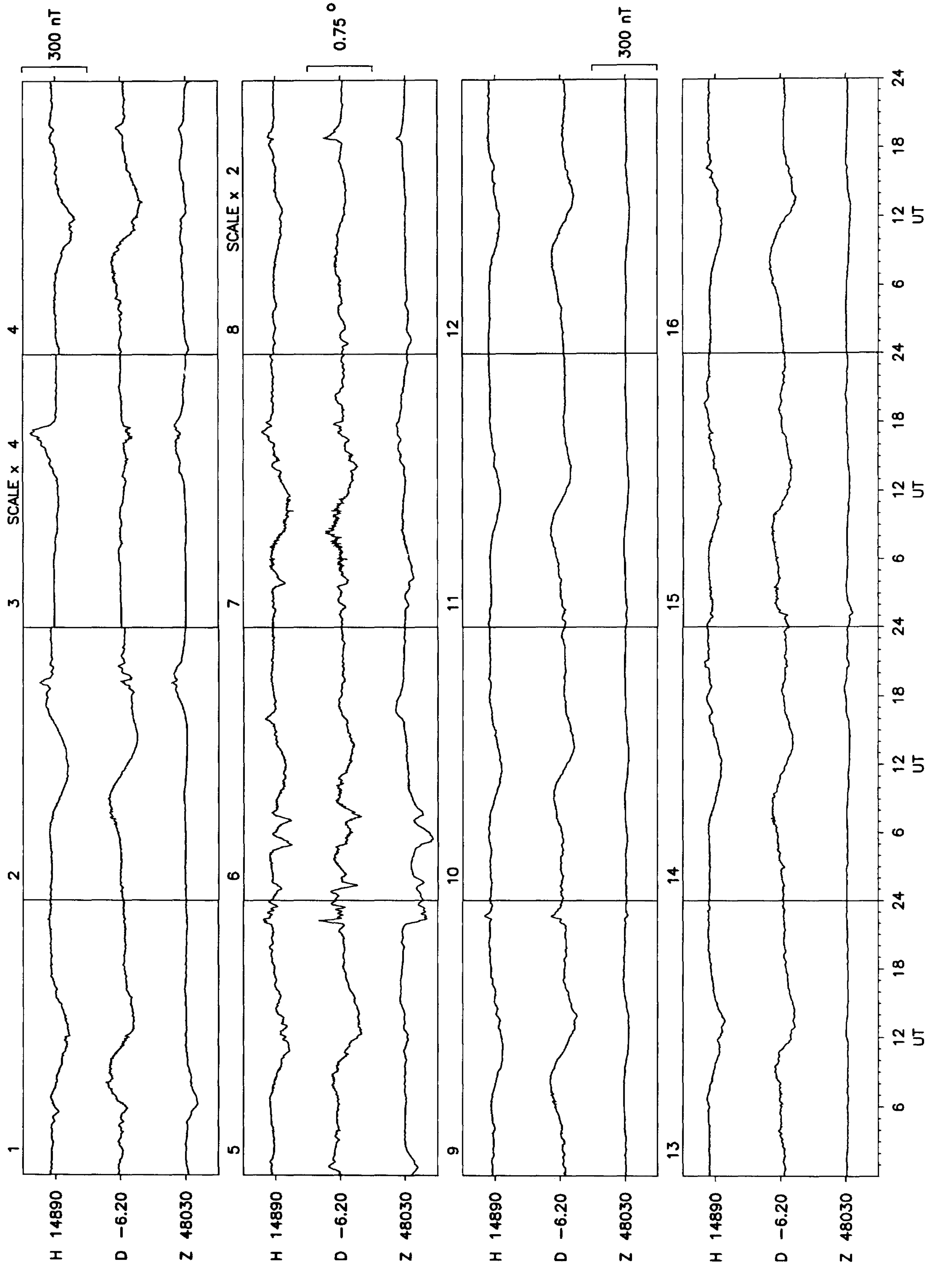
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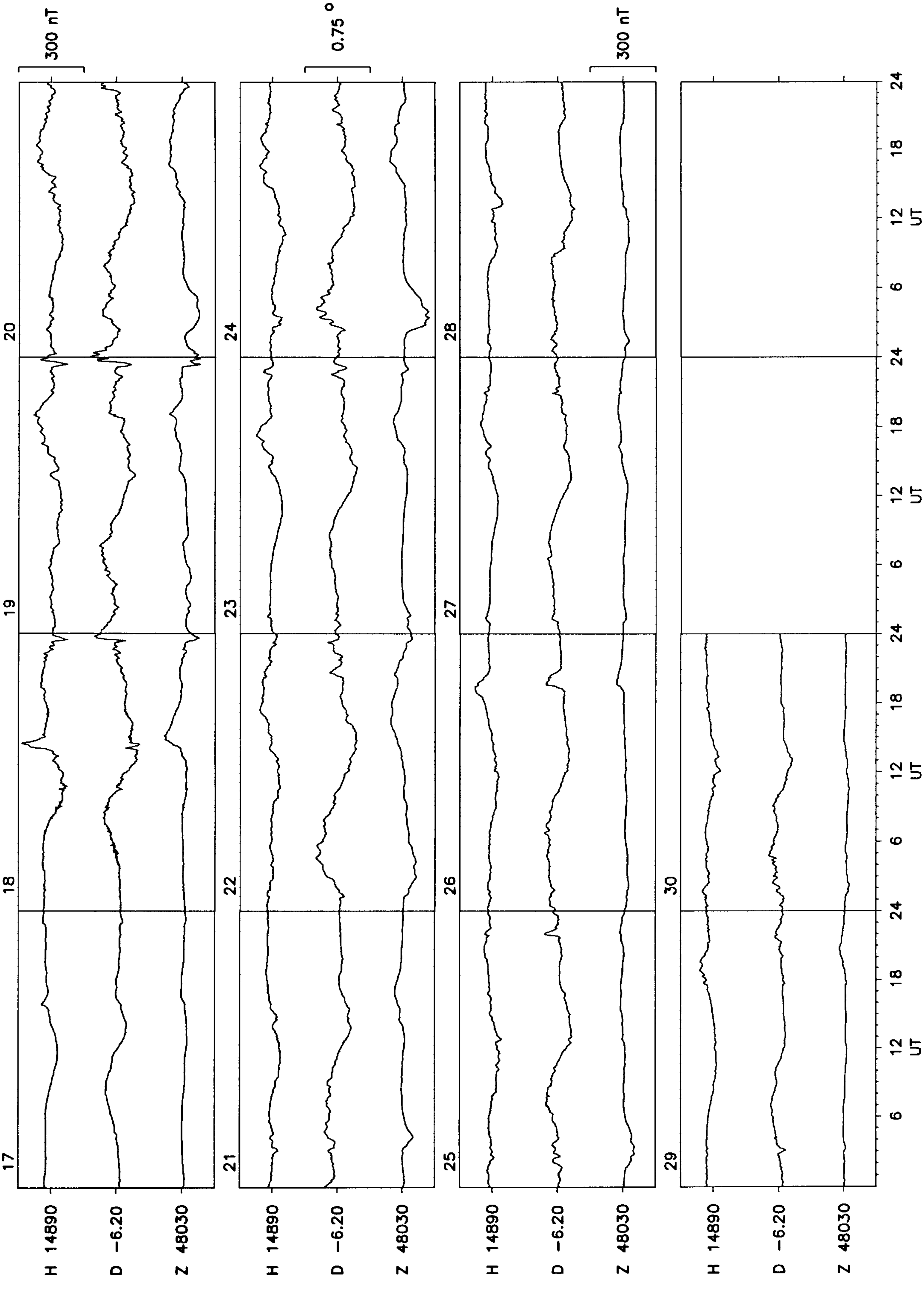
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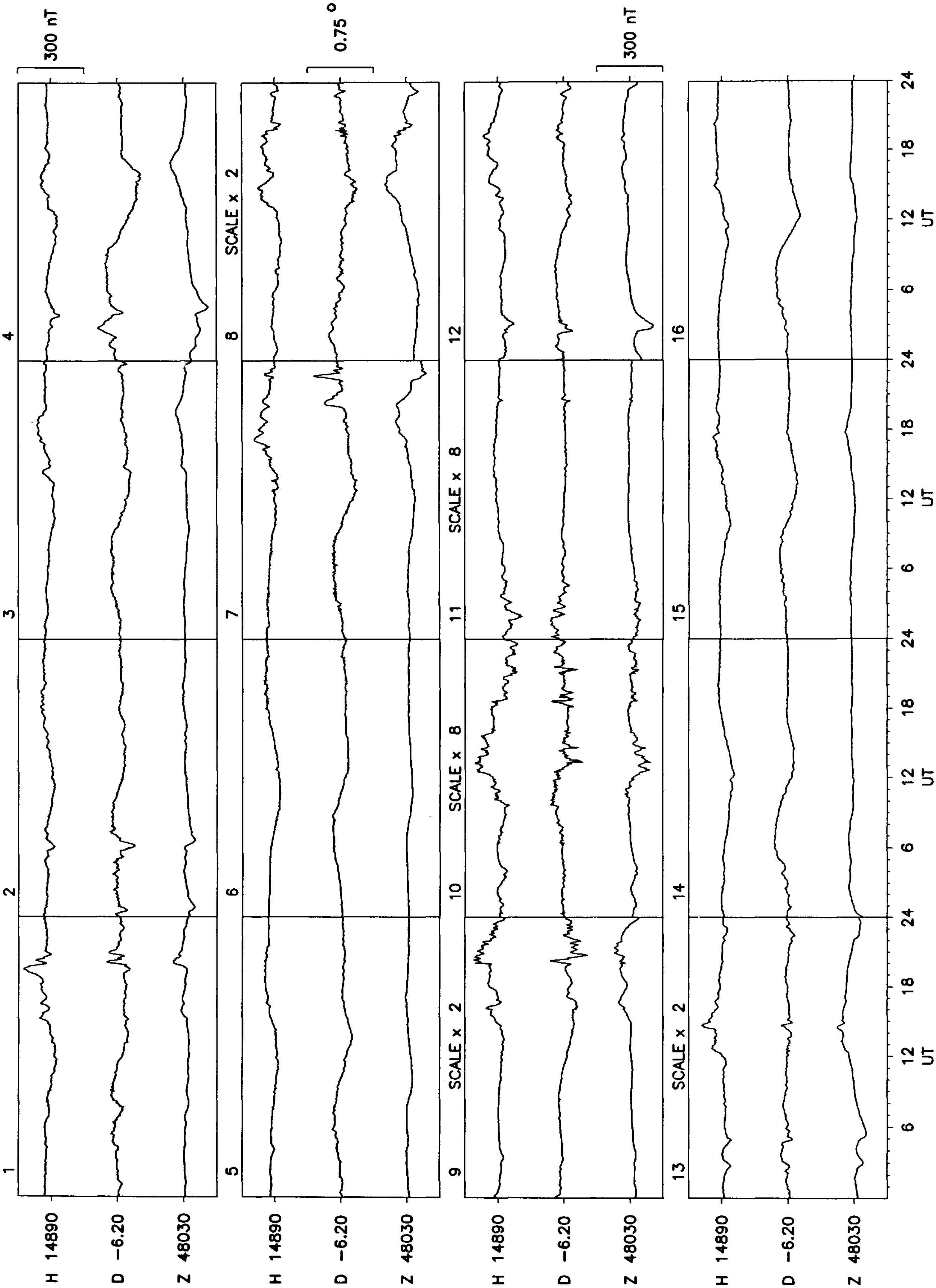

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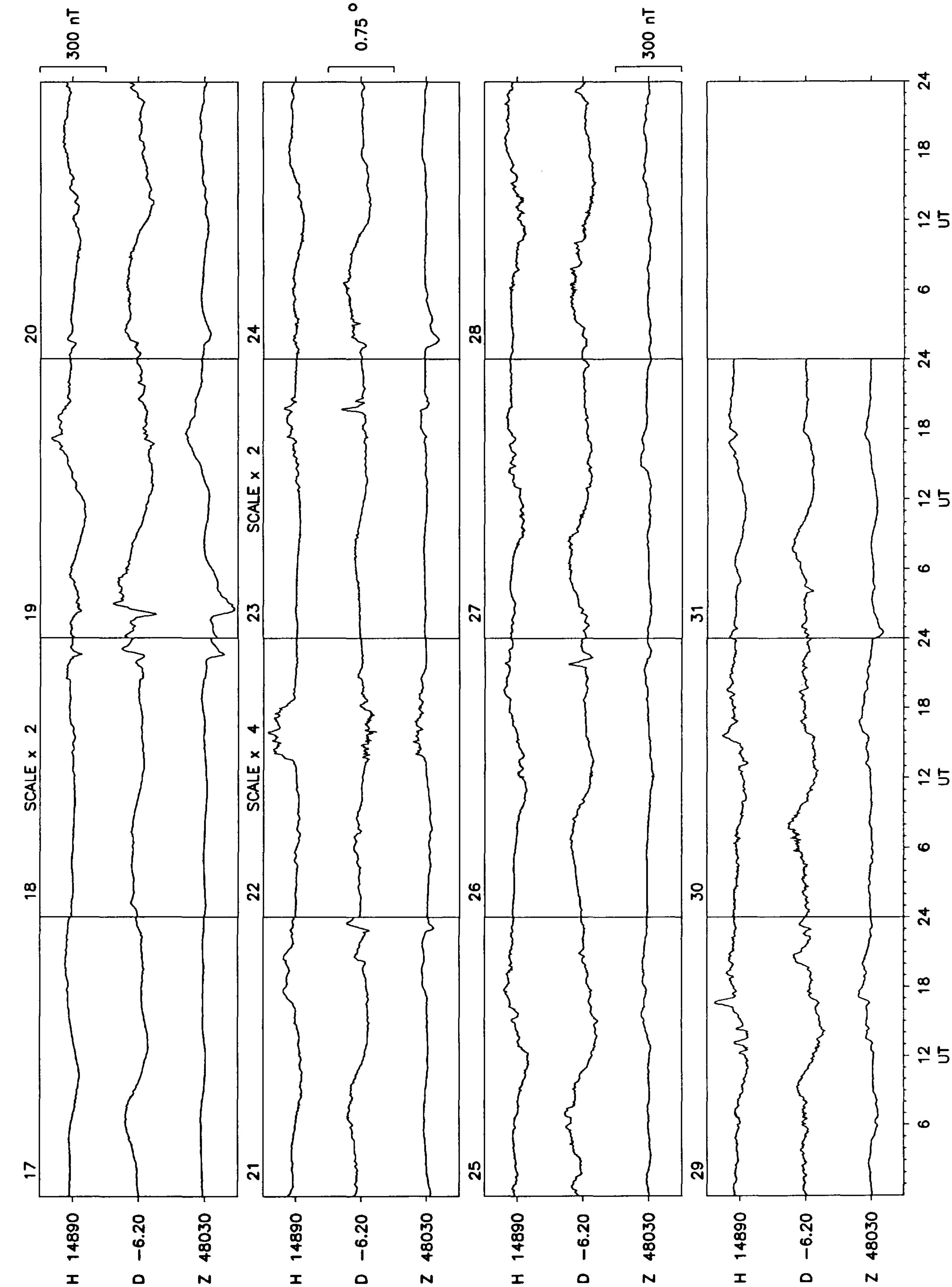

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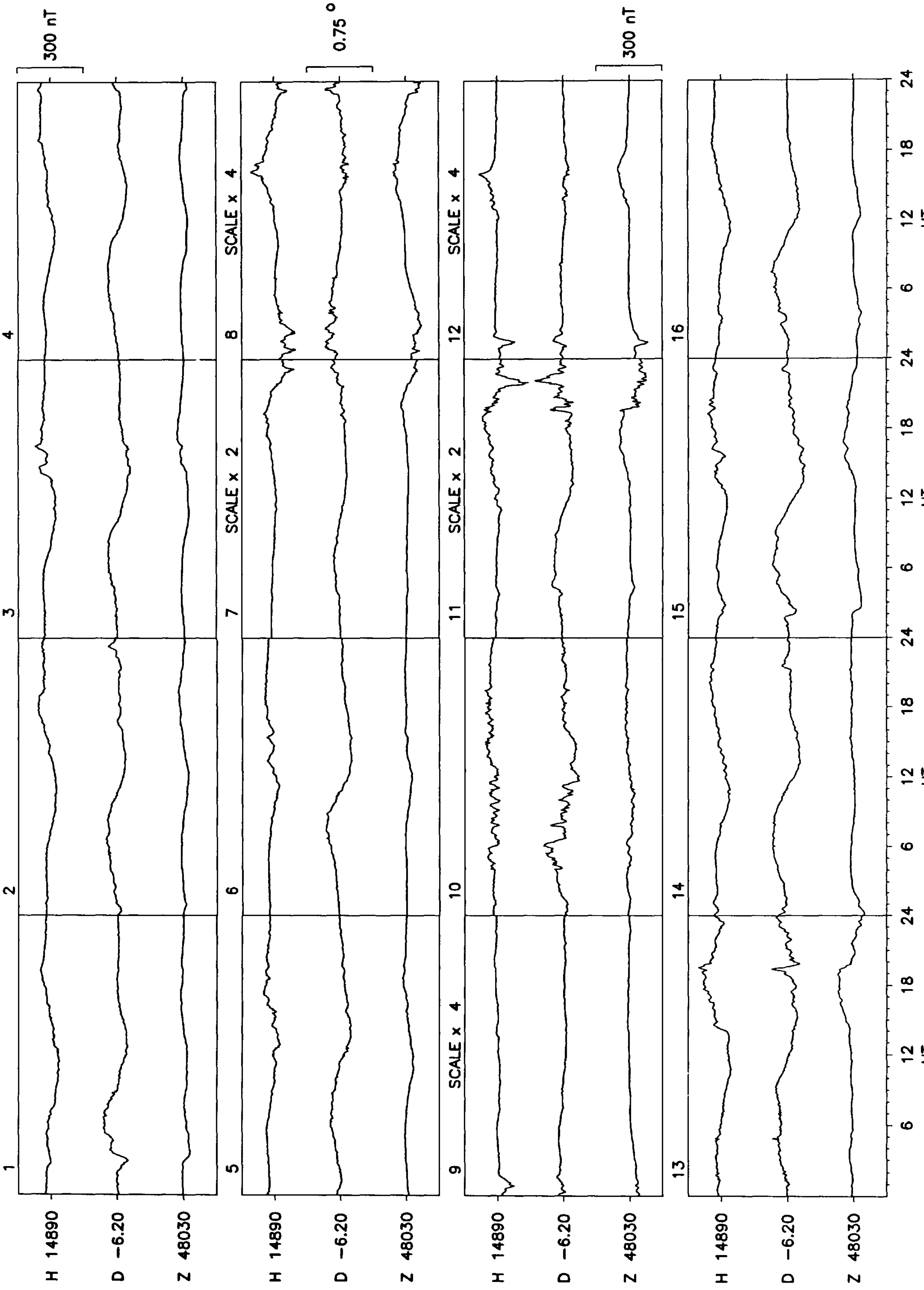

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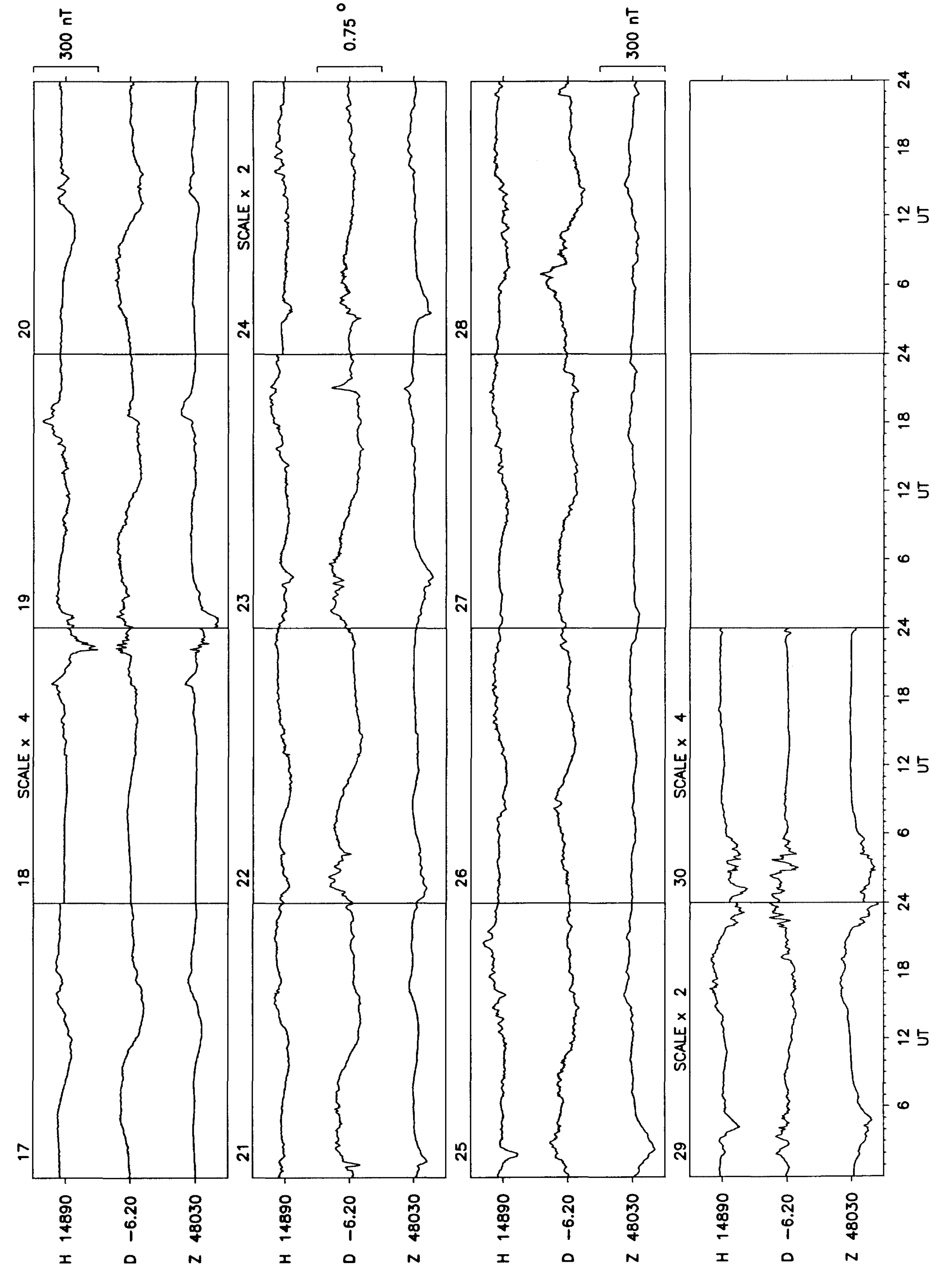
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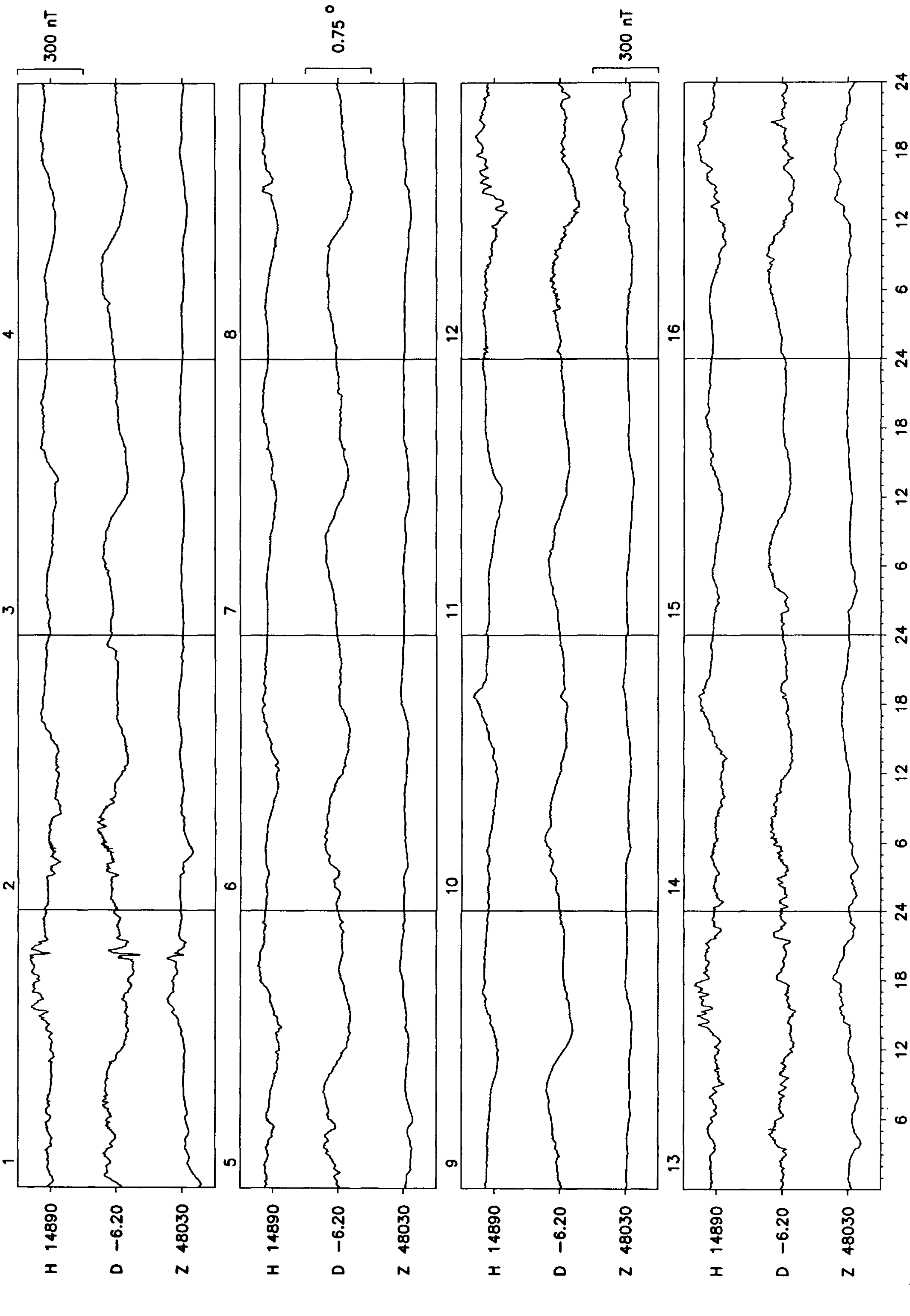
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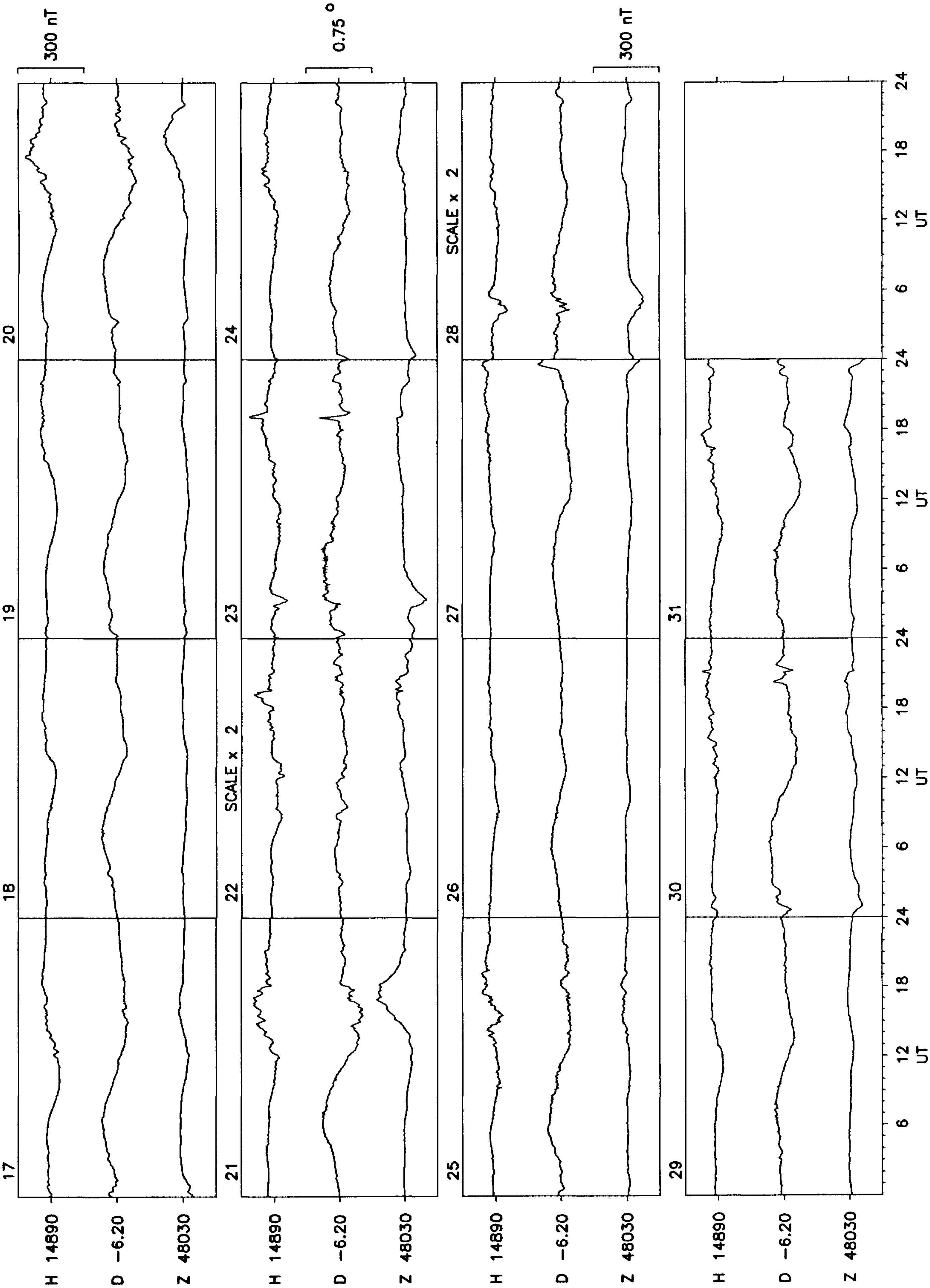
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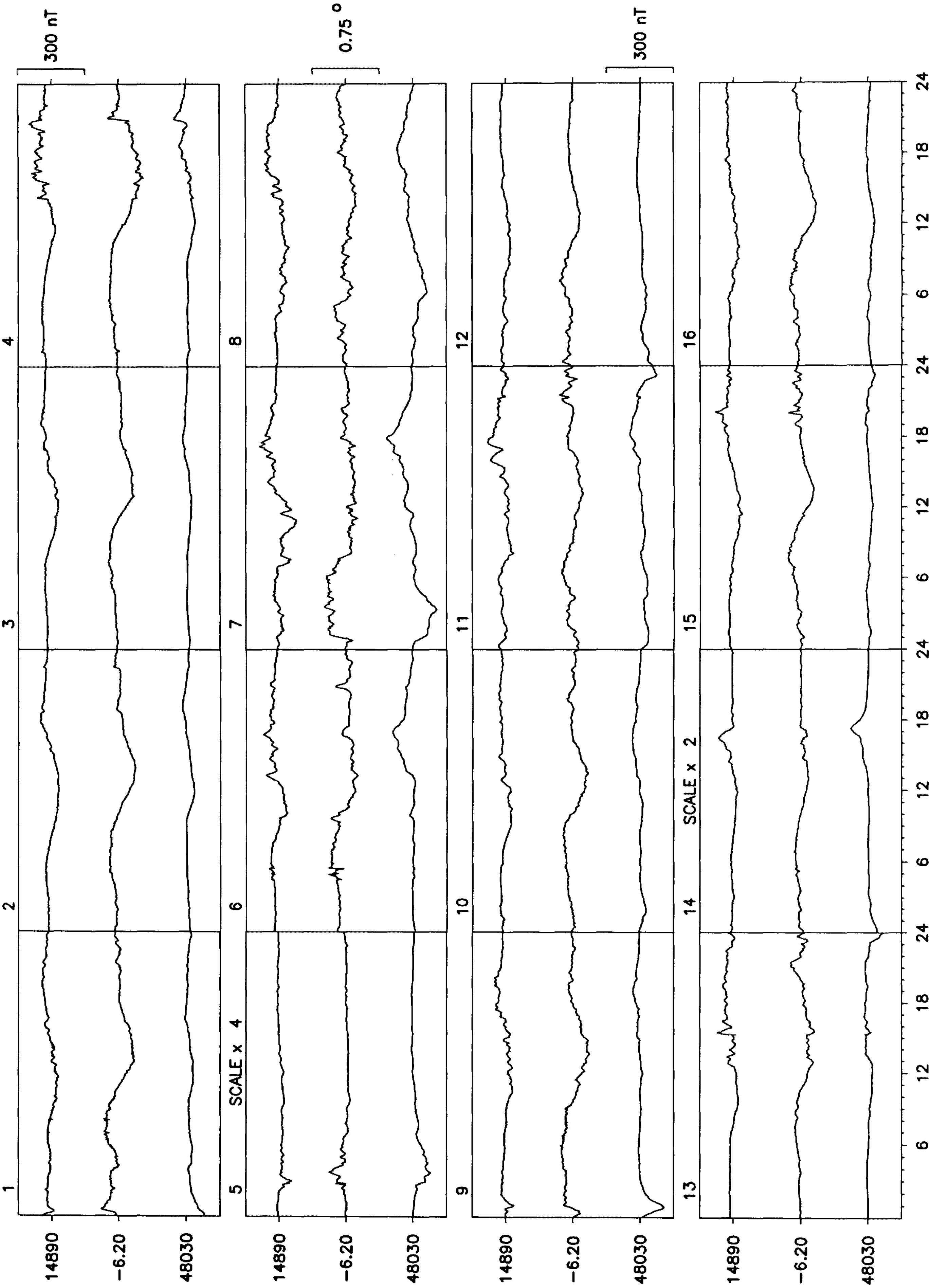
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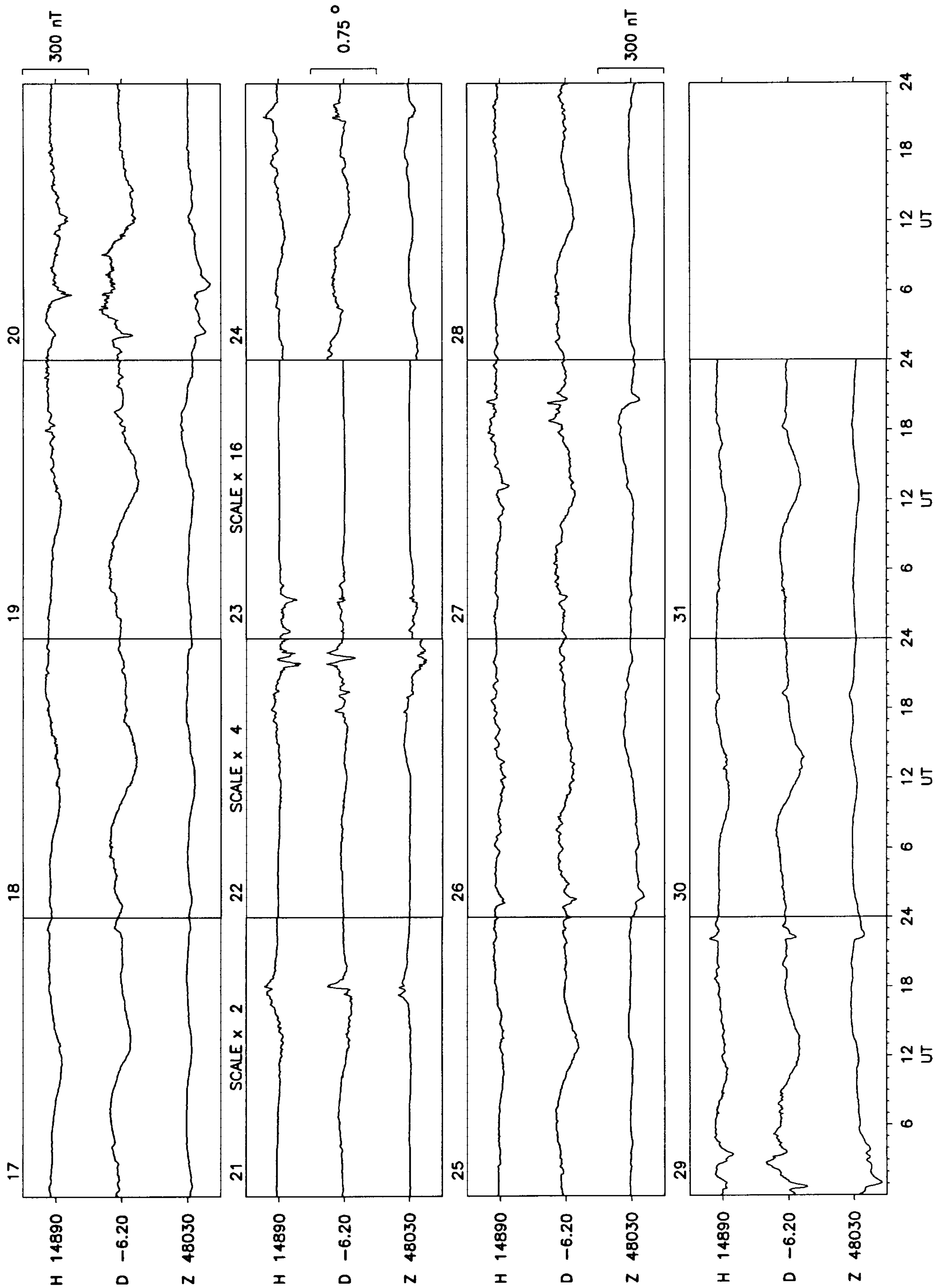
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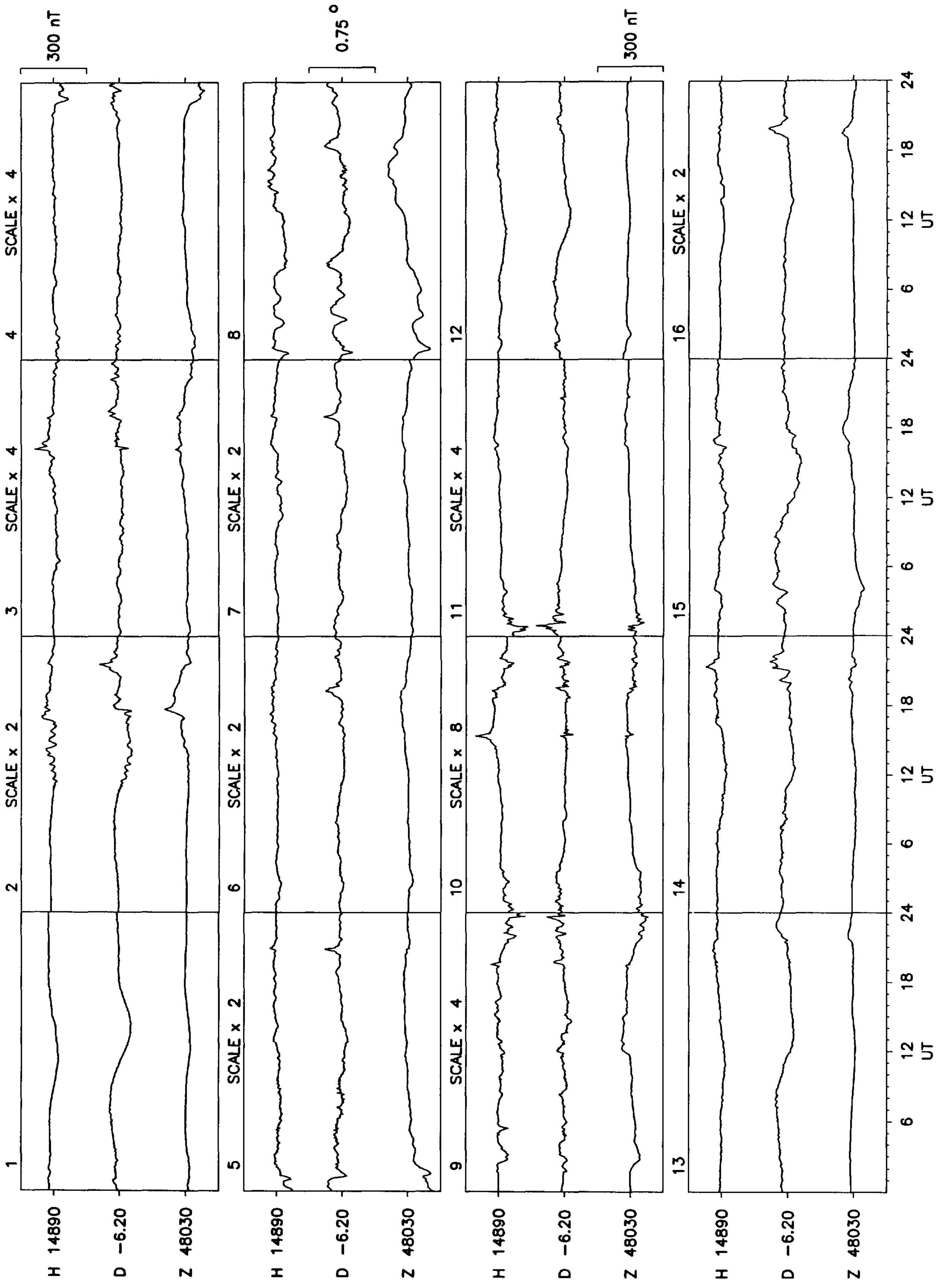
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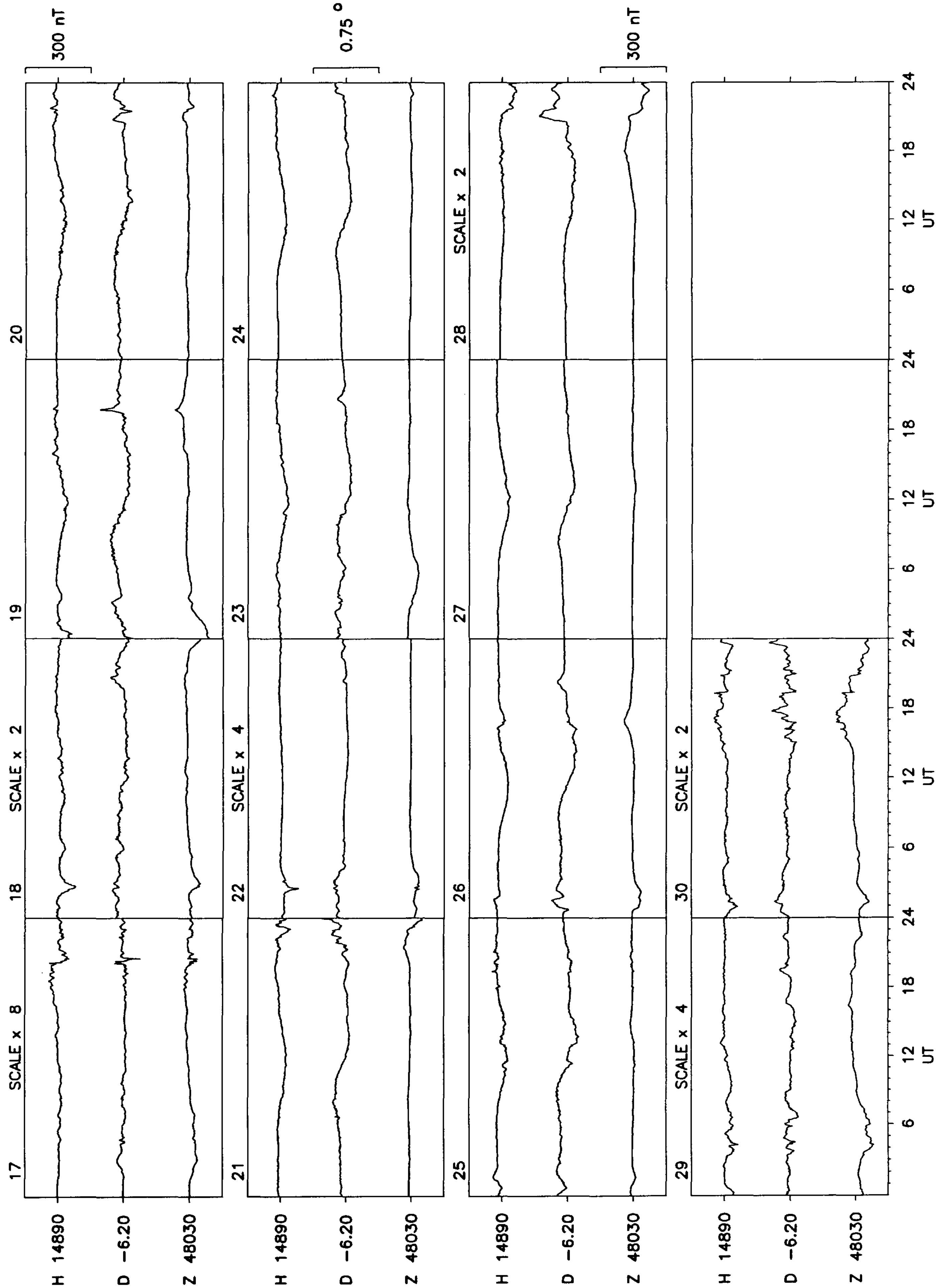
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SCALE x 4
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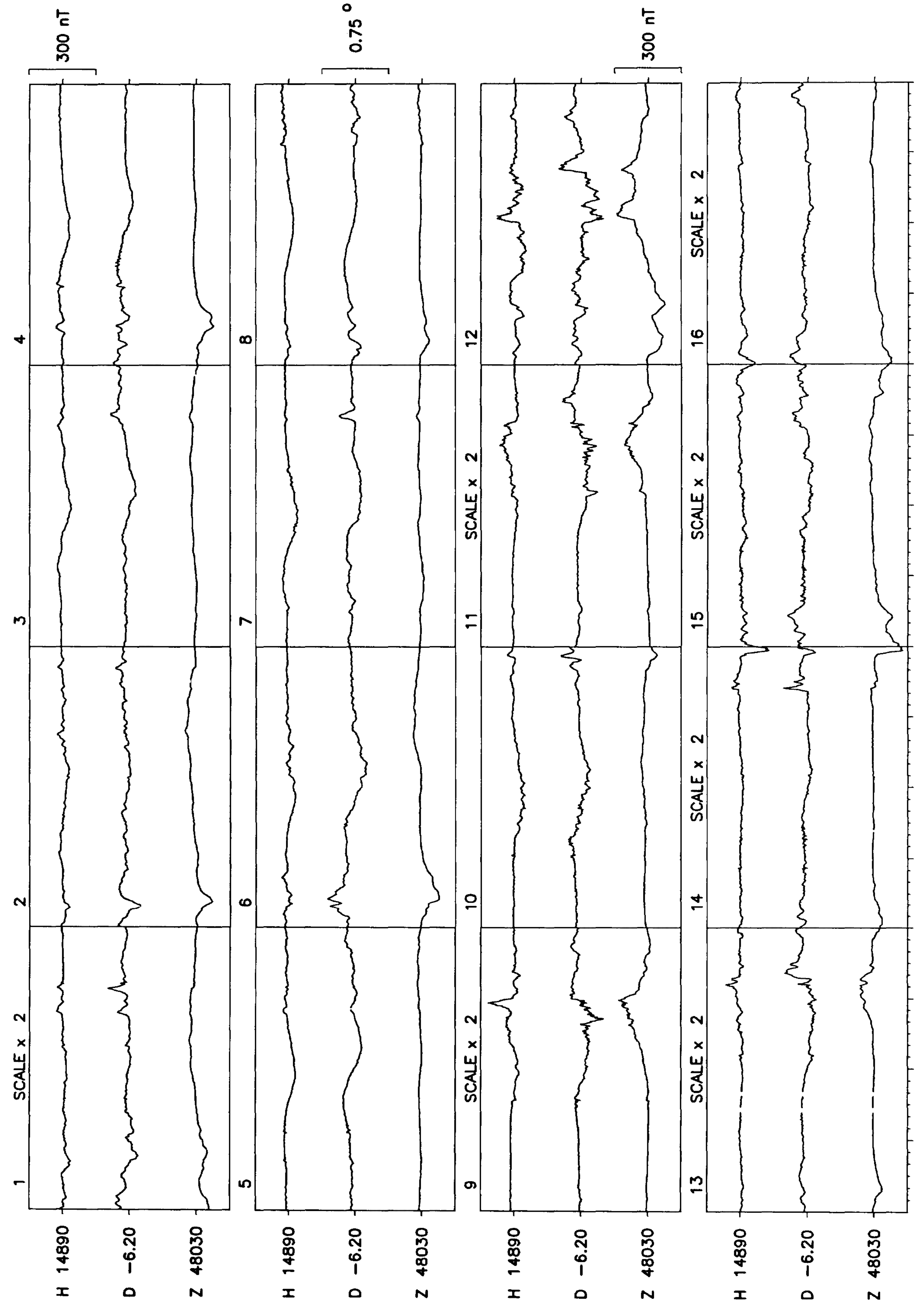
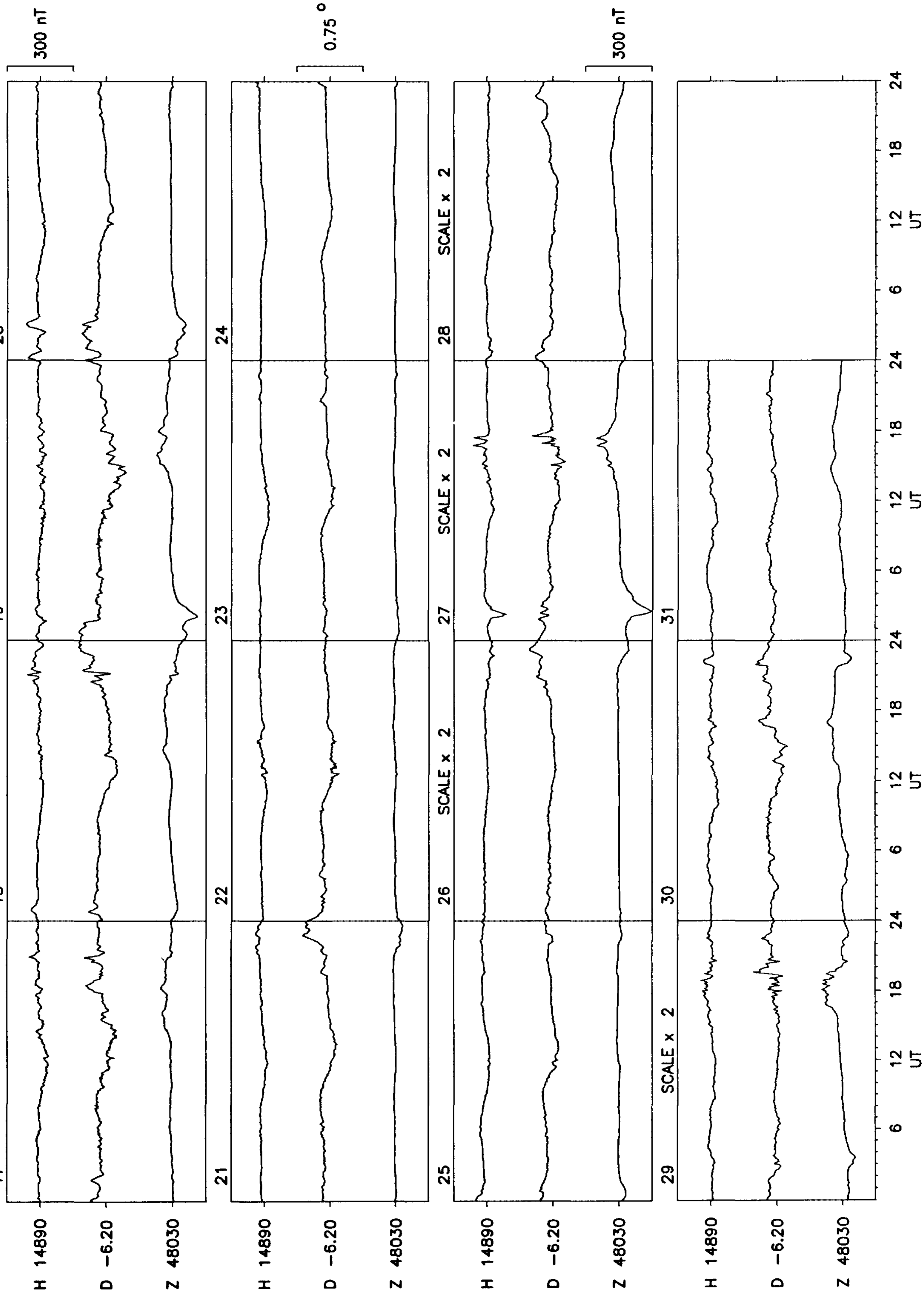
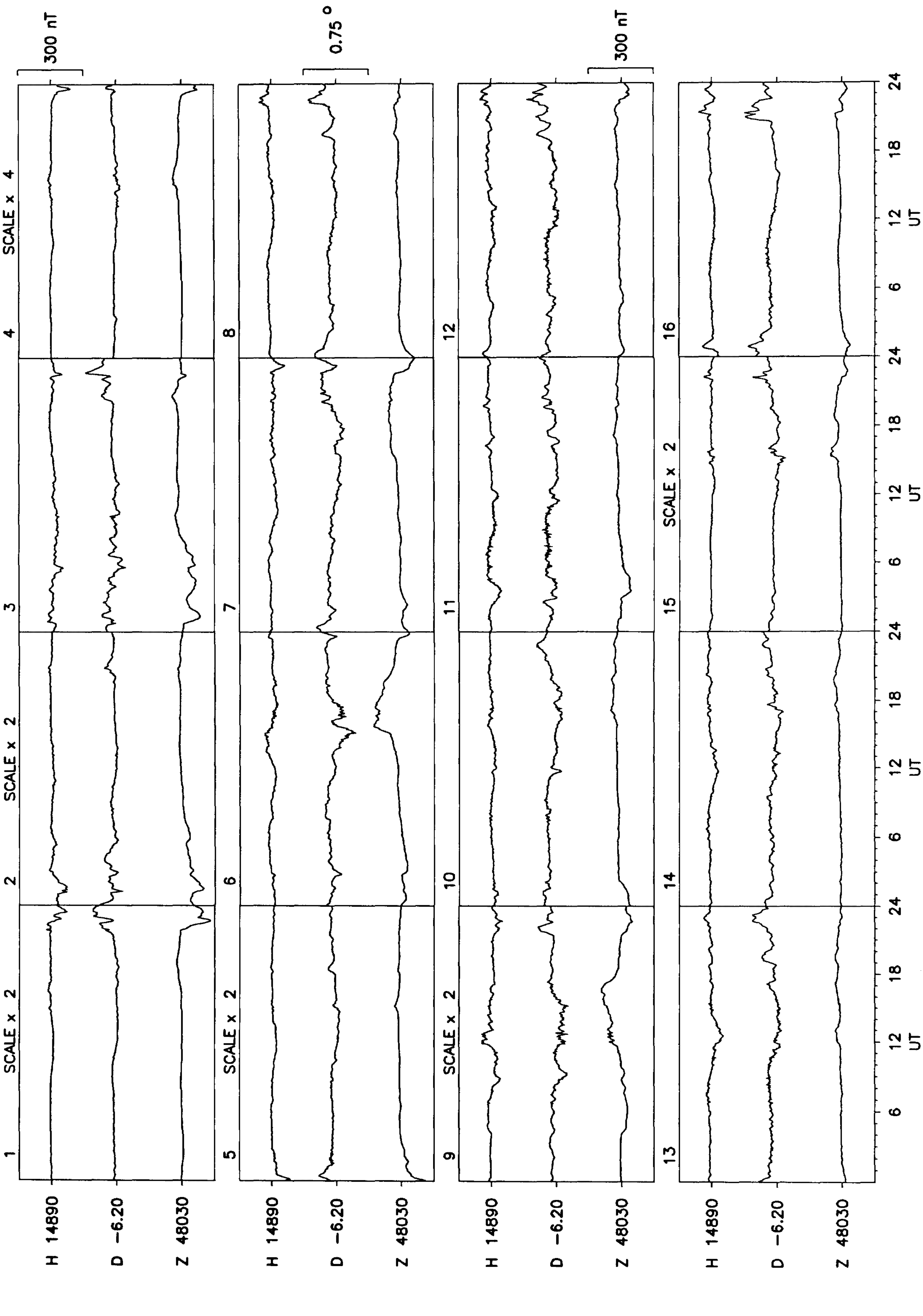
SCALE x 2
H 14890
D −6.20
Z 48030
6
12
18
24
UT

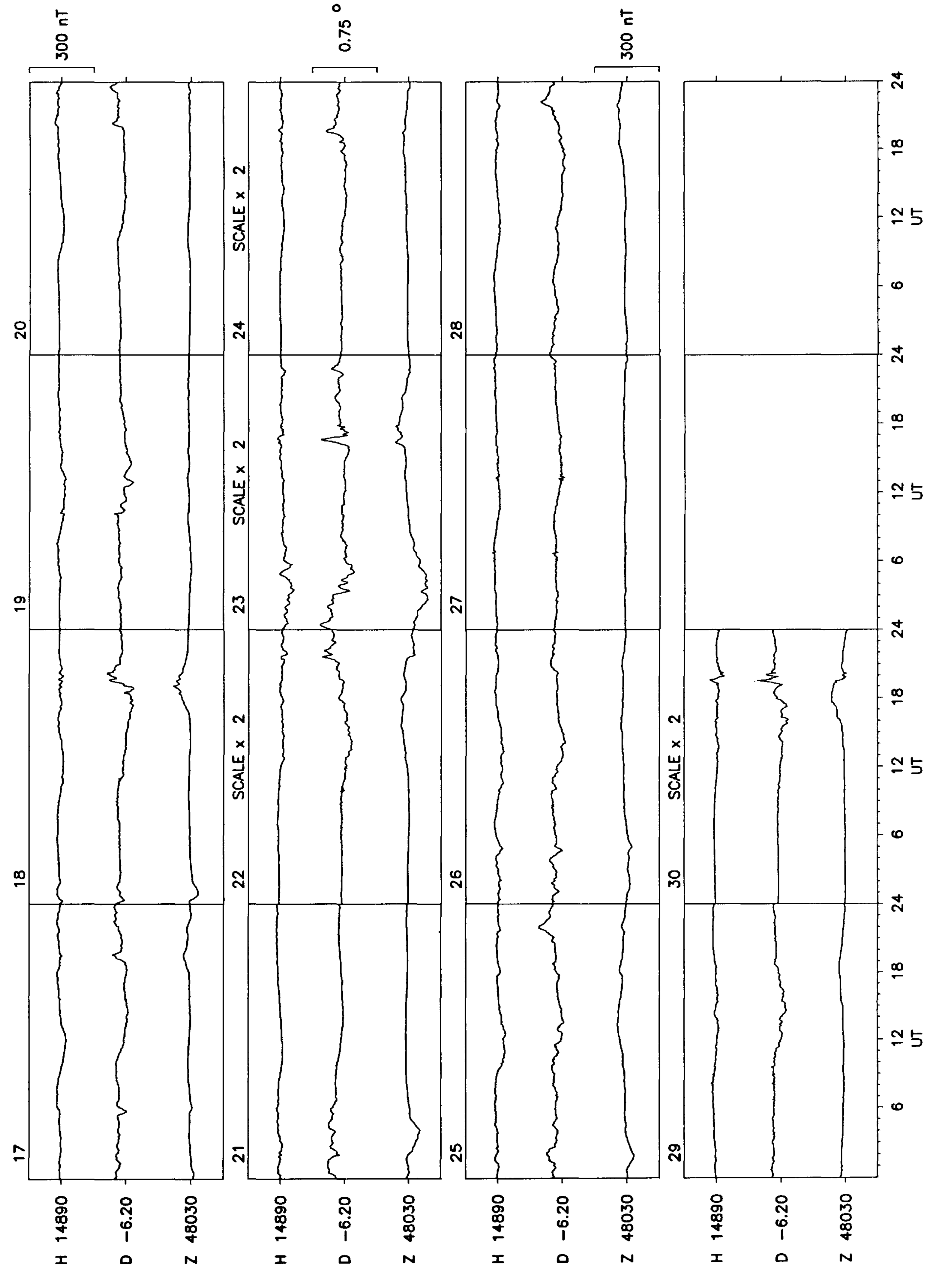

300 nT
0.75 °
300 nT
H 14890
D −6.20
Z 48030
SCALE x 2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
6
12
18
24
UT


300 nT
0.75 °
300 nT
H 14890
D −6.20
Z 48030
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
SCALE x 2
6
12
18
24
UT

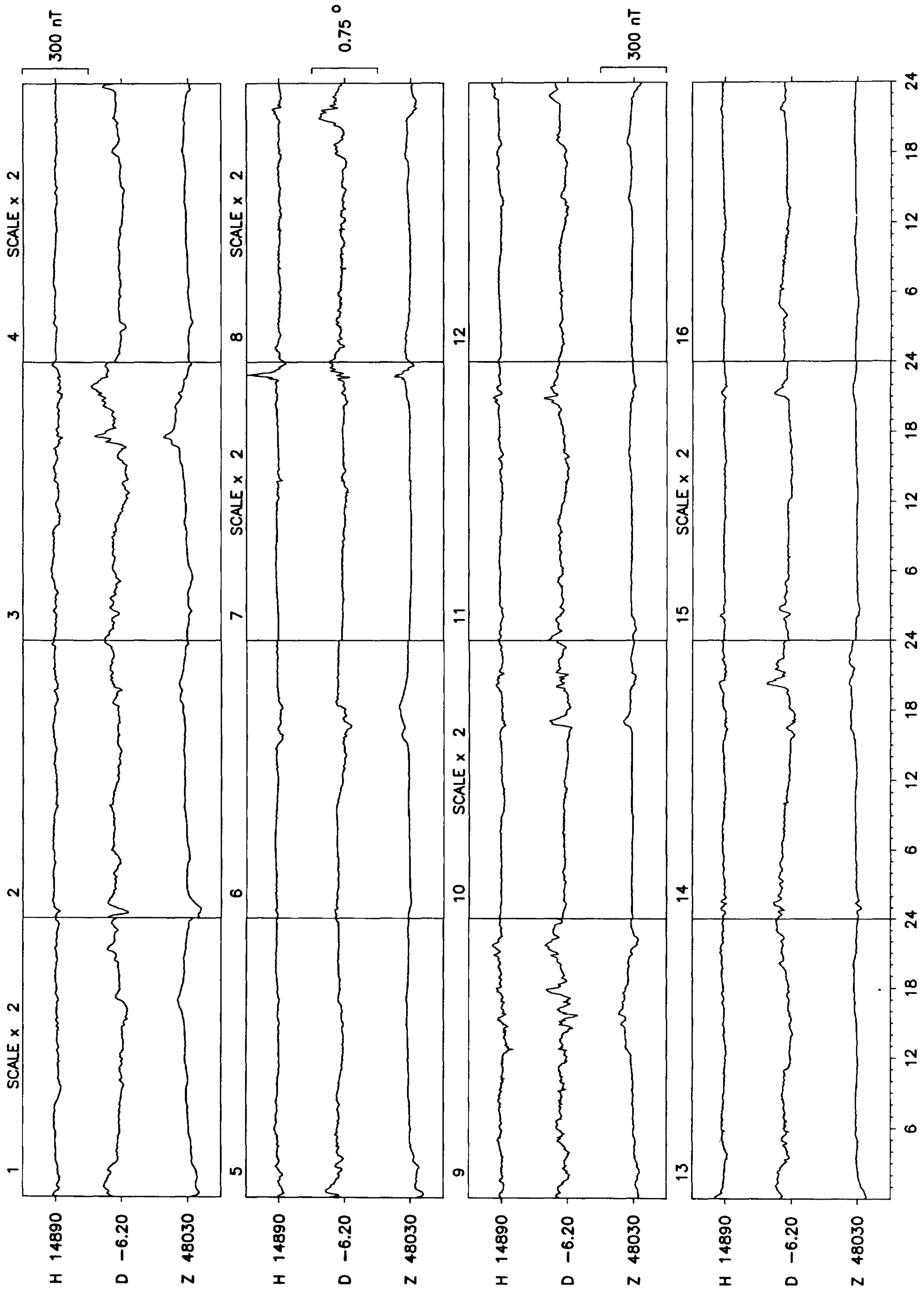
LE 10 92

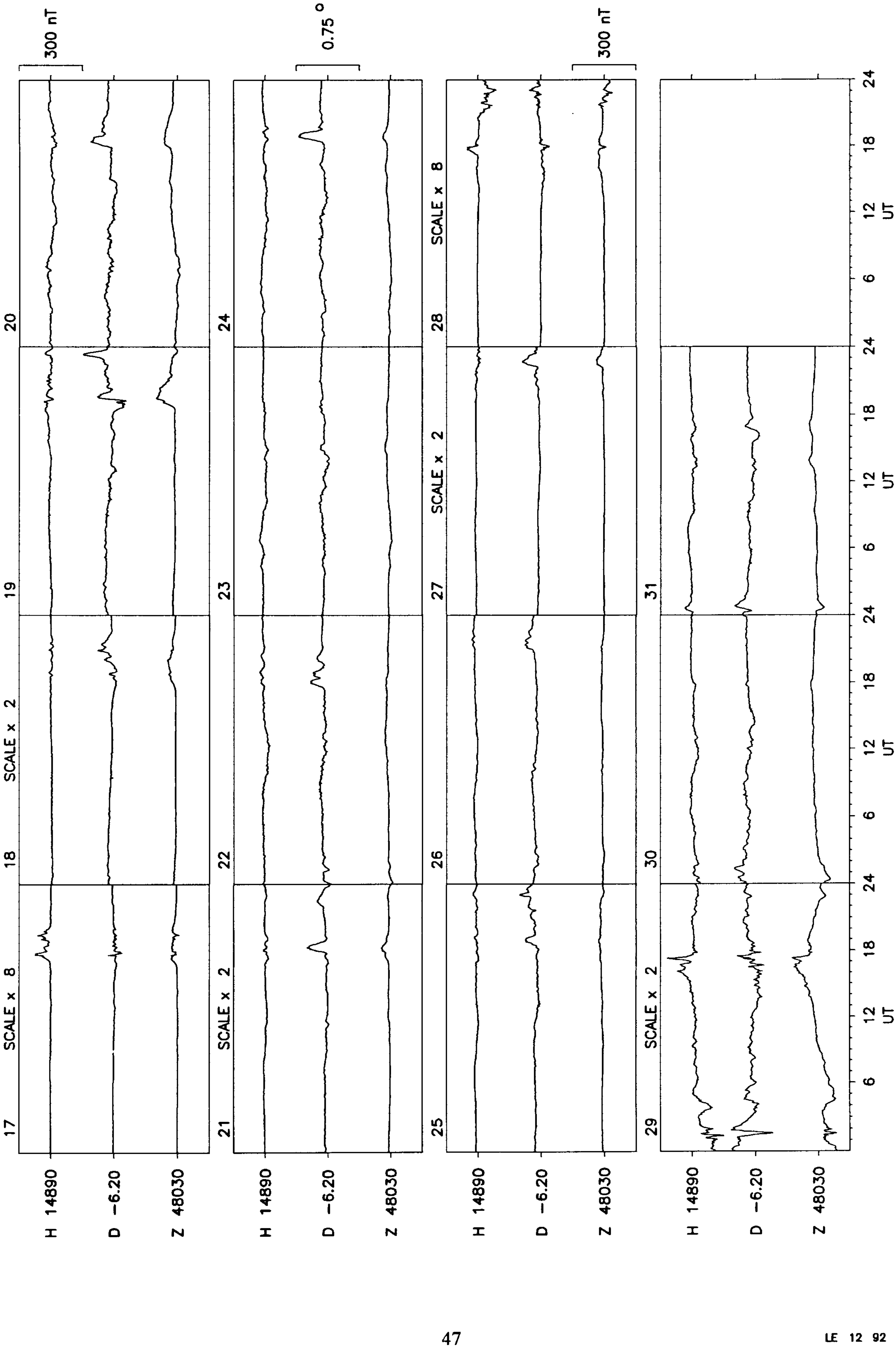


300 nT
0.75 °
300 nT
SCALE x 4
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
H 14890
D −6.20
Z 48030
6
12
18
24
UT

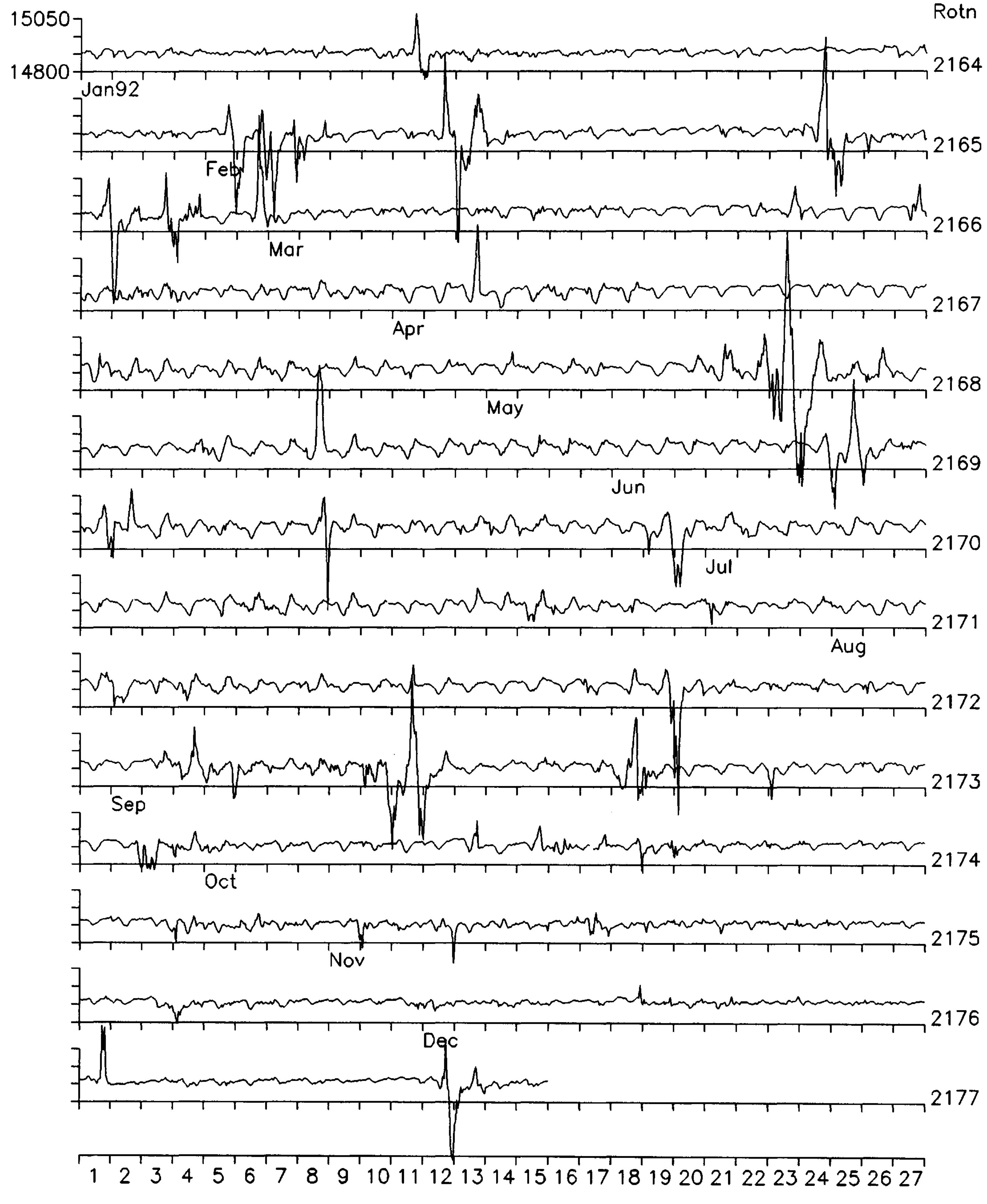

300 nT
0.75 °
300 nT
17
18
19
20
21
22
23
24
25
26
27
28
29
30
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
H 14890
D −6.20
Z 48030
6
12
18
24
UT

LE 11 92

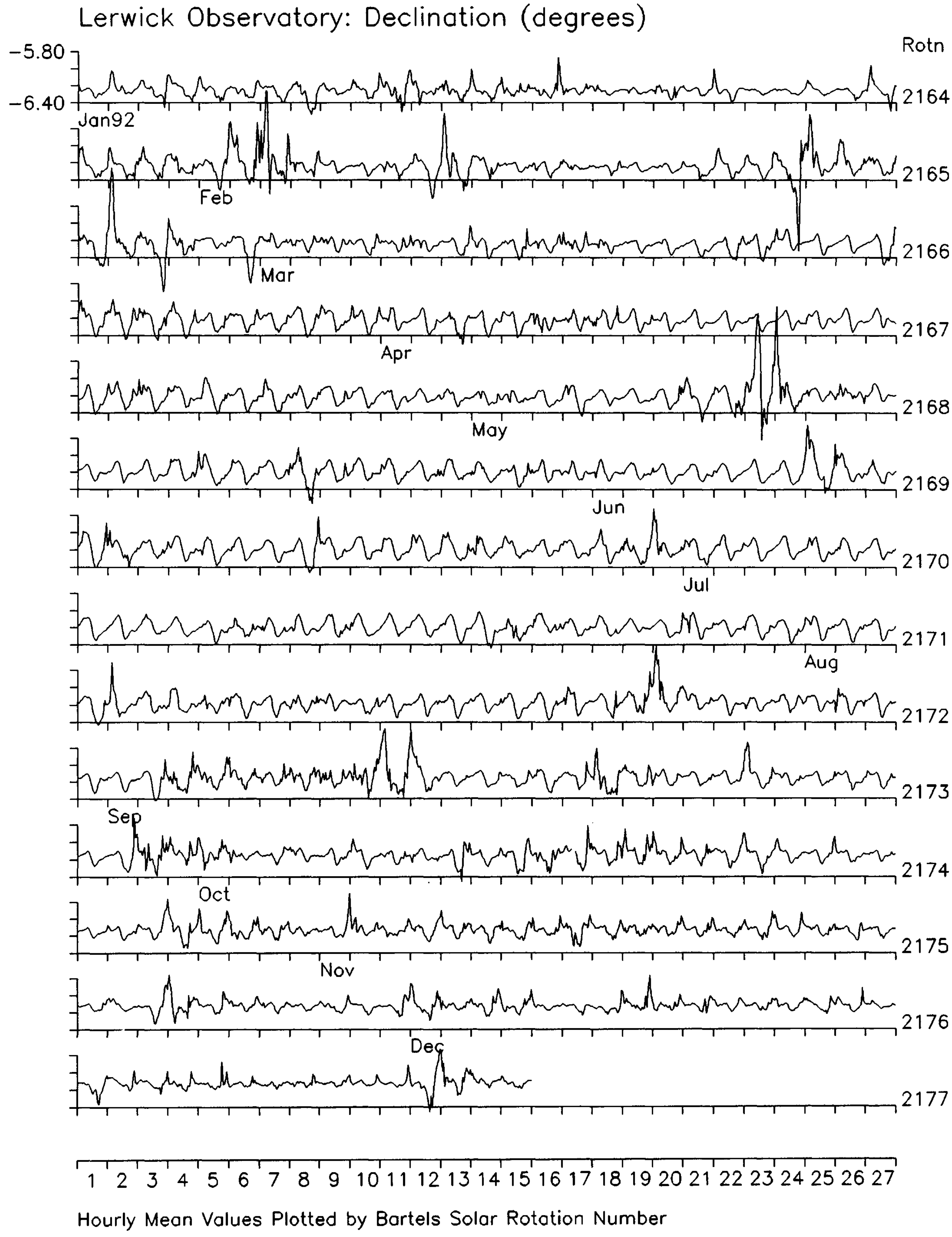

300 nT
0.75 °
300 nT
SCALE x 2
H 14890
D −6.20
Z 48030
UT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
6
12
18
24


300 nT
0.75 °
300 nT
SCALE x 8
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 8
SCALE x 2
SCALE x 2
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
H 14890
D -6.20
Z 48030
UT
6
12
18
24

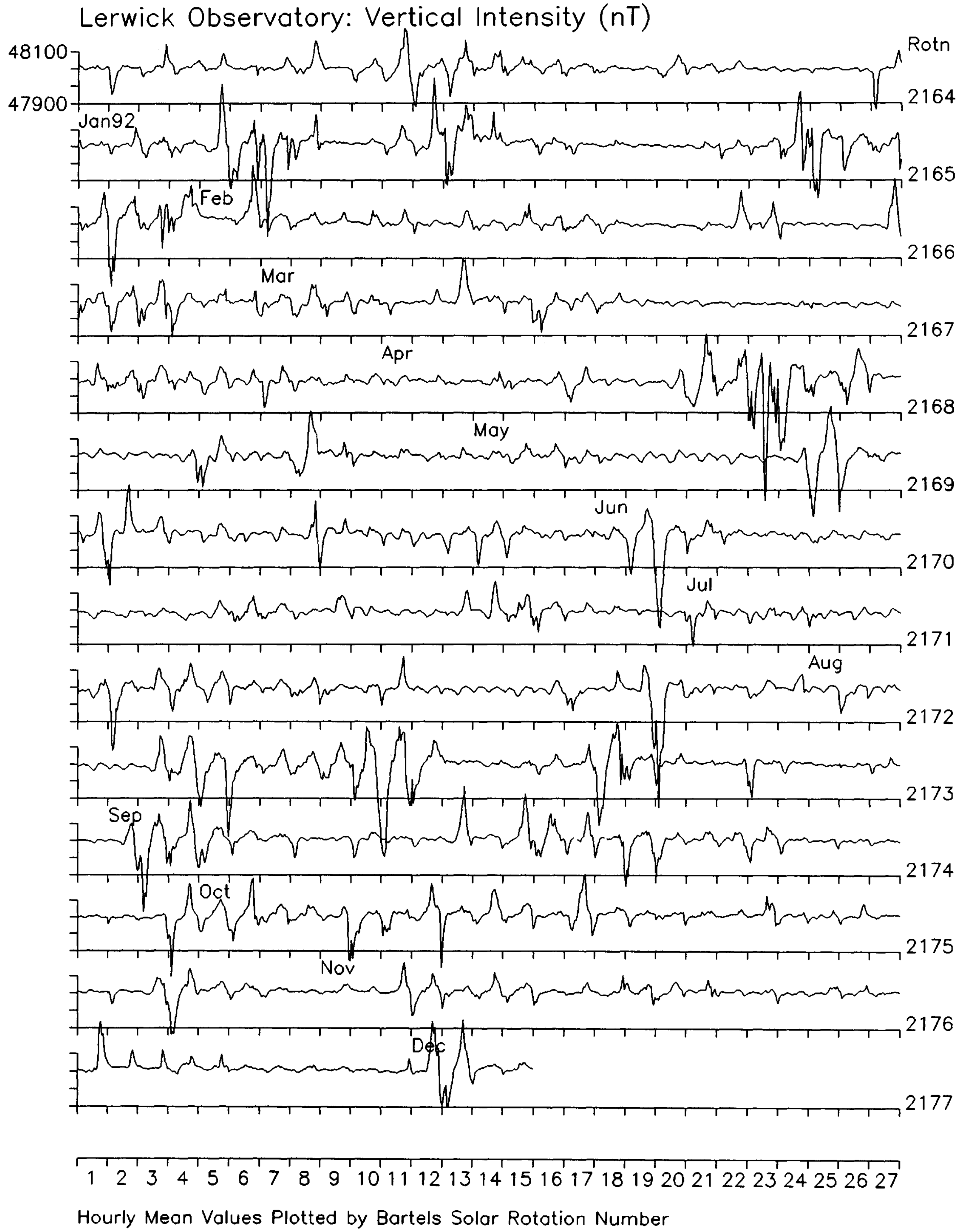
Lerwick Observatory: Horizontal Intensity (nT)

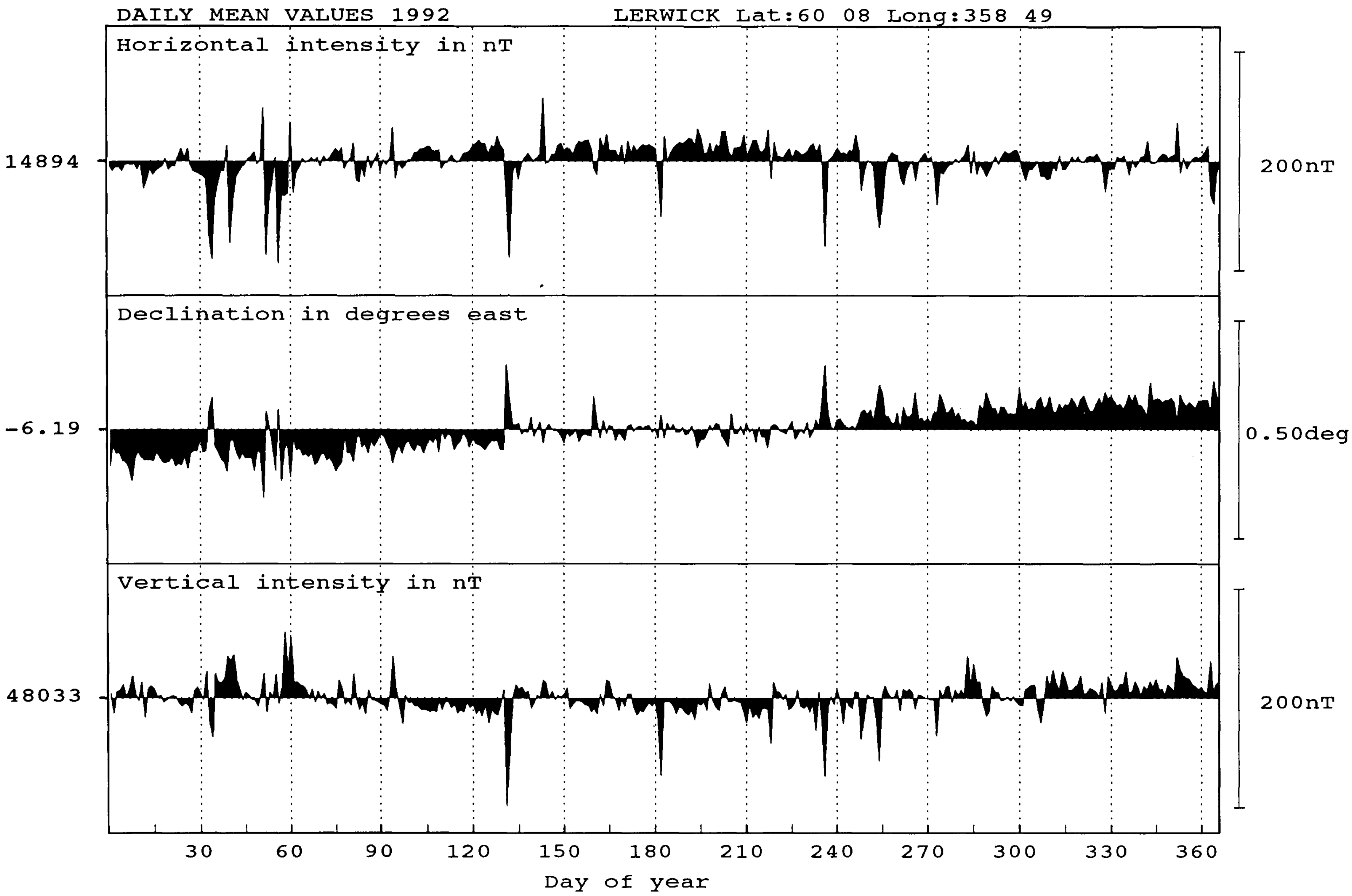


Hourly Mean Values Plotted by Bartels Solar Rotation Number



Lerwick Observatory: Declination (degrees)
-5.80
-6.40
Rotn
Jan92
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
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)
48100
47900
Rotn
Jan92
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
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 1992
LERWICK Lat:60 08 Long:358 49
Horizontal intensity in nT
14894
200nT
Declination in degrees east
-6.19
0.50deg
Vertical intensity in nT
48033
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly and annual mean values for Lerwick 1992

Month	D	H	I	X	Y	Z	F
Jan	-6 15.3	14889	72 46.7	14800	-1622	48035	50290
Feb	-6 14.2	14874	72 47.9	14786	-1616	48045	50295
Mar	-6 14.3	14893	72 46.5	14805	-1618	48035	50291
Apr	-6 13.3	14899	72 45.9	14811	-1615	48027	50285
May	-6 11.6	14898	72 46.0	14811	-1607	48028	50286
Jun	-6 11.3	14902	72 45.7	14815	-1606	48026	50285
Jul	-6 11.7	14909	72 45.2	14822	-1609	48026	50287
Aug	-6 10.8	14899	72 45.8	14812	-1604	48024	50282
Sep	-6 9.2	14887	72 46.7	14801	-1596	48029	50283
Oct	-6 8.7	14893	72 46.5	14807	-1594	48038	50294
Nov	-6 7.7	14891	72 46.7	14806	-1590	48042	50297
Dec	-6 7.5	14894	72 46.6	14809	-1589	48045	50301
Annual	-6 11.3	14894	72 46.3	14807	-1606	48033	50289

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

Lerwick Observatory K Indices 1992

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3111 1311	1122 3557	3342 1222	1331 2111	1121 2343	2311 2110	3222 3343	3211 2211	1000 0100	3432 2342	1001 2225	3232 2323
2	4323 1211	6633 3386	2222 2231	1111 1231	3331 1121	1000 1222	2332 2212	1110 0221	1113 4434	3211 2212	5422 2133	3201 1122
3	2213 2144	7764 4377	2211 1331	0233 5733	1111 3232	1000 3310	1100 2210	0001 2210	3443 4654	0011 1121	2332 1023	2212 2433
4	2322 1233	3521 2253	1111 2333	1112 4221	3301 3311	1000 1112	0100 1111	1101 3332	3333 3326	2221 1000	2212 3326	3311 2233
5	3211 2232	2011 1000	2221 2332	2122 3223	1101 1101	1002 2320	2311 2221	6533 4222	5332 3243	0110 1111	5122 2222	3210 0100
6	1221 2233	0011 2101	3120 1111	3442 2311	0000 1111	0011 3210	1211 2110	1312 3332	3222 2343	3211 2210	3211 3313	1000 1220
7	1101 2221	2212 3201	1011 2324	2332 3321	1111 2334	1111 1235	0000 1111	3233 4321	3223 3342	1211 1130	3121 1233	0111 3026
8	1222 3342	3331 5745	2311 3221	3222 3240	3332 5453	6532 5656	0001 3311	2322 3322	3331 3332	2100 0022	3111 1123	4232 2354
9	2210 1002	8655 5655	2224 3341	1110 1112	3301 4456	6222 3222	1000 1101	3112 2321	5544 5466	2113 4533	2345 4424	3212 3423
10	3211 2224	4322 4421	1212 2223	1100 1111	6668 8787	1333 3221	1110 1231	1011 2211	6545 6877	0122 2113	2112 1223	2112 1433
11	3312 3664	2011 1112	3223 3431	1000 1000	8754 5453	1312 3356	1001 2101	2232 2323	7432 2442	2212 4444	3322 2322	2111 1232
12	4232 2223	3221 2203	2222 2201	0100 1100	3312 2332	6232 5622	2222 4332	2210 1100	2110 1111	2332 4422	2222 2233	1101 2122
13	3323 2324	2222 1000	0121 1100	0112 2001	3423 5423	1211 3233	2333 4423	0000 3423	0001 0022	2221 2353	2112 3233	3211 1111
14	3221 2333	0111 2233	0010 0101	1110 1121	2101 1000	2111 1112	3222 3331	2211 3411	1111 1223	3222 2156	2112 2322	2101 0233
15	3222 3221	0101 1100	0022 1211	2211 2221	0011 1210	3210 3321	2201 2210	1111 1132	2211 2321	5333 3345	2111 3434	3211 2223
16	1222 2255	1100 0001	1022 3333	0000 1210	1101 2210	1211 1010	1122 2332	1121 1211	1111 2242	5322 2324	3111 1143	0210 1001
17	2112 1233	1122 3211	2114 3442	1000 1211	0000 0011	0101 2211	2100 2210	1100 1001	5555 4686	2112 3332	1211 1121	0021 3772
18	2211 0000	3212 1211	3232 2210	1222 5324	2110 2334	1110 3467	1110 2110	1101 1211	5333 3243	2011 2234	2001 1231	1001 0243
19	0111 1110	3212 2223	0001 1110	3221 3344	4310 1331	4111 2442	2100 0111	1100 2232	3212 2231	3212 3323	0112 2100	1001 2143
20	3221 2312	5423 5686	0011 1110	4221 3433	3111 2222	0211 3201	1201 2432	3433 3210	1112 2123	4312 1101	0000 0022	1121 2231
21	1000 1114	7675 4221	1123 4454	2211 2210	2011 1323	3211 2312	0112 4322	0112 3442	0110 0124	0111 1123	2210 0000	0112 1343
22	3101 2200	4432 2234	3322 3232	2211 2222	3443 7664	3301 2202	2343 4353	1223 3557	6511 2133	3101 2311	0112 2334	2011 1331
23	0000 0010	2320 2225	4432 3234	2010 2333	1110 2452	3320 2343	3422 2242	8952 3233	2212 2121	1101 1011	4432 2523	1211 2110
24	1000 0001	2222 2457	3322 2345	3322 3323	2221 1211	3422 3432	2101 2221	2211 1233	0000 0012	0000 0002	0011 2242	1111 1130
25	2100 1000	7743 3353	4322 2333	2211 2213	2221 3321	4221 3332	2102 3421	1000 2112	3112 2221	3111 1112	2111 1113	0000 1123
26	0000 1211	3232 3797	1111 3242	2111 1131	0011 3123	1121 1212	0101 1110	3221 2221	3100 1221	2211 1143	2211 1122	1001 0012
27	4412 1134	7445 4462	2111 2244	2010 1222	2222 3221	2111 2222	0001 0224	1212 3232	0001 1000	5323 4523	1010 1102	0000 0014
28	4311 2222	1011 2123	3111 2123	2122 3111	2122 3222	1232 2212	2522 3213	2100 1112	0011 1355	4222 2323	1101 0113	2121 4767
29	3321 2134	2213 4865	2222 2343	2211 1232	1221 3432	4522 4345	0110 1211	4412 2023	5554 4443	3322 2353	0011 2110	6533 3633
30	3422 2333		2211 2223	2212 2111	2221 3322	6643 2313	2111 2233	0000 2120	4322 3544	2211 3423	0001 2352	2111 2201
31	3231 1131		3211 2333		2220 1310		1111 2322	0100 0210		1112 2211		3111 2300

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
1	1	16	45	SSC	A	44	- 3.5	- 19
9	1	21	53	SSC	A	17	- 1.2	- 9
26	1	14	57	SSC*	A	33	- 3.9	10
1	2	06	06	SSC*	B	11	- 5.6	
2	2	11	53	SSC*	A	42	12.8	16
8	2	14	27	SSC*	A	45	- 13.1	10
17	2	08	05	SSC*	B	- 8	5.2	- 5
20	2	01	10	SSC	B	17	- 3.9	- 3
26	2	16	57	SSC	B	76	- 7.2	5
29	2	09	19	SSC*	A	11	8.3	- 7
17	3	09	50	SSC*	B	- 47	11.4	- 7
9	5	19	57	SSC*	C	149	7.2	21
10	5	06	21	SSC*	C	- 96	22.4	- 21
26	5	12	02	SI*	C	13	0.7	- 9
10	6	04	02	SSC*	B	17	-4.7	-2
18	6	12	52	SSC	B	45	-2.1	4
4	8	14	08	SSC*	C	47	- 3.4	- 11
6	8	04	24	SSC*	B	13	- 3.9	- 4
6	8	05	18	SI*	B	- 23	10.5	
13	8	15	14	SI*	A	54	2.1	- 17
9	9	01	39	SSC	B	15	- 7.0	3
8	10	18	39	SSC*	B	17	- 1.2	3
9	10	09	13	SSC*	C	- 25	- 4.8	23
1	11	21	46	SSC*	A	32	- 4.8	- 24
4	11	13	12	SSC	B	11	- 5.6	4
07	12	07	54	SSC*	C	- 9	1.3	- 3
07	12	13	45	SSC*	B	- 53	3.6	16
17	12	06	15	SSC*	B	10	- 1.5	- 4

Notes

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

The quality of the event is classified as follows :

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

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

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
7	7	16	07	16	12	16	18	13	-0.7	-4
8	7	09	45	09	52	09	59	-8	1.5	
9	7	16	08	16	21	16	29	-7	1.5	

Notes

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

Annual Values of Geomagnetic Elements

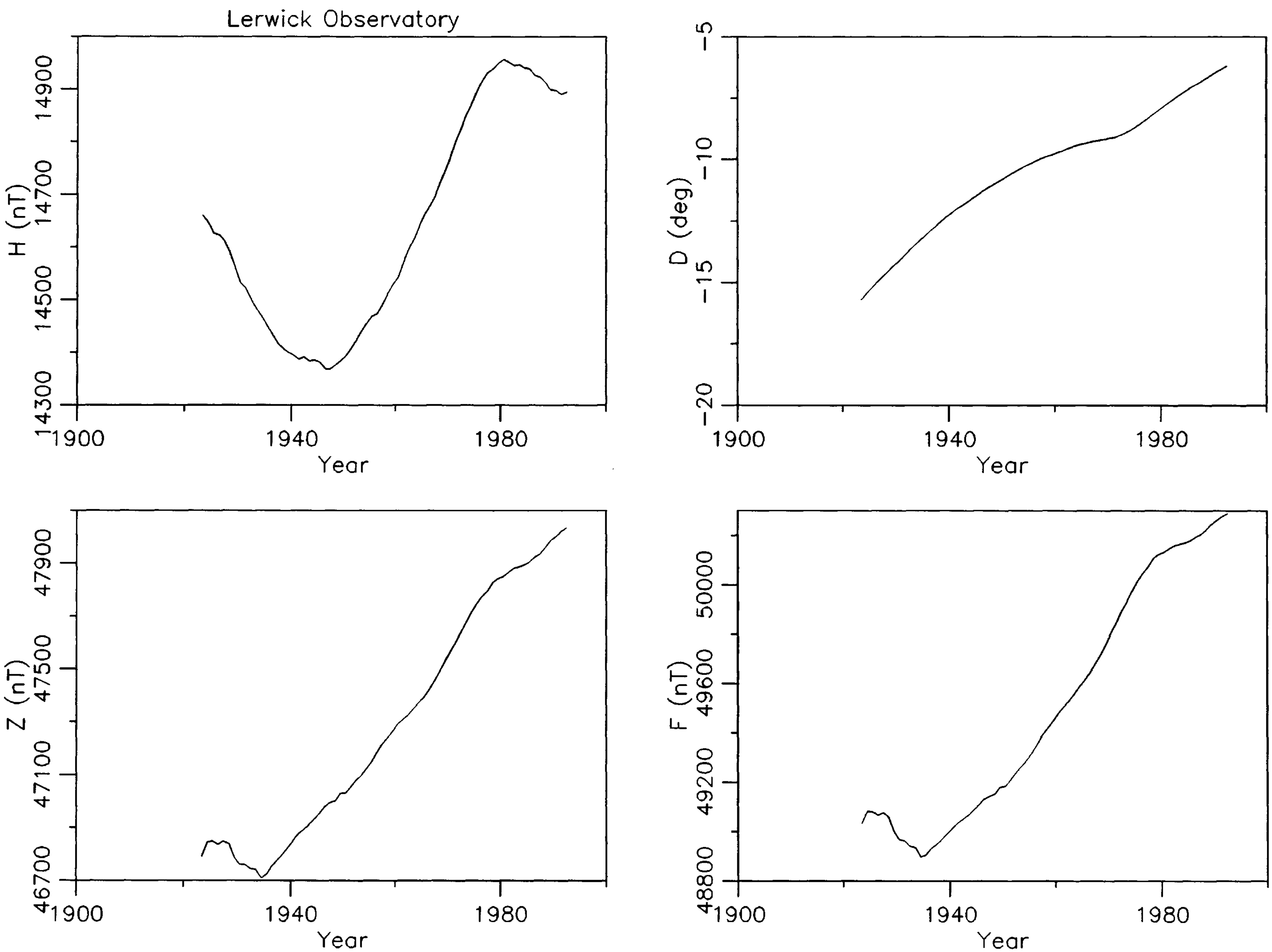
Lerwick

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

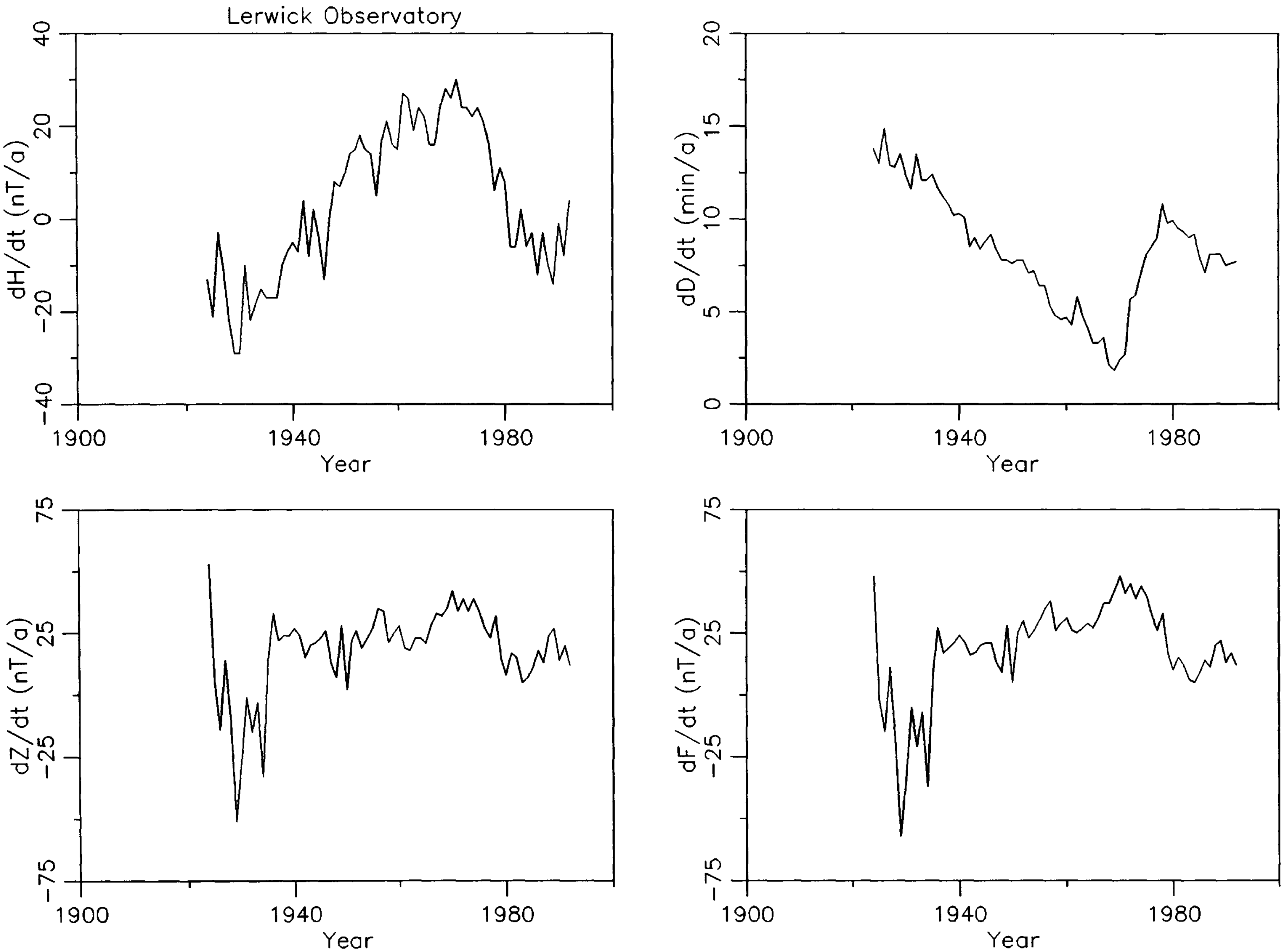
	Year	D		H	I		X	Y	Z	F
	1984.5	-7	13.4	14936	72	40.9	14818	-1878	47902	50177
	1985.5	-7	5.5	14933	72	41.3	14819	-1844	47913	50186
	1986.5	-6	58.4	14921	72	42.5	14811	-1811	47931	50200
	1987.5	-6	50.3	14918	72	43.0	14812	-1776	47944	50211
	1988.5	-6	42.2	14908	72	44.1	14806	-1740	47968	50231
	1989.5	-6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

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

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

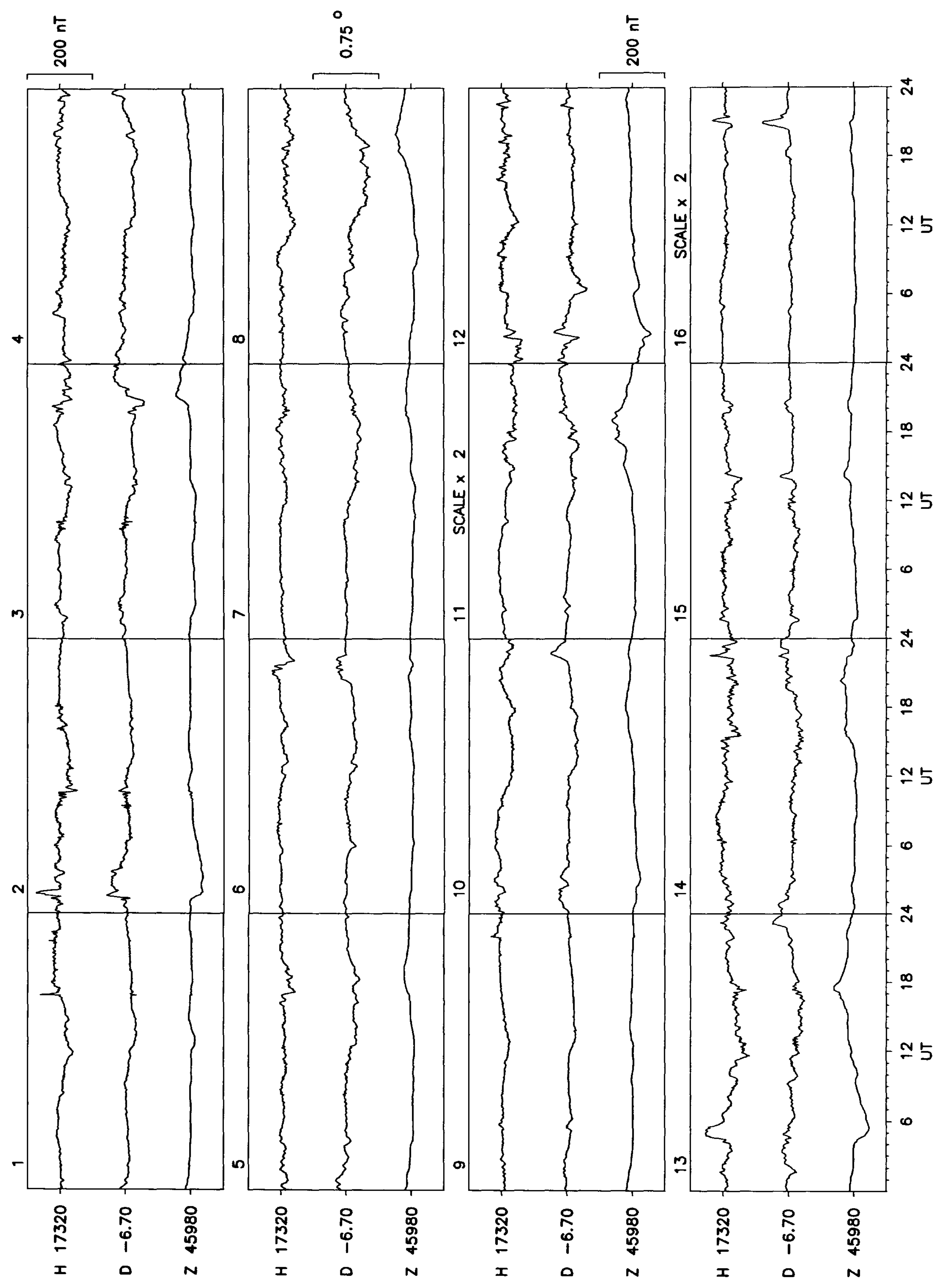


Annual mean values of H, D, Z & F at Lerwick



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

Eskdalemuir 1992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0.75 °
200 nT
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SCALE x 2
SCALE x 2
H 17320
D −6.70
Z 45980
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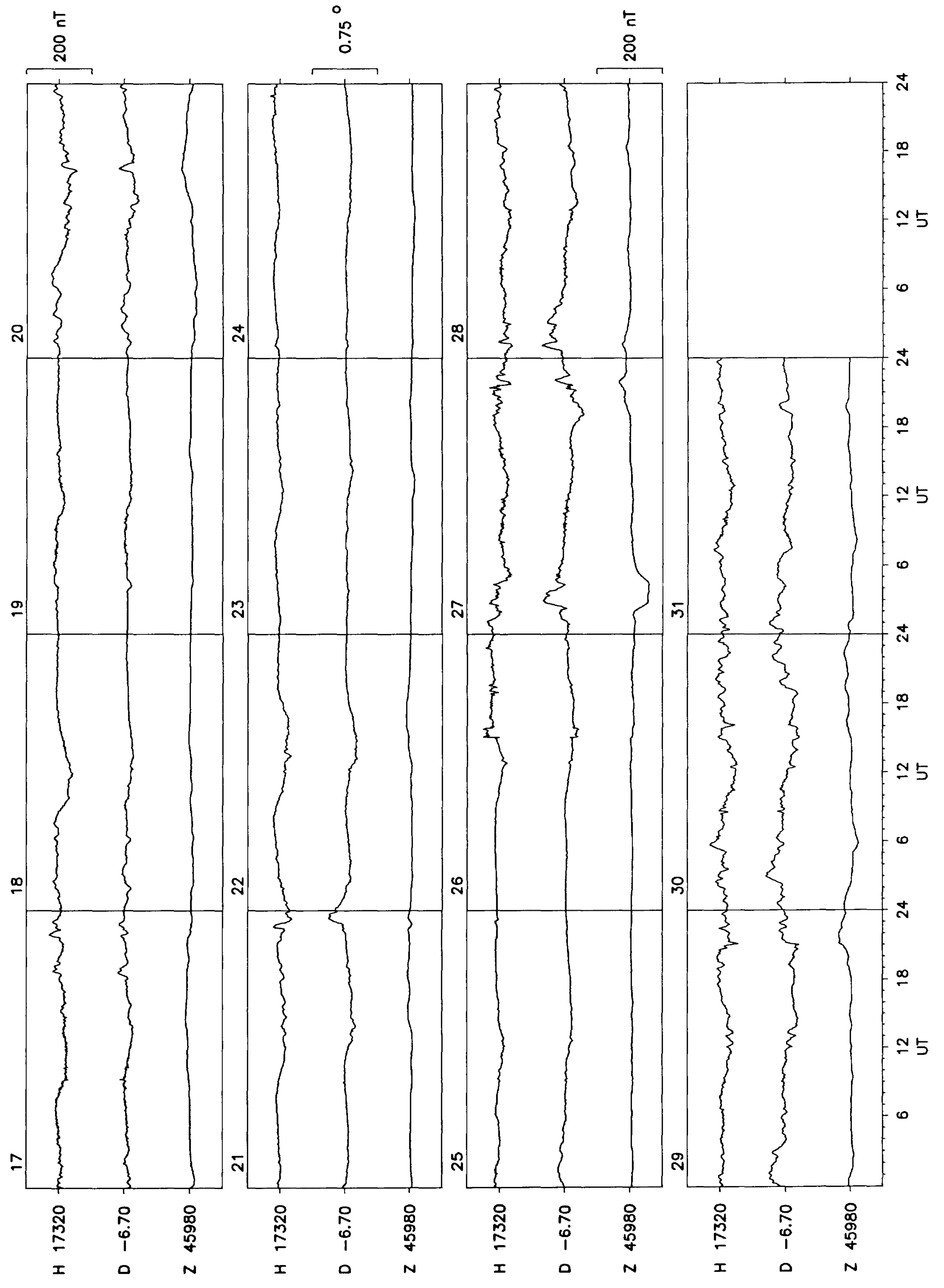
12
18
24
UT



200 nT
0.75 °
200 nT
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H 17320
D −6.70
Z 45980
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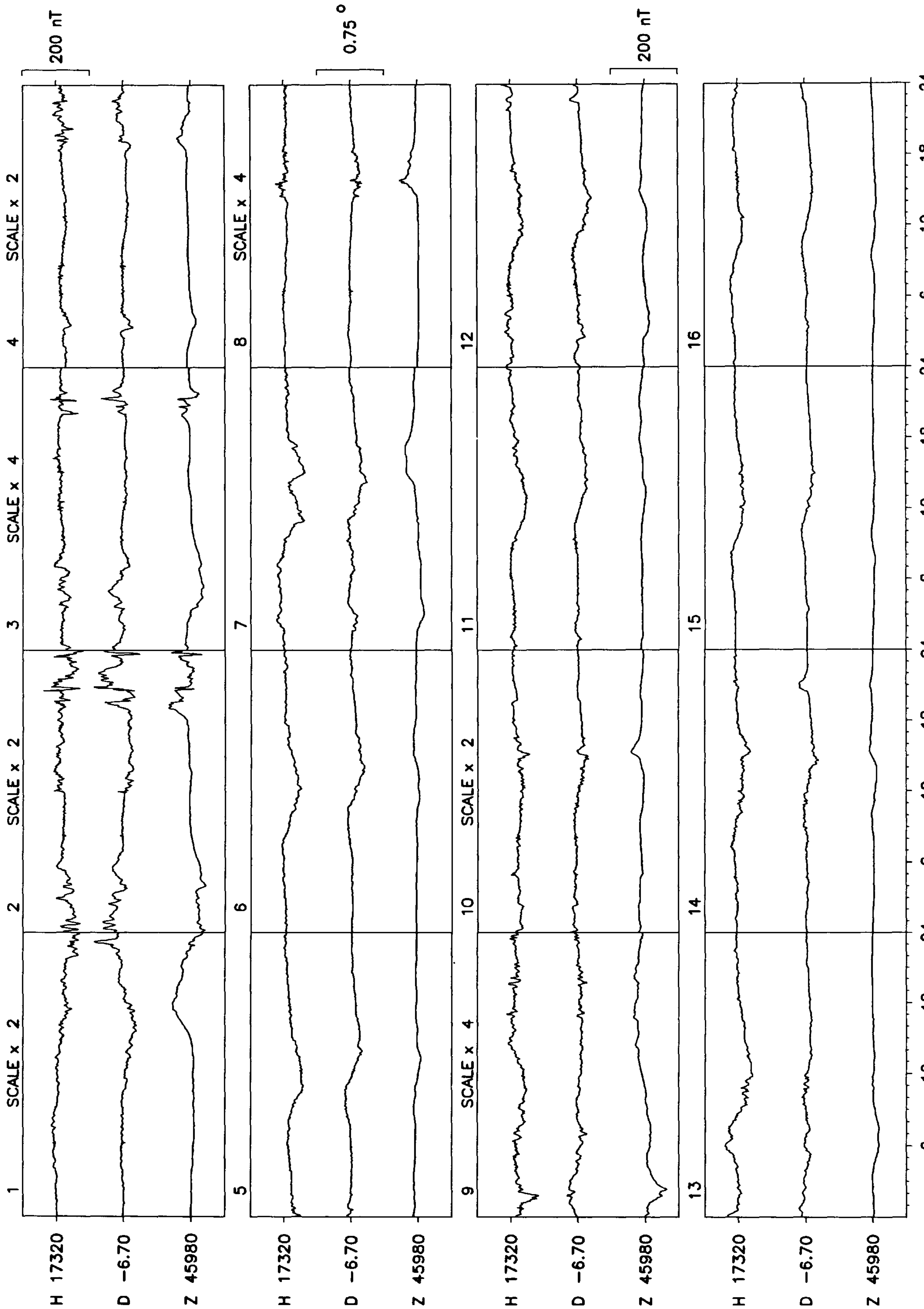
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200 nT
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SCALE x 4
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H 17320
D -6.70
Z 45980
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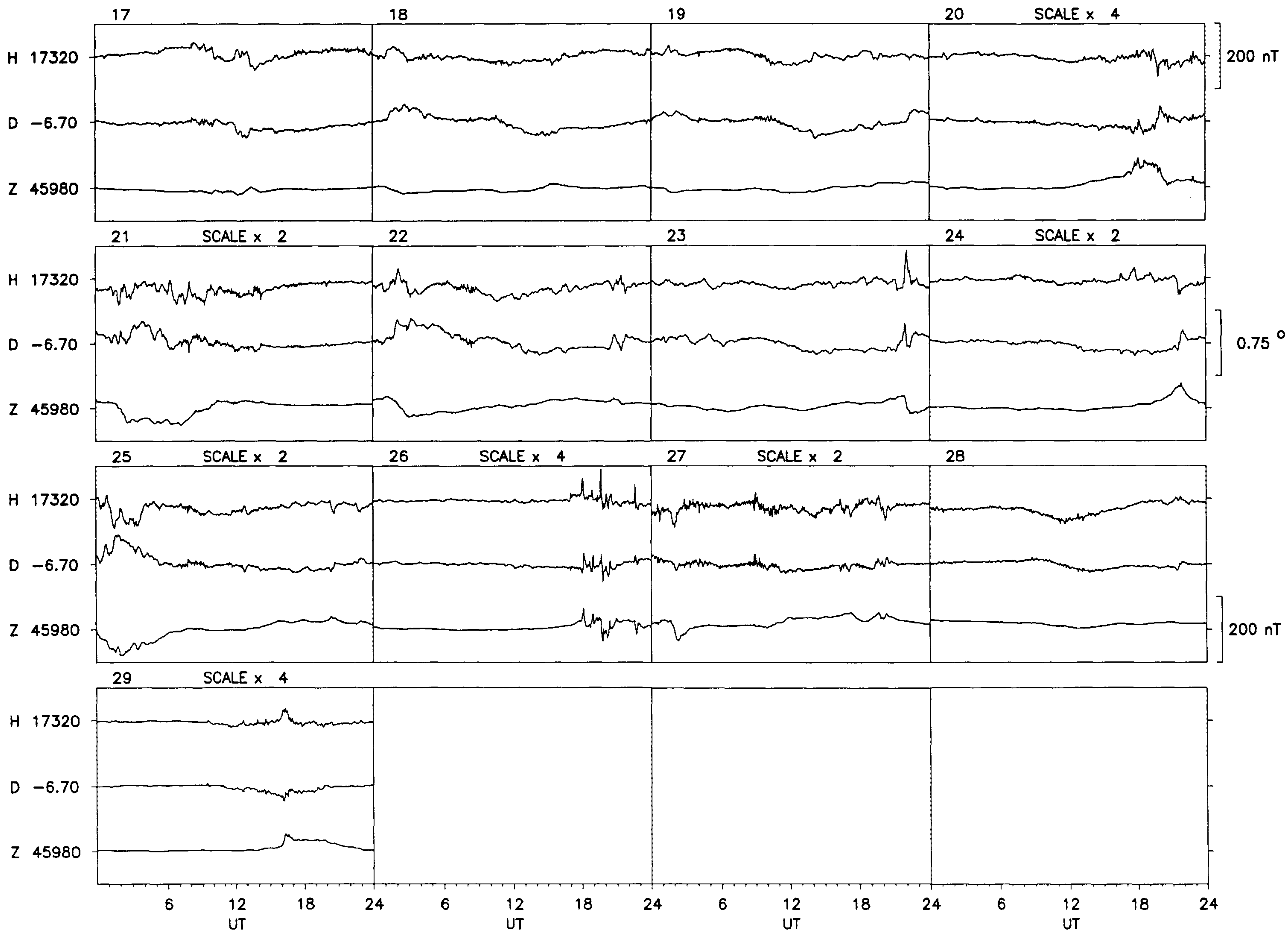
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SCALE x 2
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SCALE x 4
H 17320
D −6.70
Z 45980
200 nT
0.75 °
200 nT
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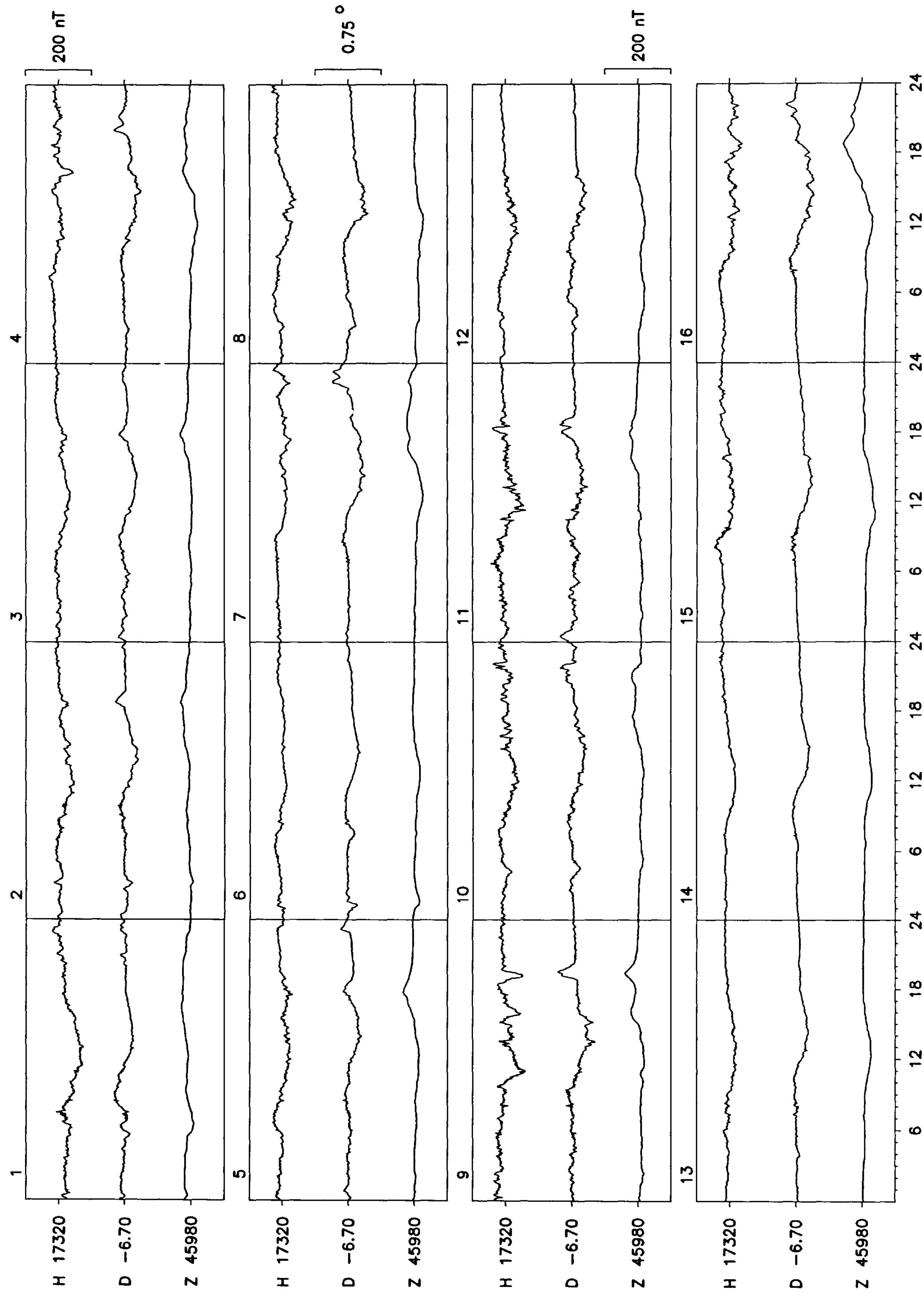
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200 nT
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D −6.70
Z 45980
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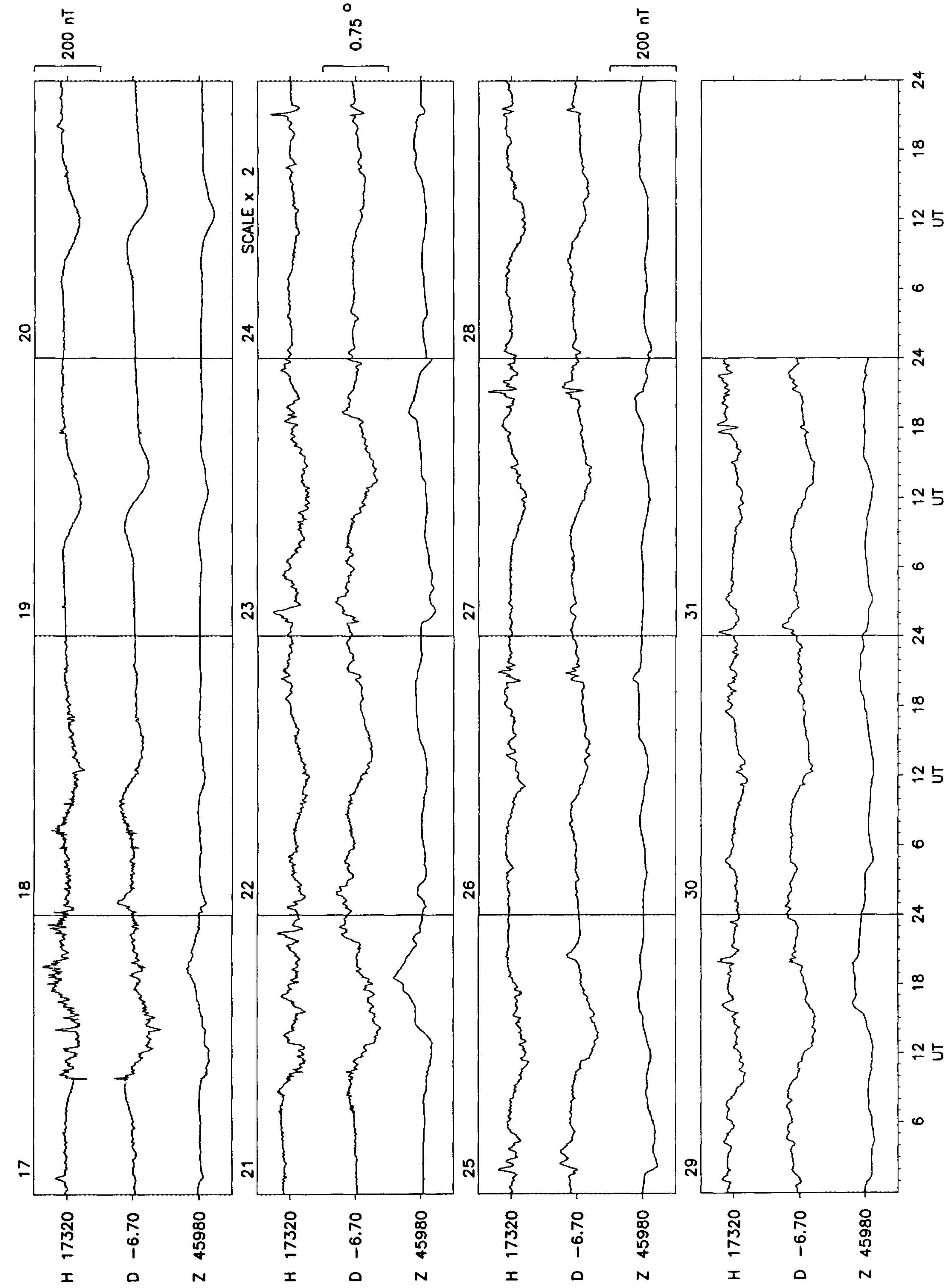

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200 nT
SCALE x 2
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D −6.70
Z 45980
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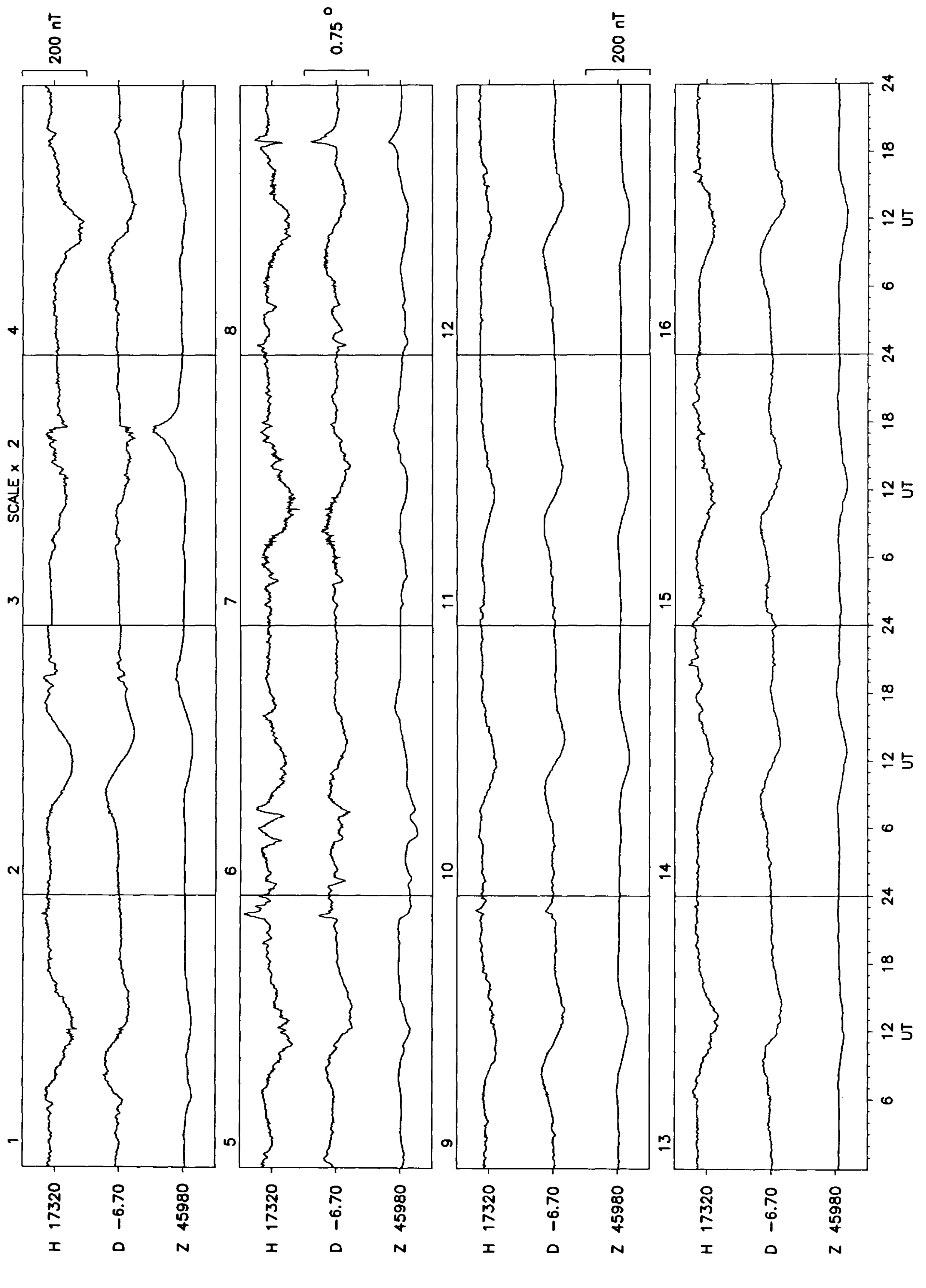
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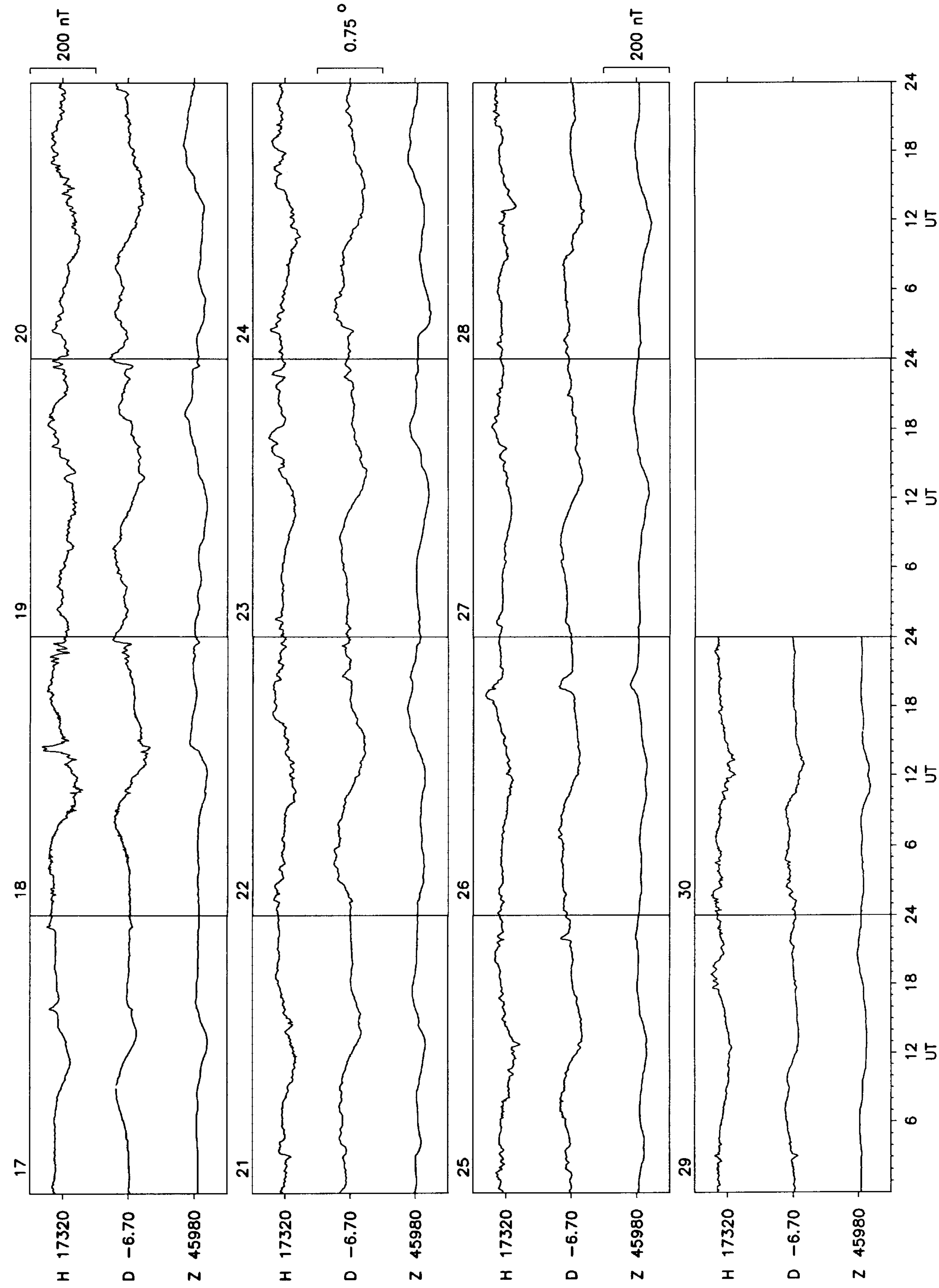
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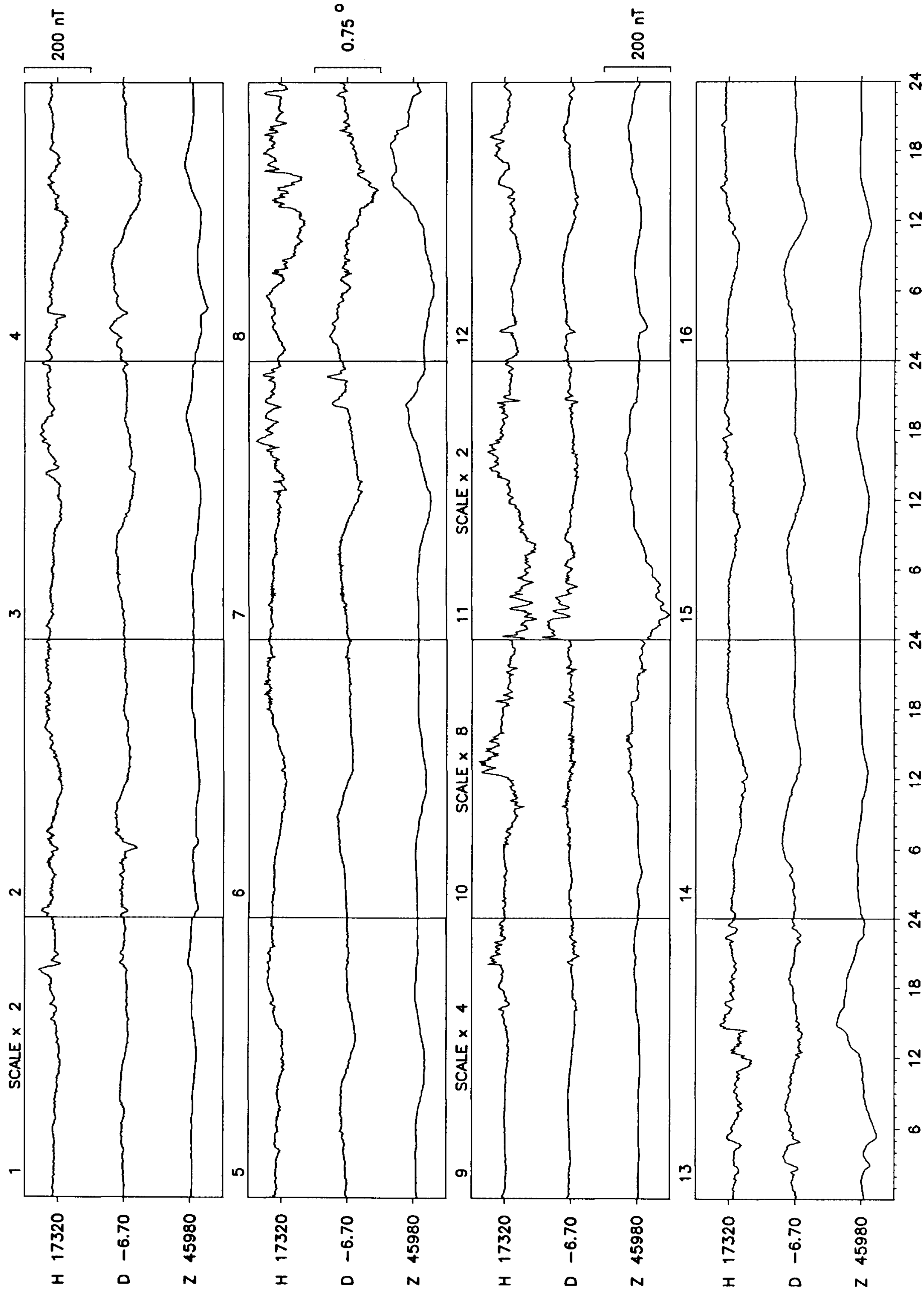
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SCALE x 2
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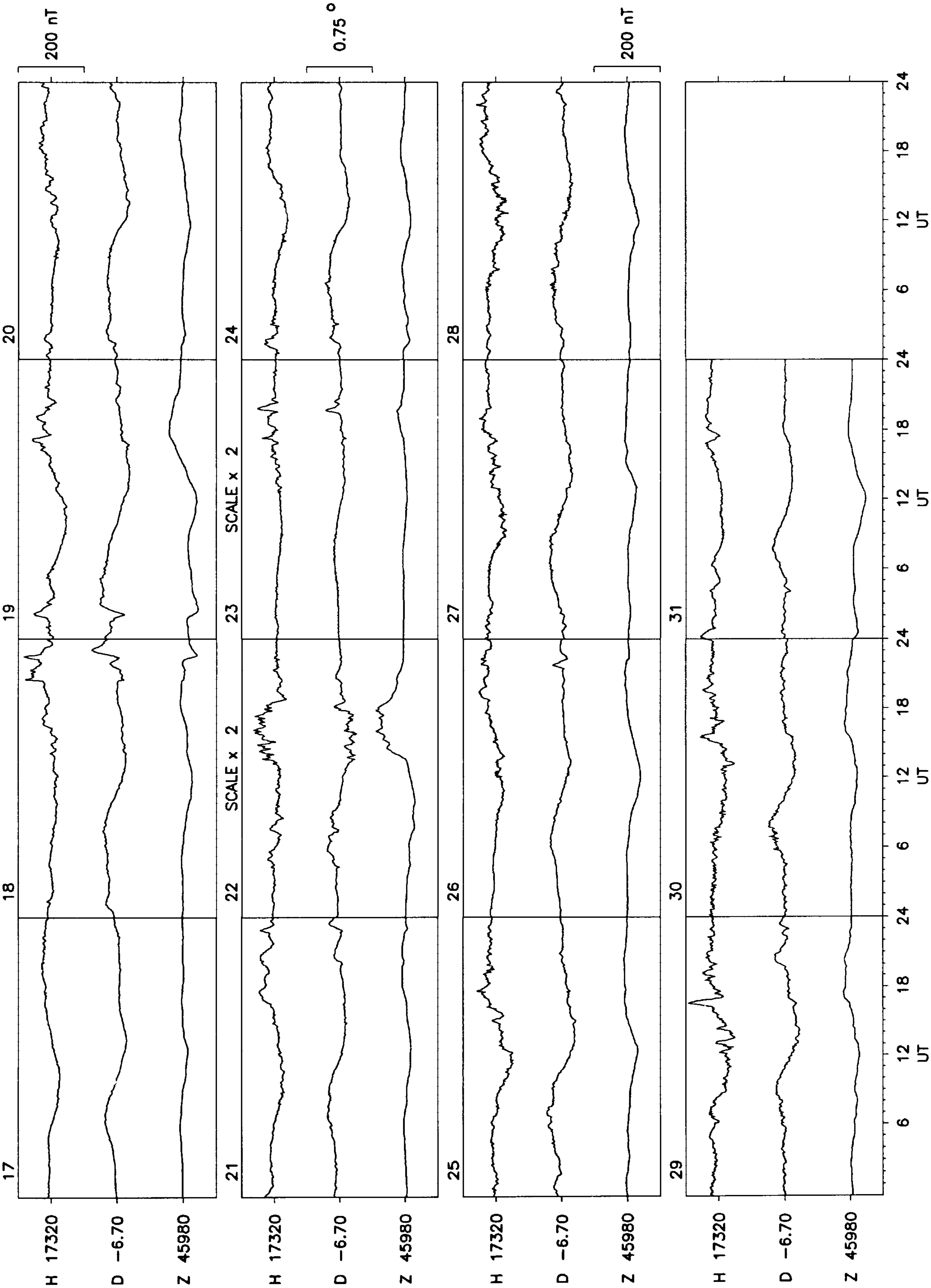

H 17320
D −6.70
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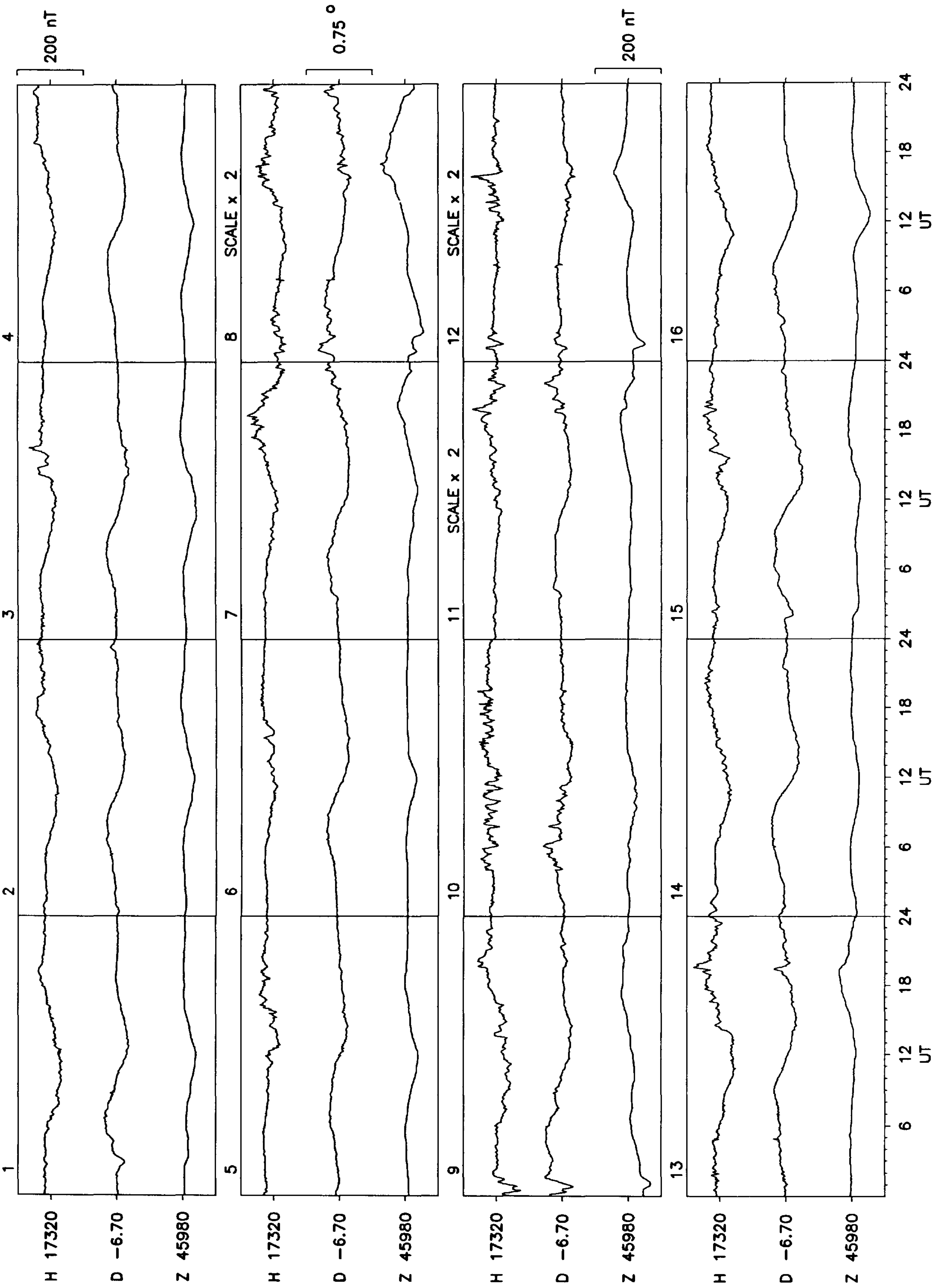
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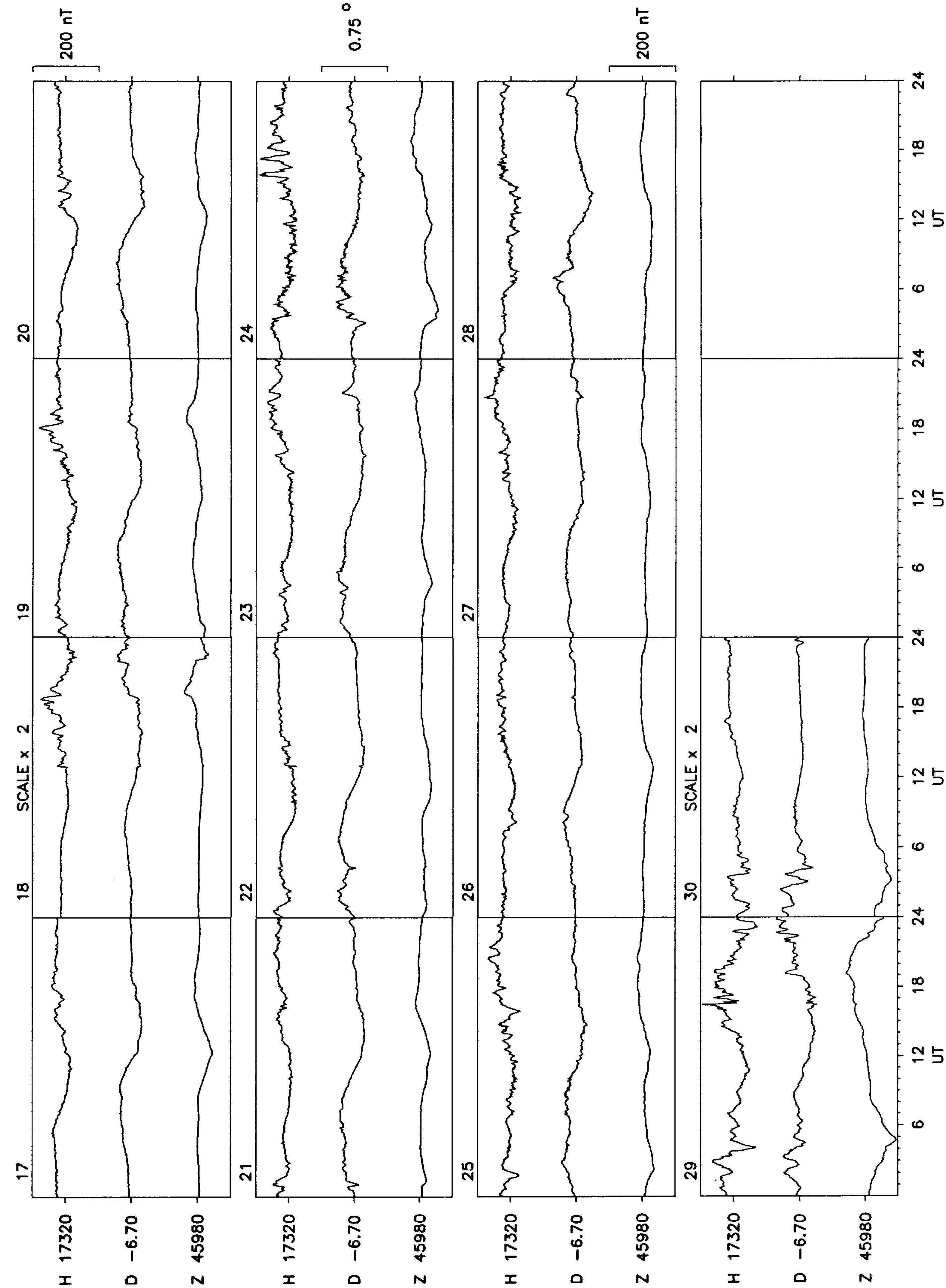

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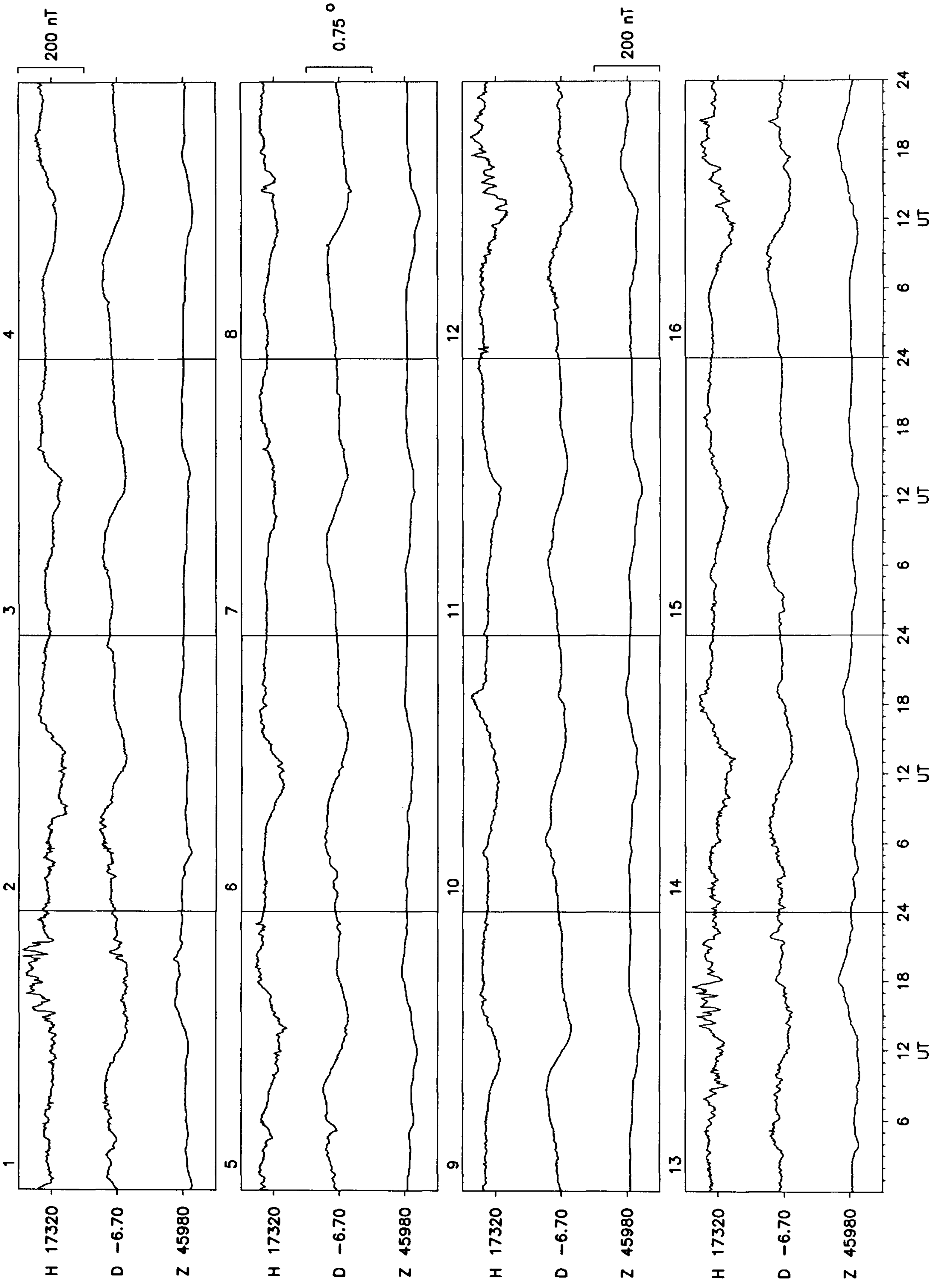

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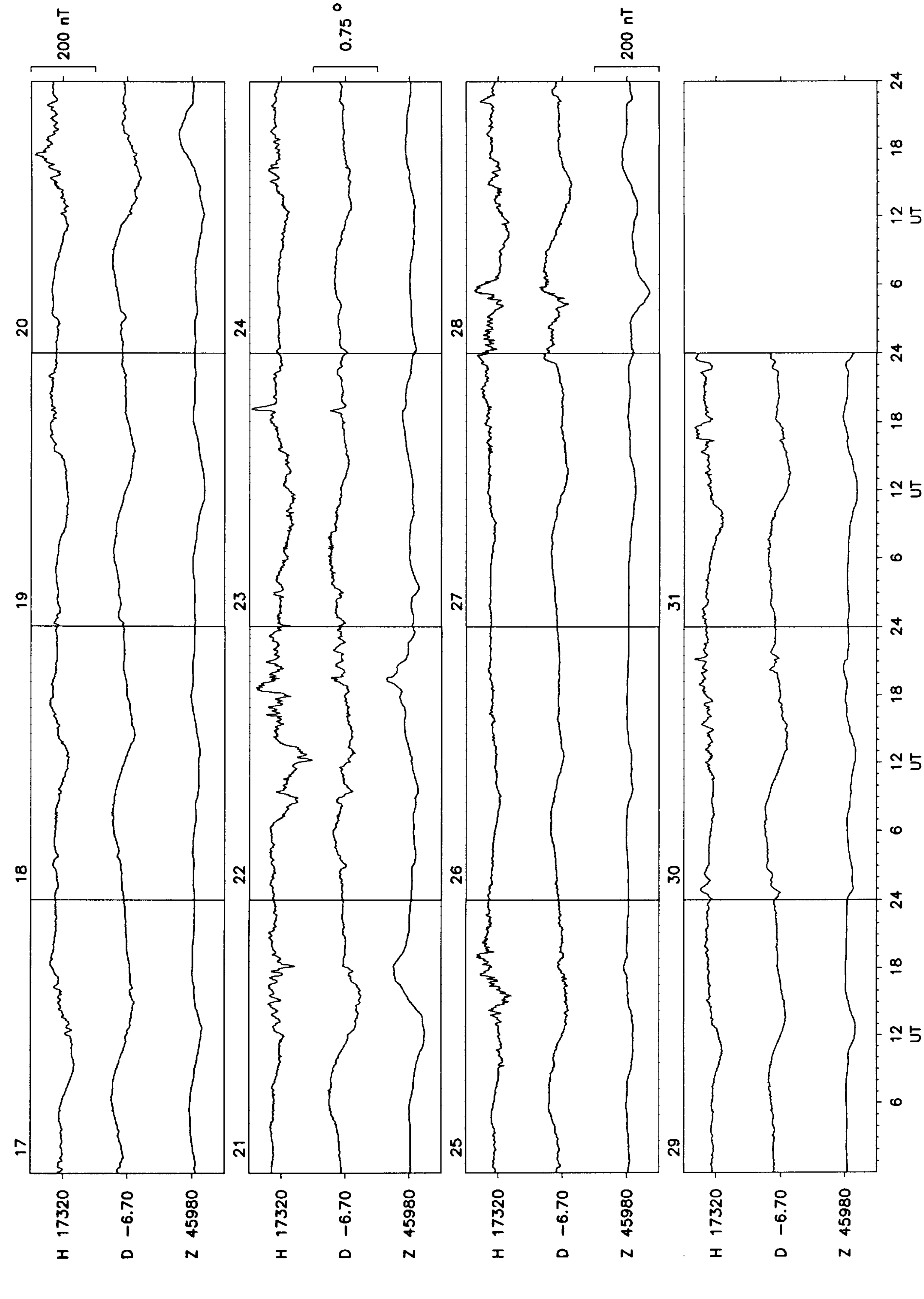
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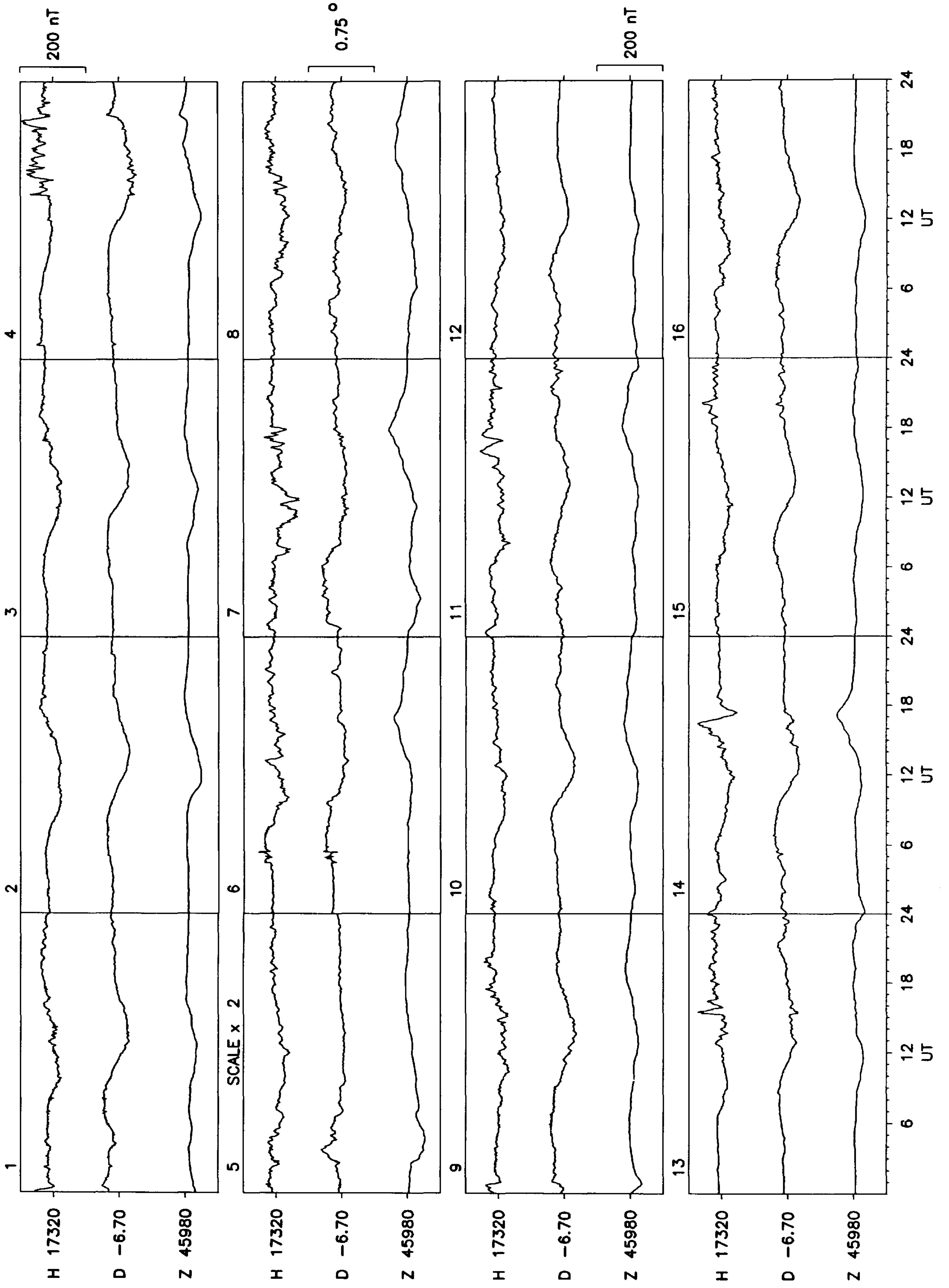

200 nT
0.75 °
200 nT
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Z 45980
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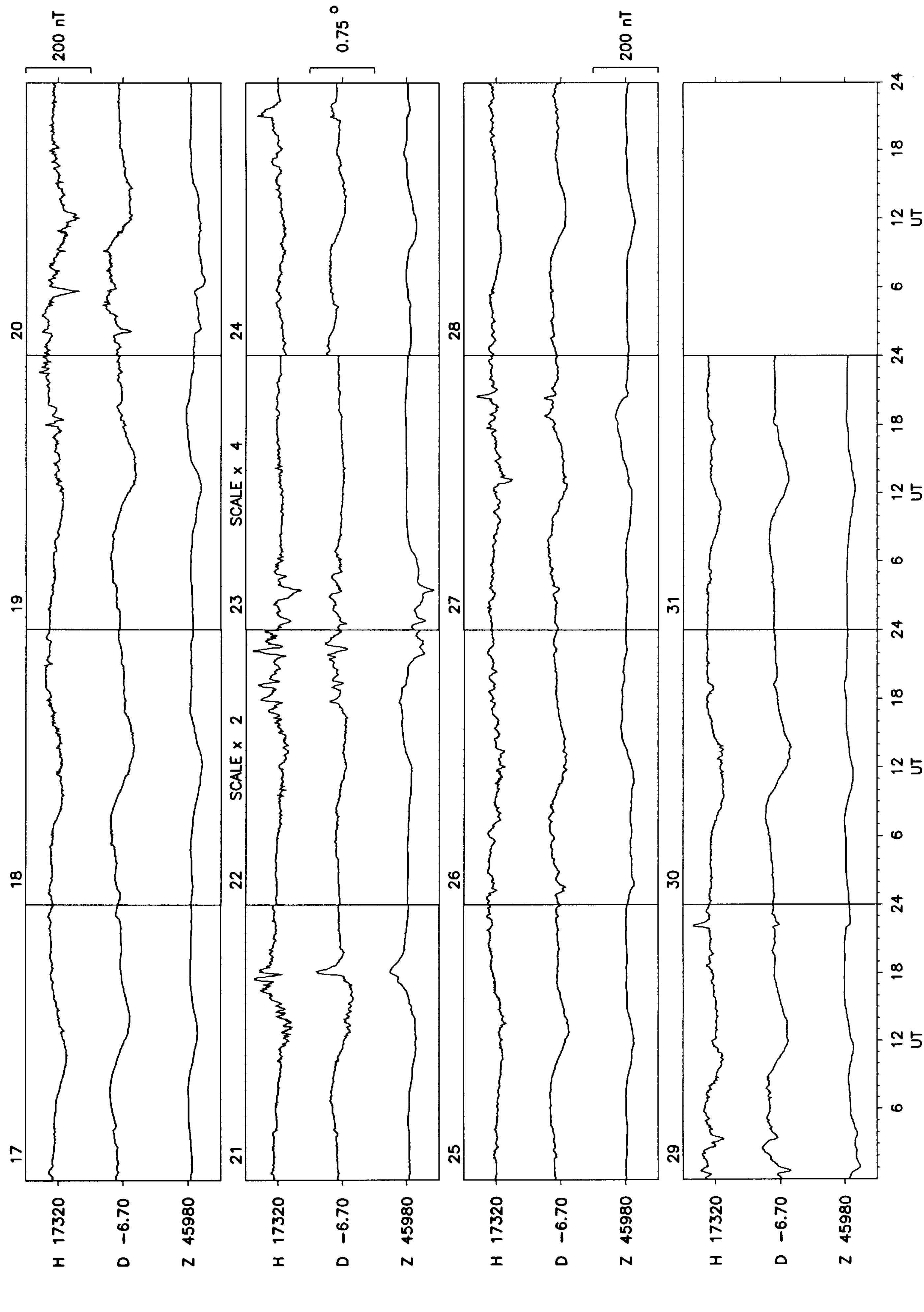
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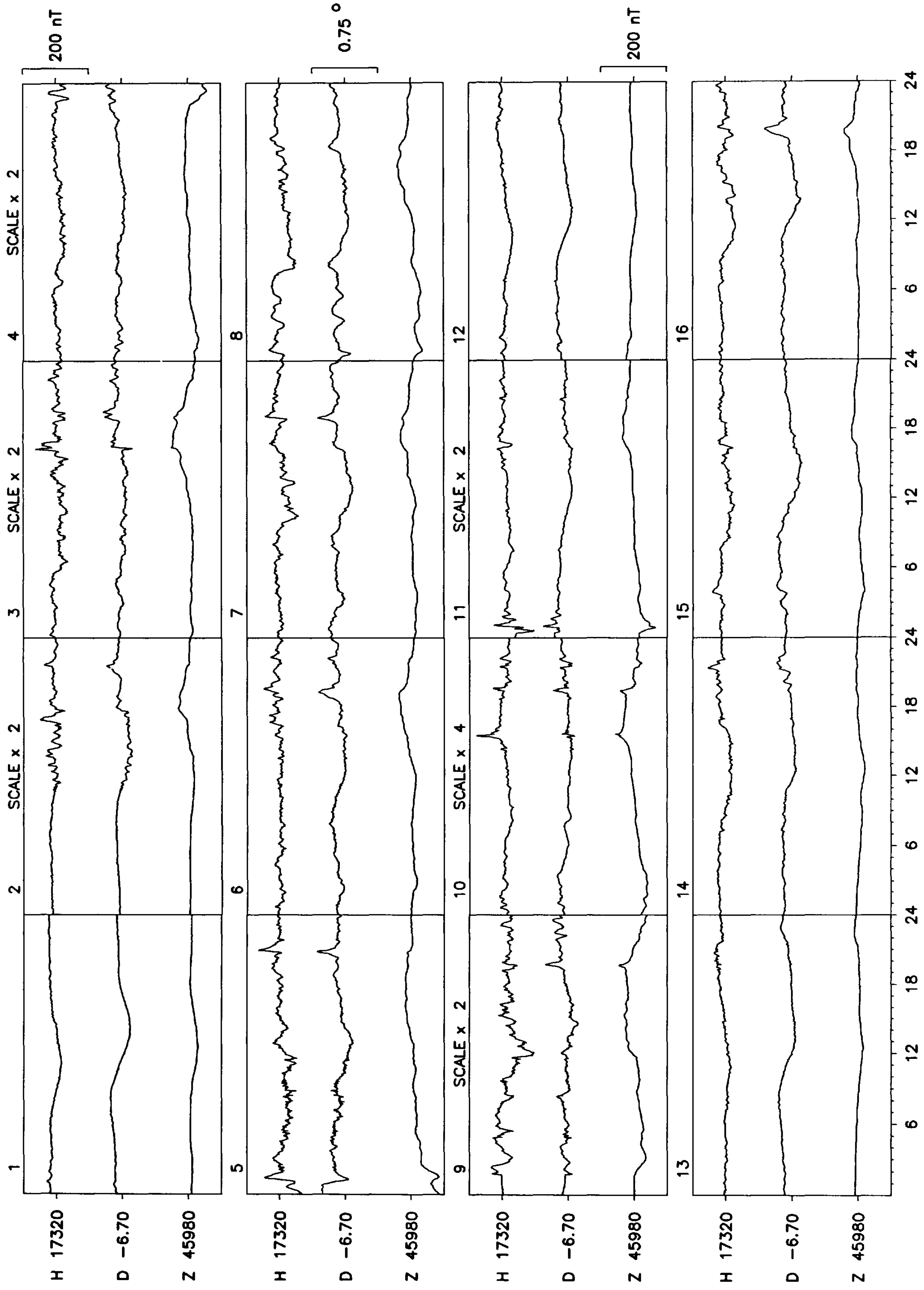
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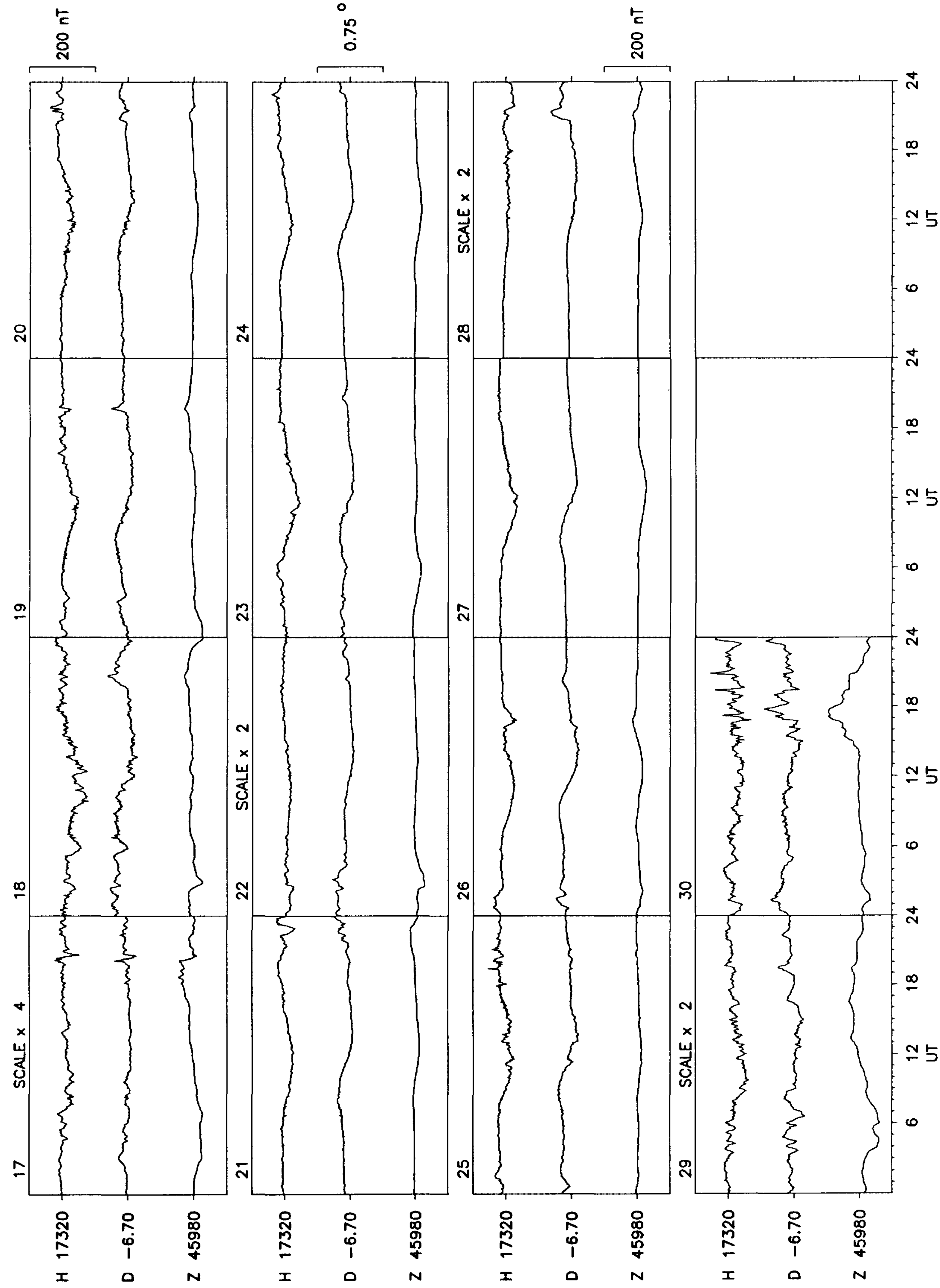
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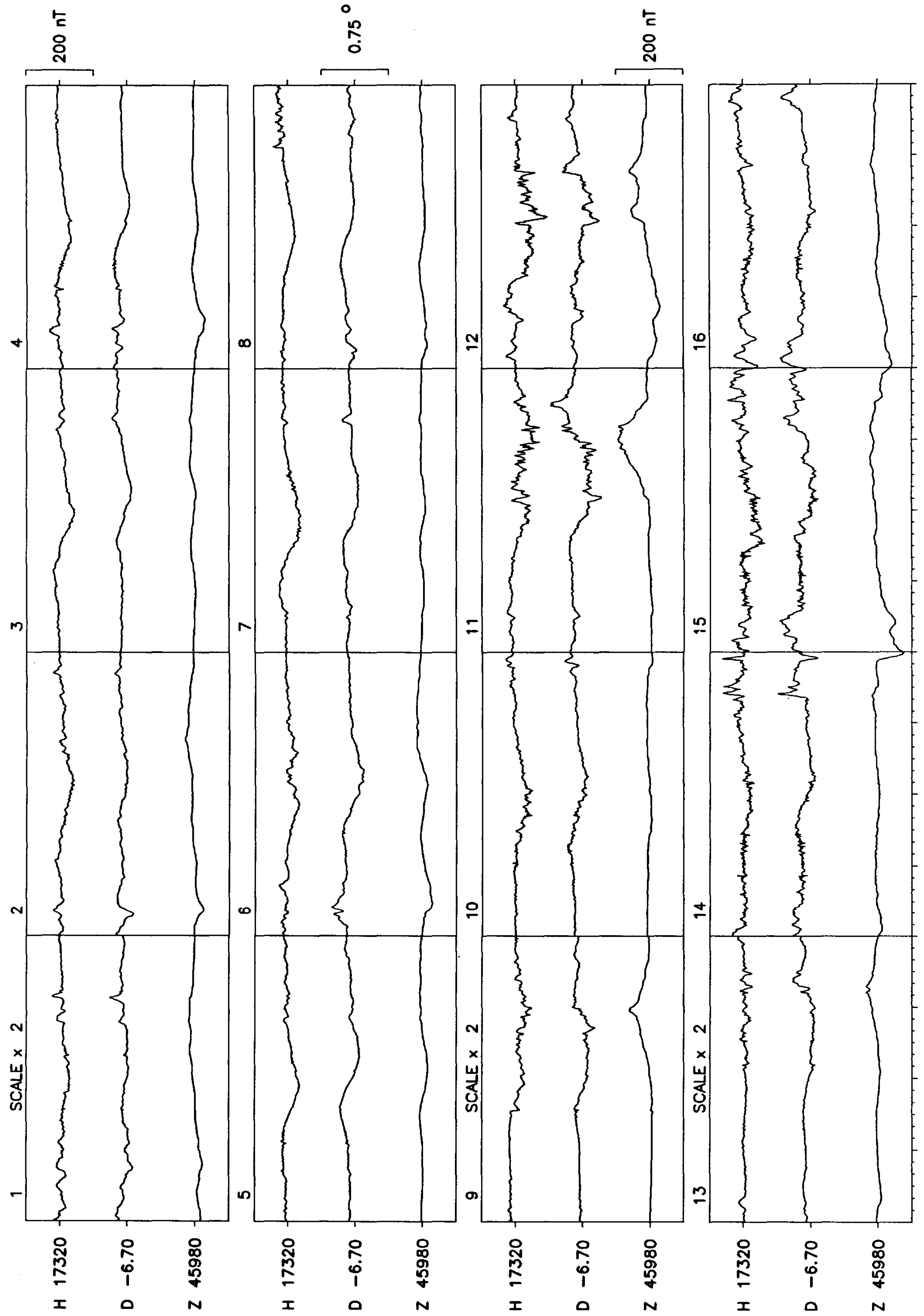
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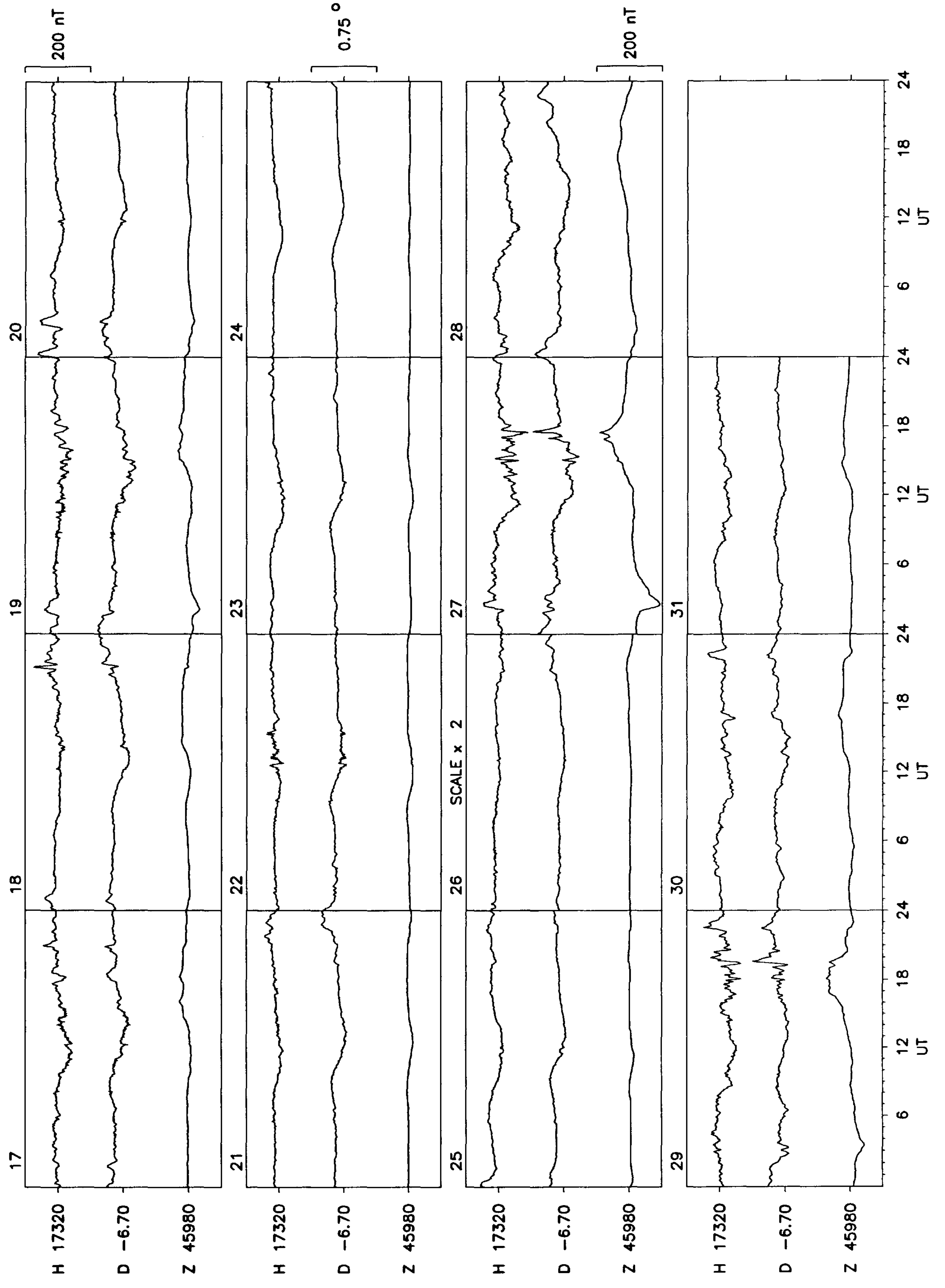
200 nT
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SCALE x 2
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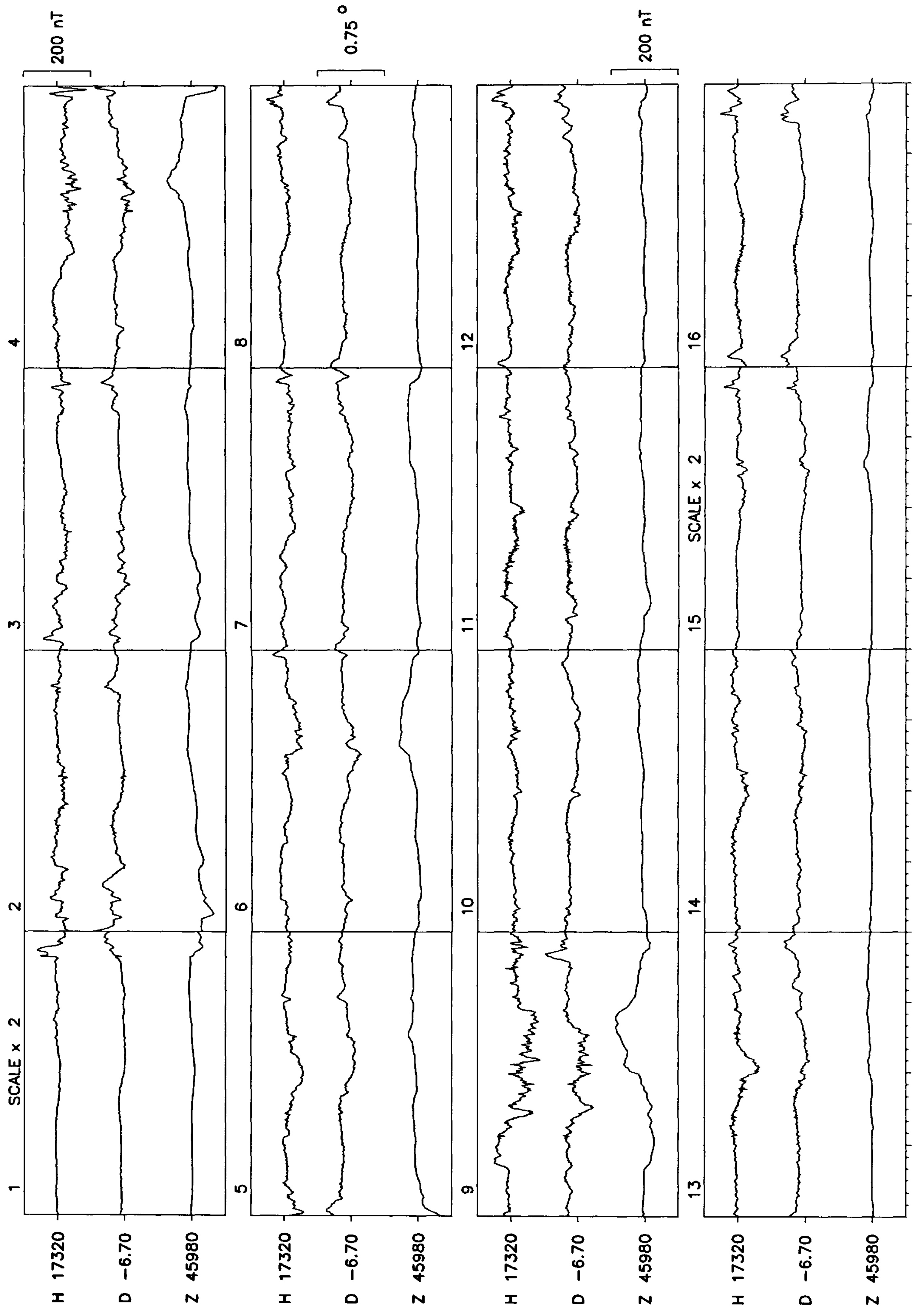

SCALE x 2
SCALE x 2
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0.75 °
200 nT
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D −6.70
Z 45980
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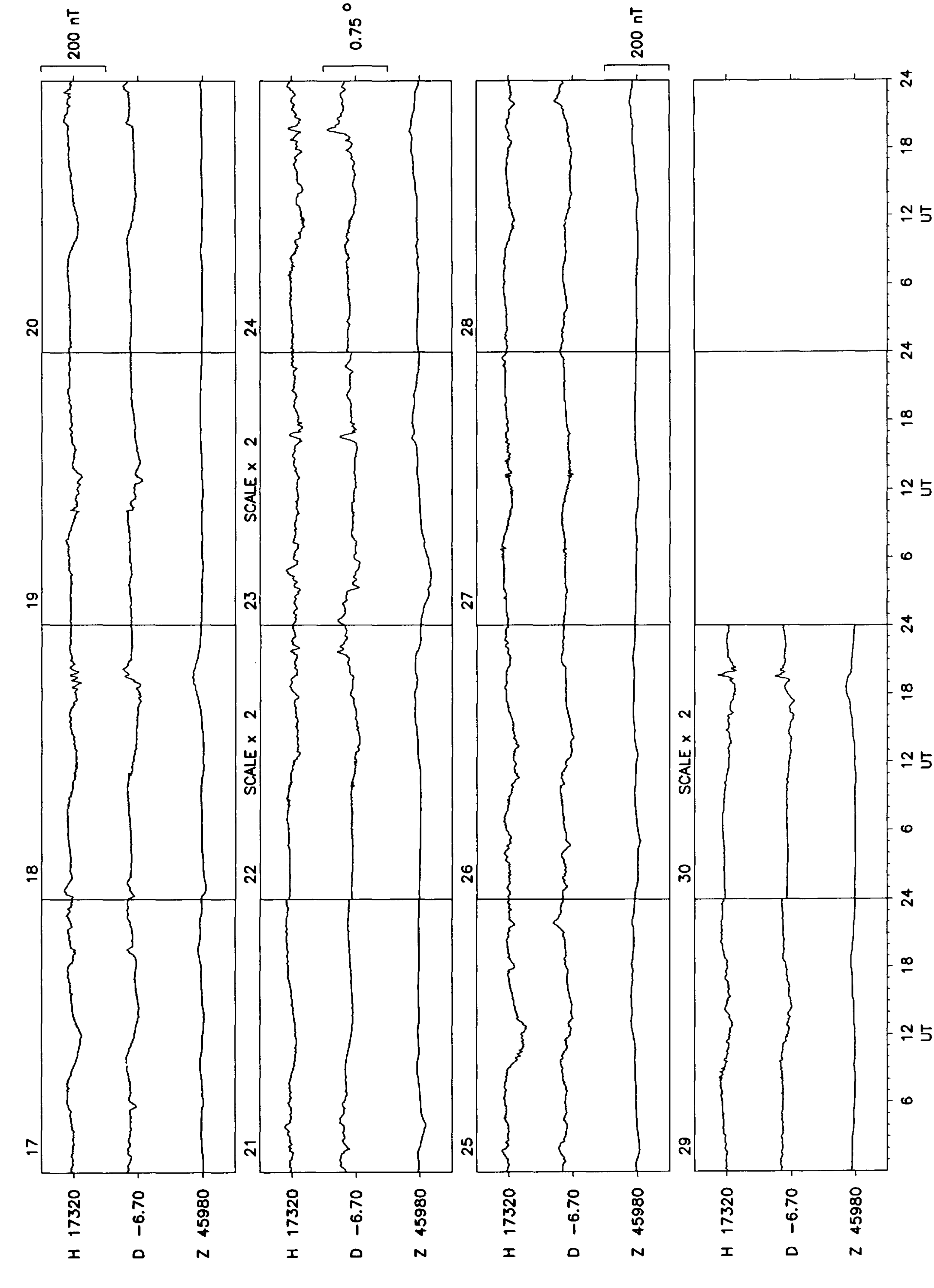

200 nT
0.75 °
200 nT
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SCALE x 2
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Z 45980
H 17320
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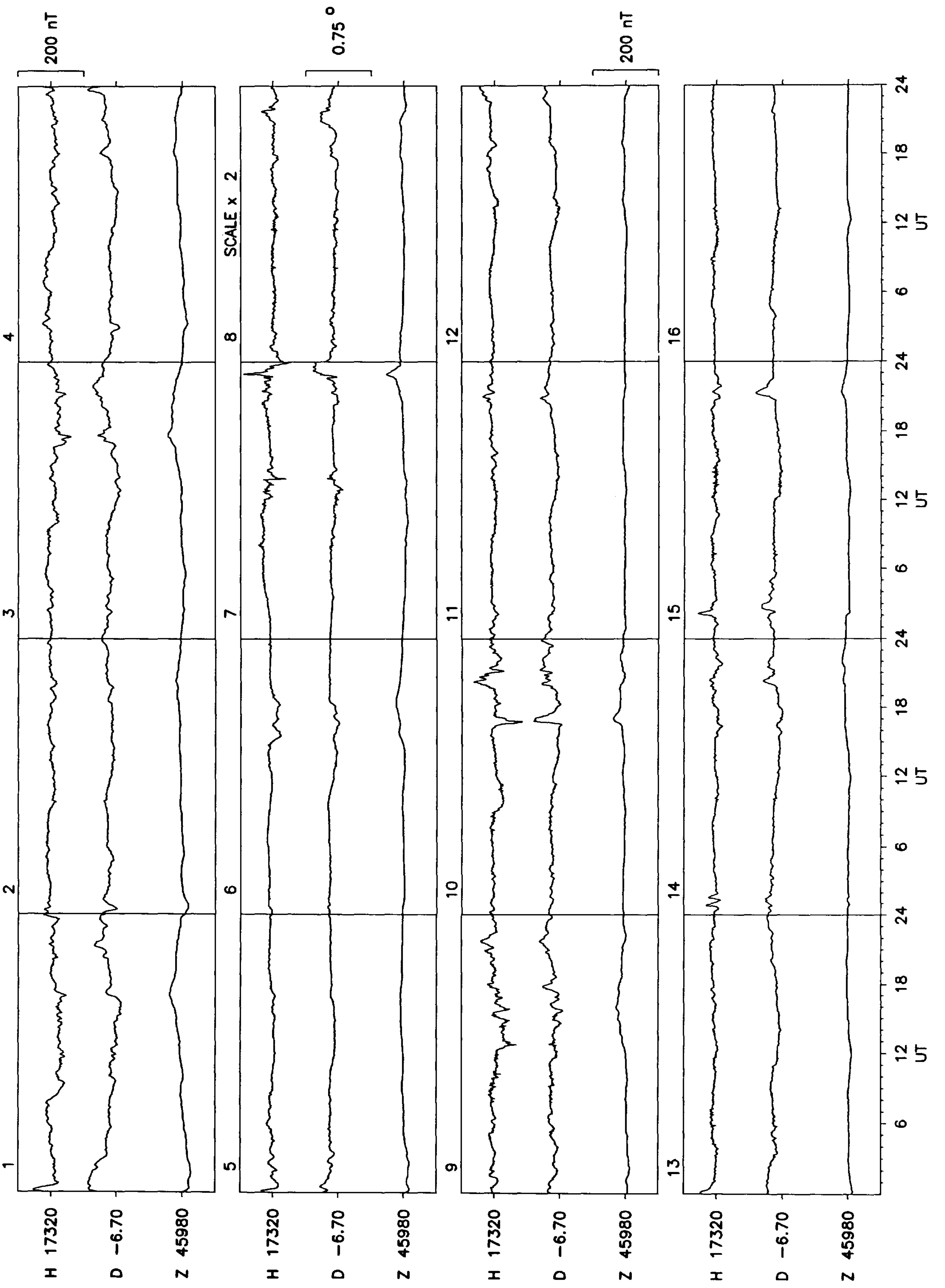
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200 nT
SCALE x 2
H 17320
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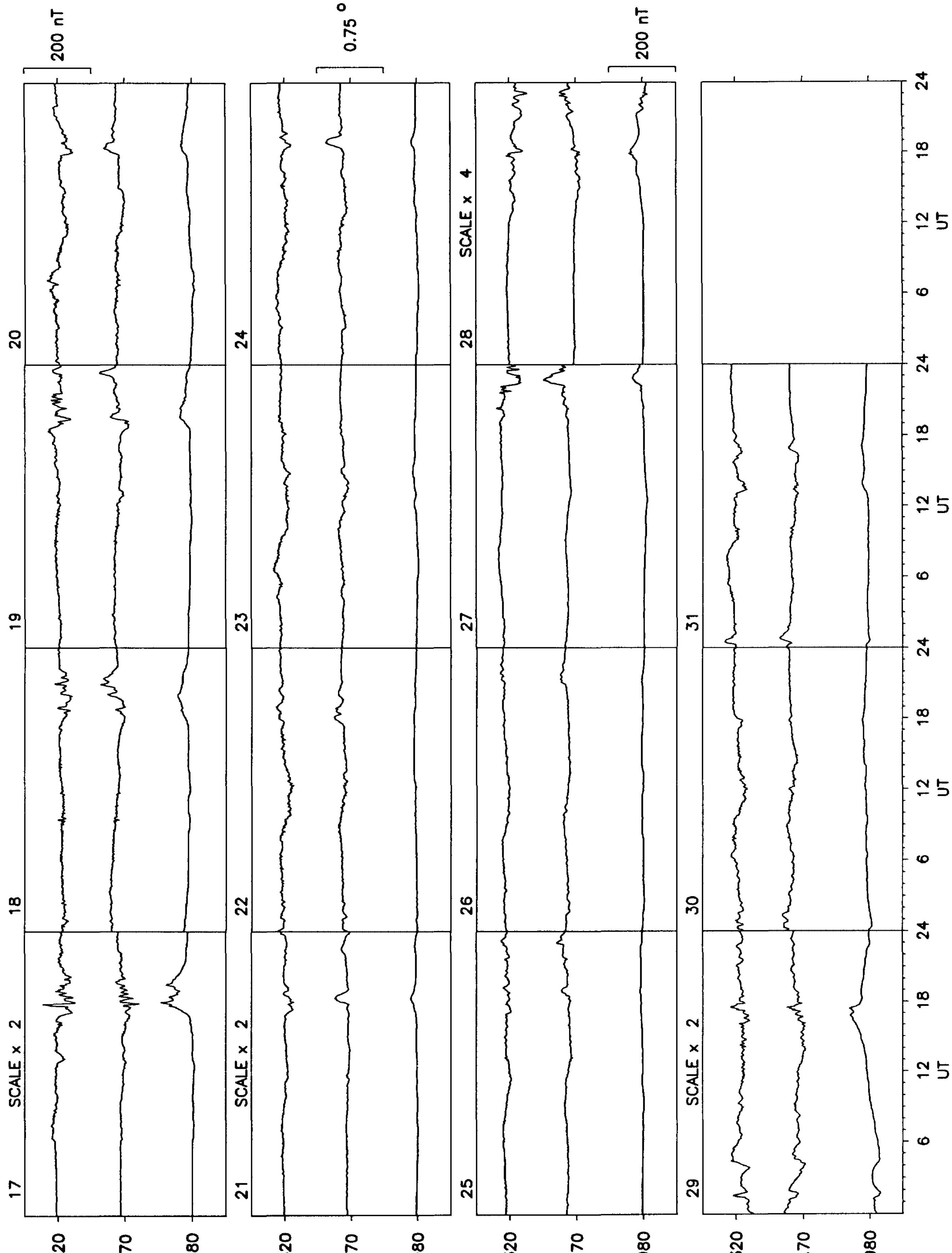
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H 17320
D −6.70
Z 45980
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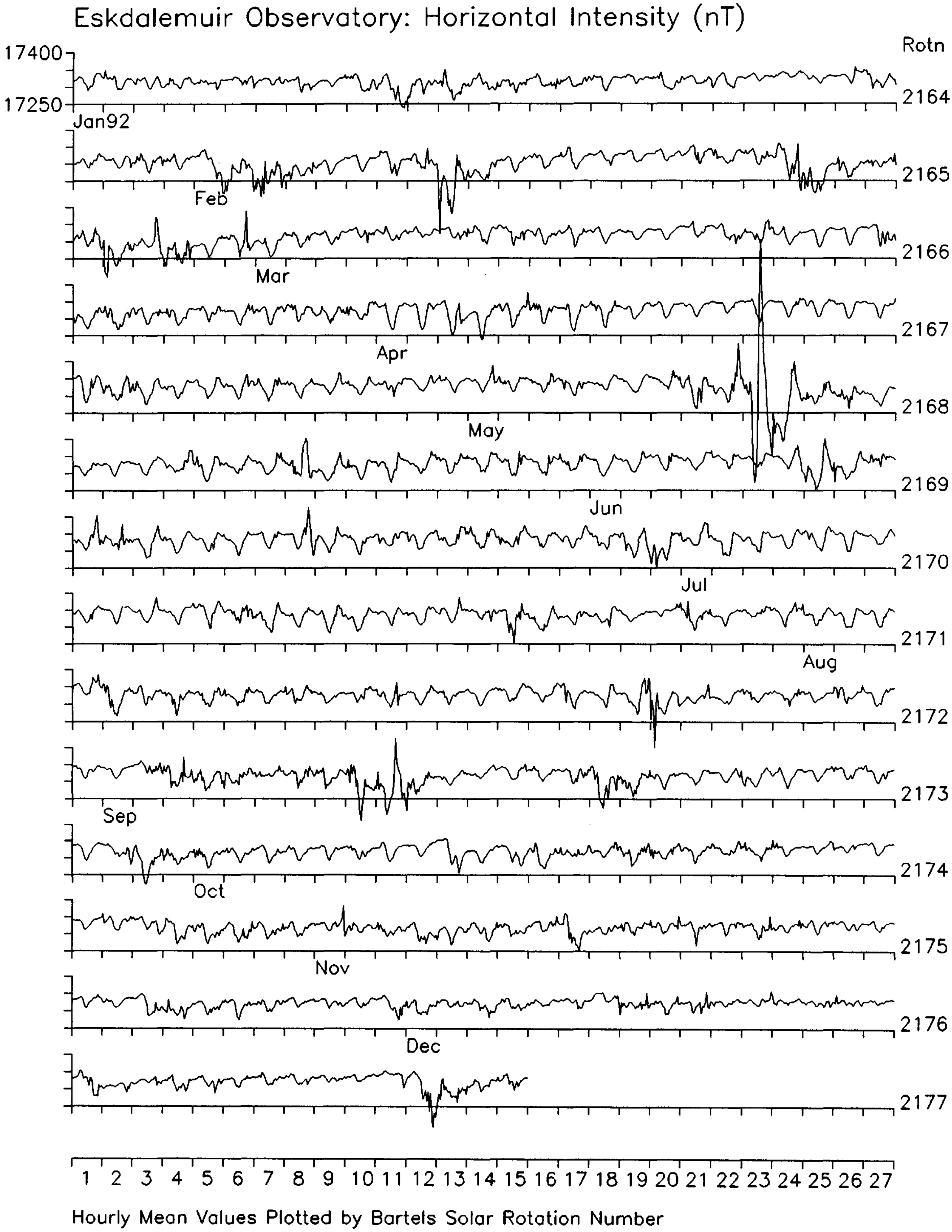
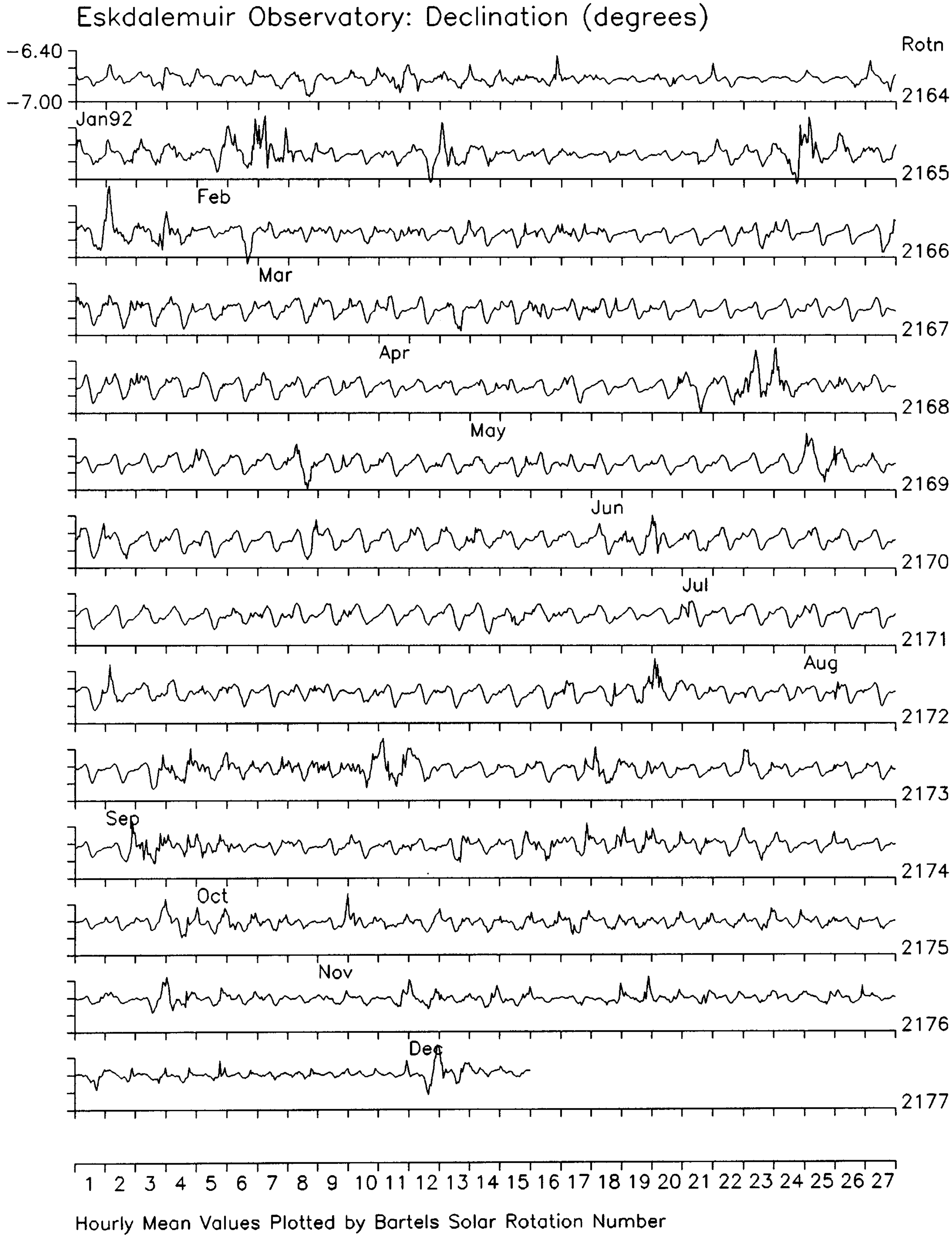
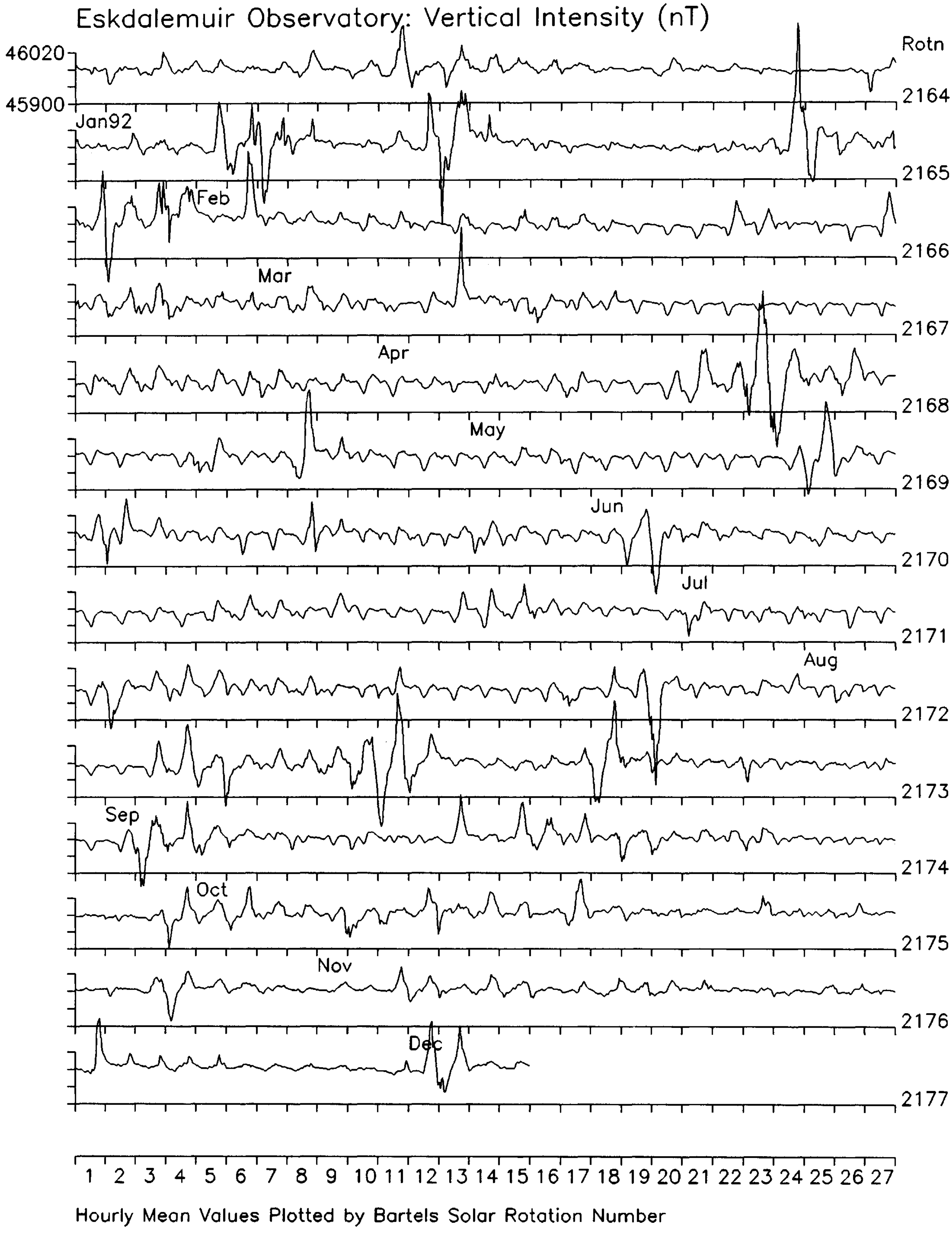
ES 12 92



Eskdalemuir Observatory: Horizontal Intensity (nT)
17400
17250
Rotn
2164
Jan92
2165
Feb
2166
Mar
2167
Apr
2168
May
2169
Jun
2170
Jul
2171
Aug
2172
2173
Sep
2174
Oct
2175
Nov
2176
Dec
2177
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)
-6.40
-7.00
Rotn
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
Jan92
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
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)
46020
45900
Rotn
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
Jan92
Feb
Mar
Apr
May
Jun
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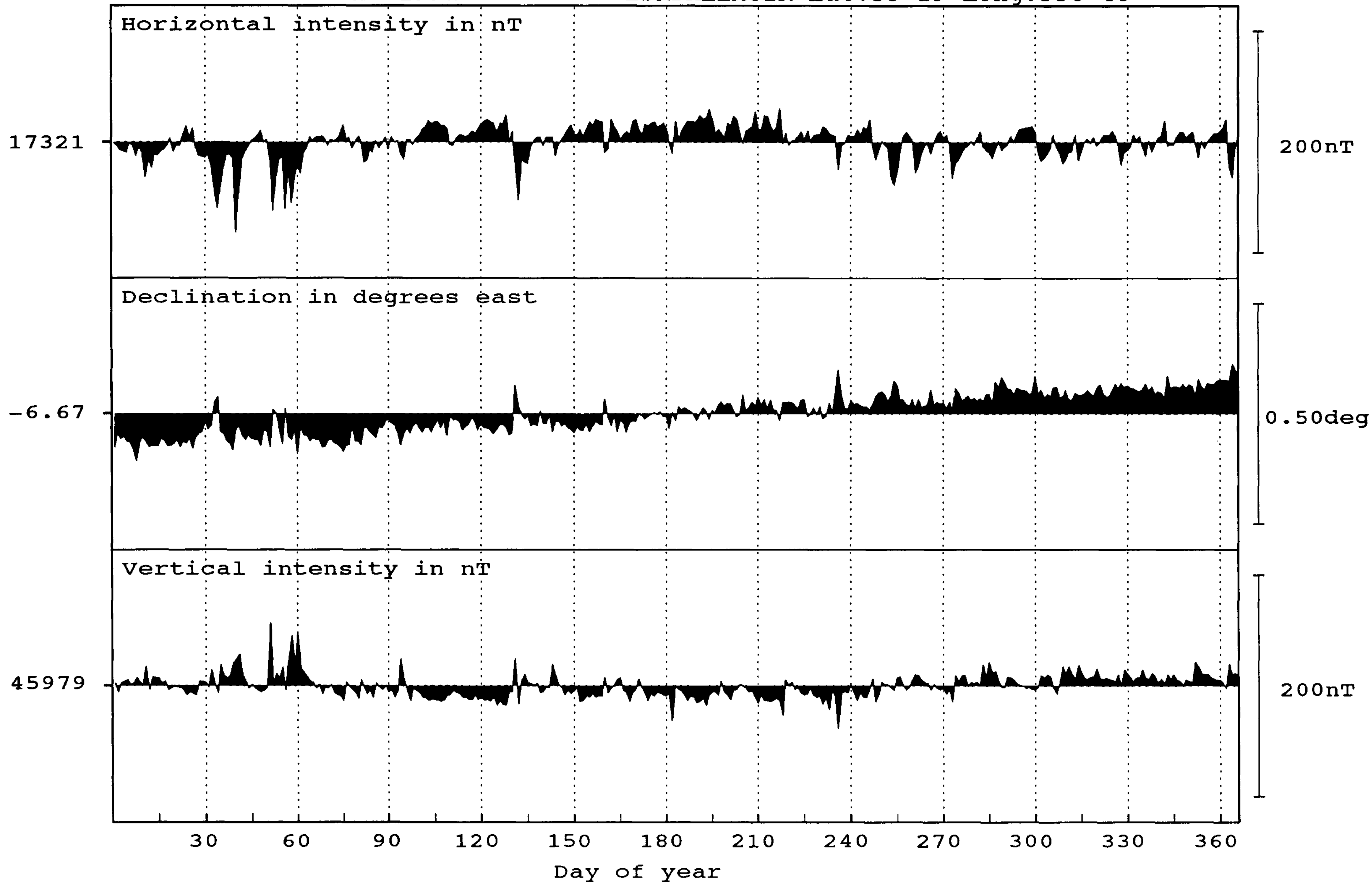
Sep
Oct
Nov
Dec
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

DAILY MEAN VALUES 1992 ESKDALEMUIR Lat:55 19 Long:356 48



Monthly and annual mean values for Eskdalemuir 1992

Month	D	H	I	X	Y	Z	F
Jan	-6 43.8	17315	69 21.9	17196	-2029	45980	49132
Feb	-6 42.5	17297	69 23.3	17179	-2021	45991	49136
Mar	-6 43.1	17320	69 21.5	17201	-2026	45977	49131
Apr	-6 41.8	17328	69 20.8	17210	-2021	45971	49128
May	-6 41.3	17323	69 21.3	17205	-2018	45976	49131
Jun	-6 40.9	17332	69 20.6	17214	-2017	45973	49132
Jul	-6 39.3	17337	69 20.2	17220	-2009	45972	49132
Aug	-6 38.9	17327	69 20.9	17210	-2006	45970	49127
Sep	-6 38.2	17315	69 21.9	17199	-2001	45979	49131
Oct	-6 37.2	17320	69 21.7	17205	-1997	45984	49138
Nov	-6 37.0	17319	69 21.8	17204	-1996	45987	49140
Dec	-6 36.0	17322	69 21.6	17207	-1991	45986	49140
Annual	-6 40.0	17321	69 21.5	17204	-2011	45979	49133

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

Eskdalemuir Observatory K Indices 1992

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3111 2423	1233 3436	2332 2223	2233 3222	1231 2353	2421 2110	3322 3444	4222 2211	1000 1100	4433 3343	1011 2325	4233 2323
2	4334 2321	5434 4366	3322 2231	1110 2231	3341 2222	1111 1222	2343 3222	1110 1221	1114 4534	3211 2212	4433 2133	3211 2122
3	3223 2244	5664 4567	2322 1332	0233 4533	2111 3332	1101 3320	1111 3311	0101 2221	3444 4654	0011 1121	3333 2123	3213 2433
4	3322 2234	2432 2254	2222 3343	1123 3332	3312 3321	1000 1122	0110 1222	2101 4443	4343 3335	2321 1001	2323 3425	3321 2334
5	3211 2332	2001 2100	2221 2333	3133 3234	1211 1111	1002 3321	2312 3322	4543 4333	5333 3343	1110 1221	4223 3222	3210 0100
6	1321 2234	0011 2111	3131 1111	4442 3311	0001 1222	0011 2310	2211 2210	1323 3333	3321 2343	3211 2211	3221 3333	1000 1220
7	1101 3232	2324 3311	1121 2324	2343 3331	2221 3444	1211 1344	0001 1211	3334 4432	3334 3342	1211 2231	3222 2233	0121 4135
8	2233 3342	3332 5543	2322 3222	3333 4341	3342 4544	5342 4444	1111 3321	2332 3323	3341 2232	3200 0132	3211 2234	4333 3354
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10	3212 3234	3323 4432	2323 3333	2110 1100	4477 8776	1344 4332	1210 1331	2102 3222	5544 4765	0123 2113	2223 2323	1222 2443
11	3313 3454	2111 1221	3334 3431	1000 1000	6544 5453	2323 4455	1010 2111	3242 3423	6332 3433	2212 4444	3333 3332	3211 2233
12	4343 3333	3222 2213	1323 3311	0101 2210	3211 2332	5233 5632	3222 4433	2221 1201	2110 1112	3342 4433	3223 3234	1100 2123
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14	4232 3434	1122 2333	0011 1111	1111 1232	2201 2001	3111 2222	3322 3331	3311 3520	1121 2223	3333 3244	2222 3332	3101 1233
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16	1323 3365	1110 2111	1132 3333	1001 2311	0101 2110	1211 2110	1122 3333	1232 2212	1121 3243	4323 2324	3211 1144	1211 2001
17	2113 2233	1223 4222	3114 4443	1000 2312	0000 0011	0111 2321	3101 2210	1100 1012	5565 4465	3223 3343	2211 1122	0032 3652
18	2221 1000	4323 2312	4333 3311	2233 4224	2110 2344	1111 3554	2211 2210	1212 2222	3334 4244	3110 3234	2001 1230	2102 1243
19	0211 1210	3223 3333	0000 1211	3322 3334	4211 2341	3112 3442	2100 1222	1110 2333	2312 3341	3223 3333	0112 2110	1011 2144
20	3222 3322	4434 4576	0010 1121	4332 3333	3211 3322	1211 3312	2201 2433	4534 4221	1112 2123	4322 2111	0001 1022	1231 2332
21	1000 2124	5555 4332	1124 4444	2311 3210	2111 1323	4210 2322	1112 3342	1112 3541	1111 1124	0111 1123	3210 0001	0112 2344
22	3100 2200	4343 3234	3332 2233	3222 2333	2444 5553	4311 3212	2344 5443	1234 3556	3422 2223	3201 3311	0123 3334	2111 2330
23	1100 1010	3321 2225	4433 3343	2110 2333	2211 3452	3321 3343	3322 2343	6743 5333	2222 2221	1111 2112	4432 3533	1221 2120
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26	0000 3322	3233 3677	1212 3243	2121 2032	0111 2233	2231 2222	1101 1210	3232 2222	3110 2320	3221 2243	2312 2122	1001 1012
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29	3321 3234	2214 4643	2332 2343	2211 1232	2232 3533	4531 4544	0110 1111	4423 2123	3554 4553	4332 3354	1111 2110	5533 3533
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31	3332 3232		4202 2443		3211 1321		2111 2423	0101 1110		1122 2212		3111 3310

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
1	1	16	45	SSC	A	64	- 3.8	- 9
9	1	21	52	SSC	A	29	- 1.7	- 4
26	1	14	58	SSC*	A	49	- 5.5	- 5
1	2	06	06	SSC*	B	17	- 4.8	- 3
2	2	11	53	SSC*	A	49	10.7	- 6
8	2	14	27	SSC*	A	65	- 14.4	- 5
17	2	08	05	SSC*	B	- 13	3.9	3
20	2	01	09	SSC*	A	53	- 5.2	- 5
26	2	16	57	SSC	B	106	- 8.5	- 7
29	2	09	19	SSC*	A	25	6.4	- 8
17	3	09	50	SSC*	B	- 47	9.2	- 4
9	5	19	57	SSC*	C	167	5.3	- 14
10	5	06	22	SSC*	C	- 73	20.5	9
26	5	12	03	SI	C	12		
10	6	04	02	SSC*	B	20	-4.6	
18	6	12	52	SSC	B	26	-5.1	
4	8	14	08	SSC*	C	58	- 4.7	- 4
6	8	04	24	SSC*	B	19	- 3.8	- 2
6	8	05	18	SI*	B	- 36	9.7	4
13	8	15	14	SI*	B	39	- 5.5	- 4
9	9	01	39	SSC	B	49	- 7.7	- 6
8	10	18	39	SSC*	B	25	- 1.2	- 3
9	10	09	12	SSC*	C	- 55	- 5.2	12
1	11	21	47	SSC	A	93	- 7.5	- 13
4	11	13	12	SSC	C	10	- 5.5	
07	12	07	54	SSC*	C	- 11	1.2	
07	12	13	45	SSC*	B	- 70	5.5	5
17	12	06	15	SSC*	B	9	- 1.6	

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)
7	7	16	07	16	11	16	16	13	-0.8	
8	7	09	44	09	50	09	56	-5	1.7	-3
9	7	16	10	16	20	16	29	-11	1.3	

Notes

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

Annual Values of Geomagnetic Elements

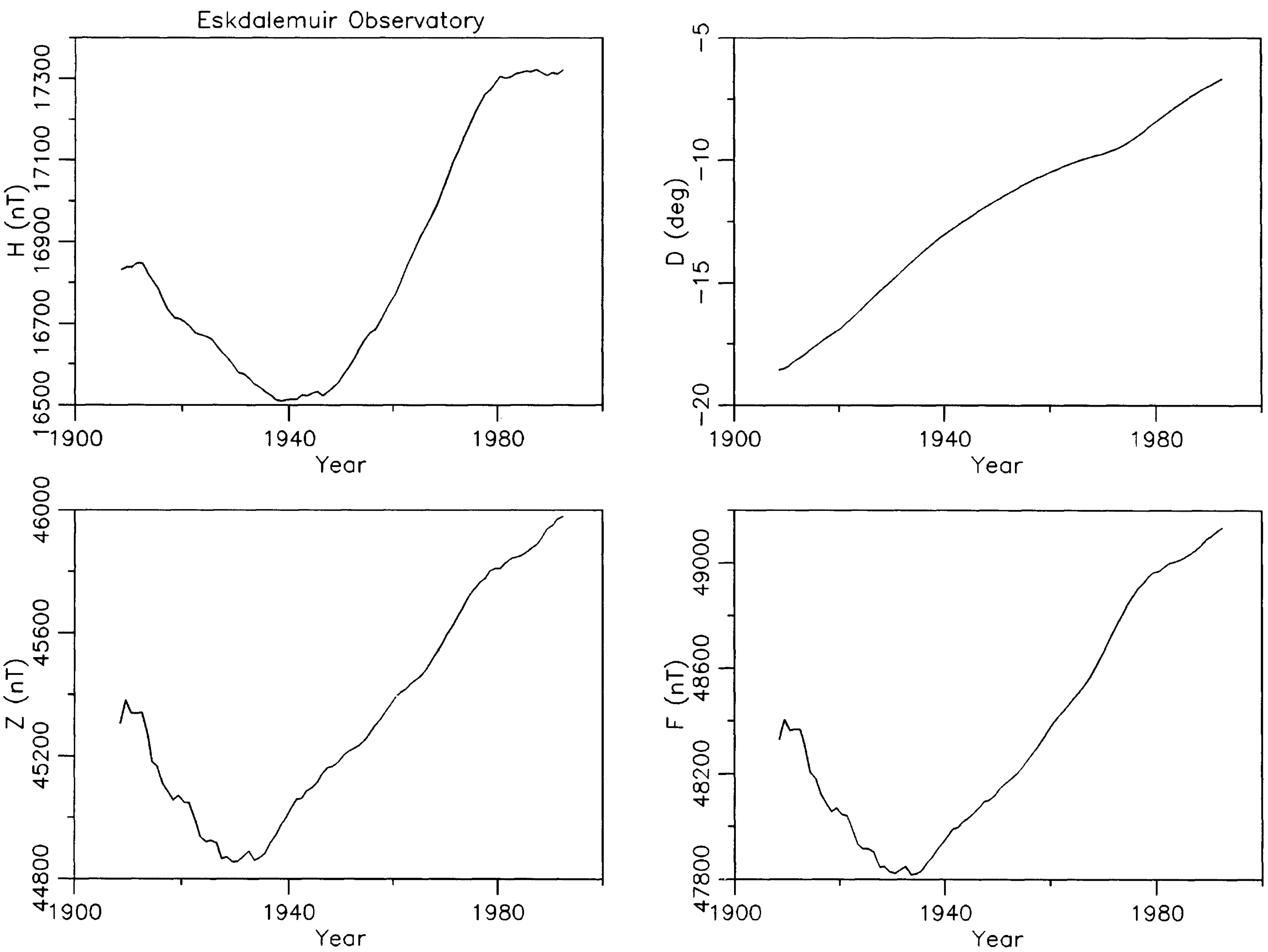
Eskdalemuir

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

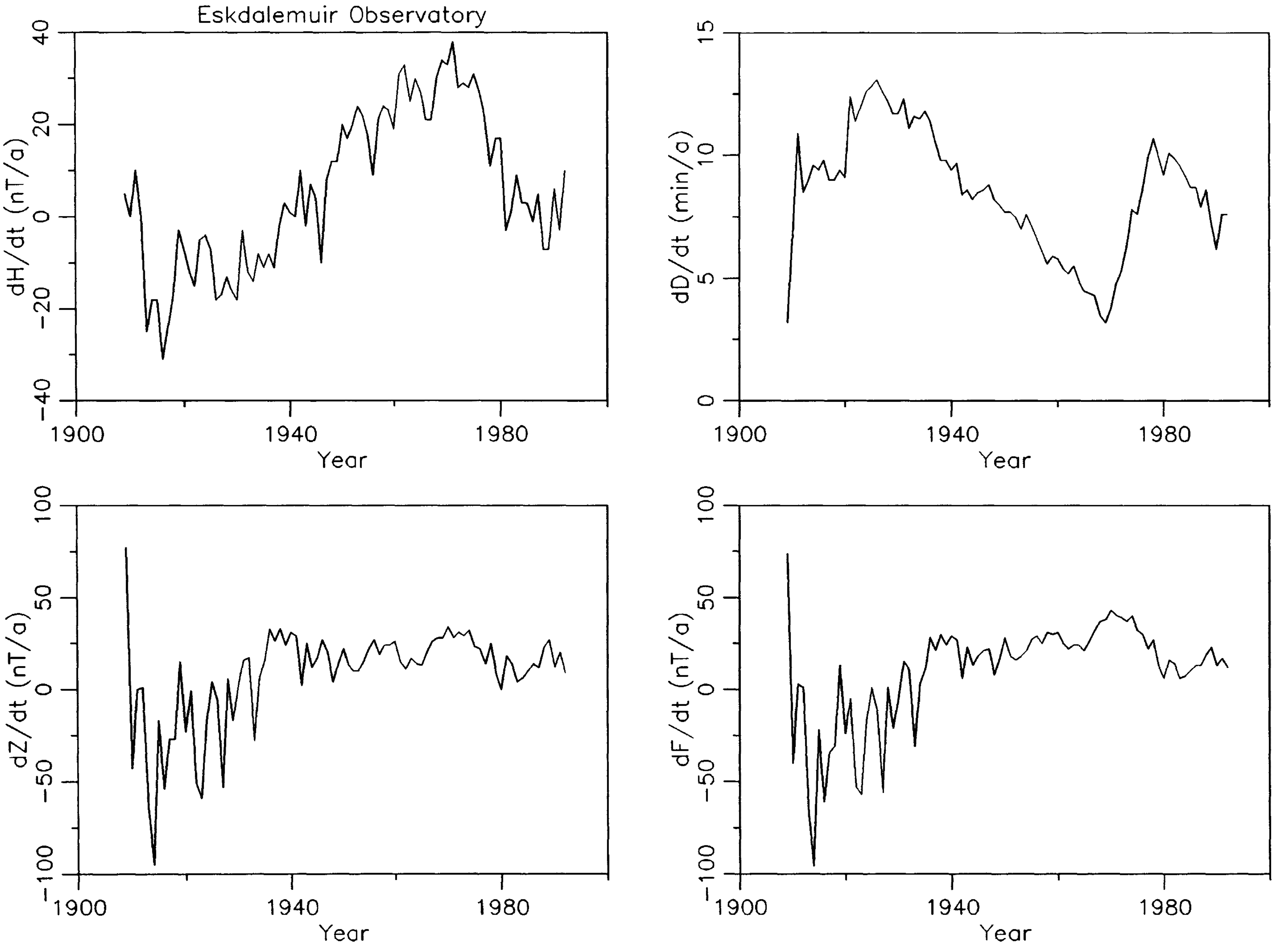
	Year	D	H	I	X	Y	Z	F
	1970.5	-9 41.6	17046	69 29.6	16803	-2870	45576	48659
	1971.5	-9 36.8	17084	69 27.8	16844	-2853	45604	48699
	1972.5	-9 31.5	17112	69 26.7	16876	-2832	45635	48738
	1973.5	-9 25.2	17141	69 25.5	16910	-2805	45664	48775
	1974.5	-9 17.4	17169	69 24.5	16944	-2772	45696	48815
	1975.5	-9 9.8	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
Note 1		0 0.0	11	0 -0.2	11	-1	22	25
	1990.5	-6 55.2	17314	69 21.2	17188	-2086	45950	49104
	1991.5	-6 47.6	17311	69 21.9	17189	-2048	45970	49121
	1992.5	-6 40.0	17321	69 21.5	17204	-2011	45979	49133

1 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

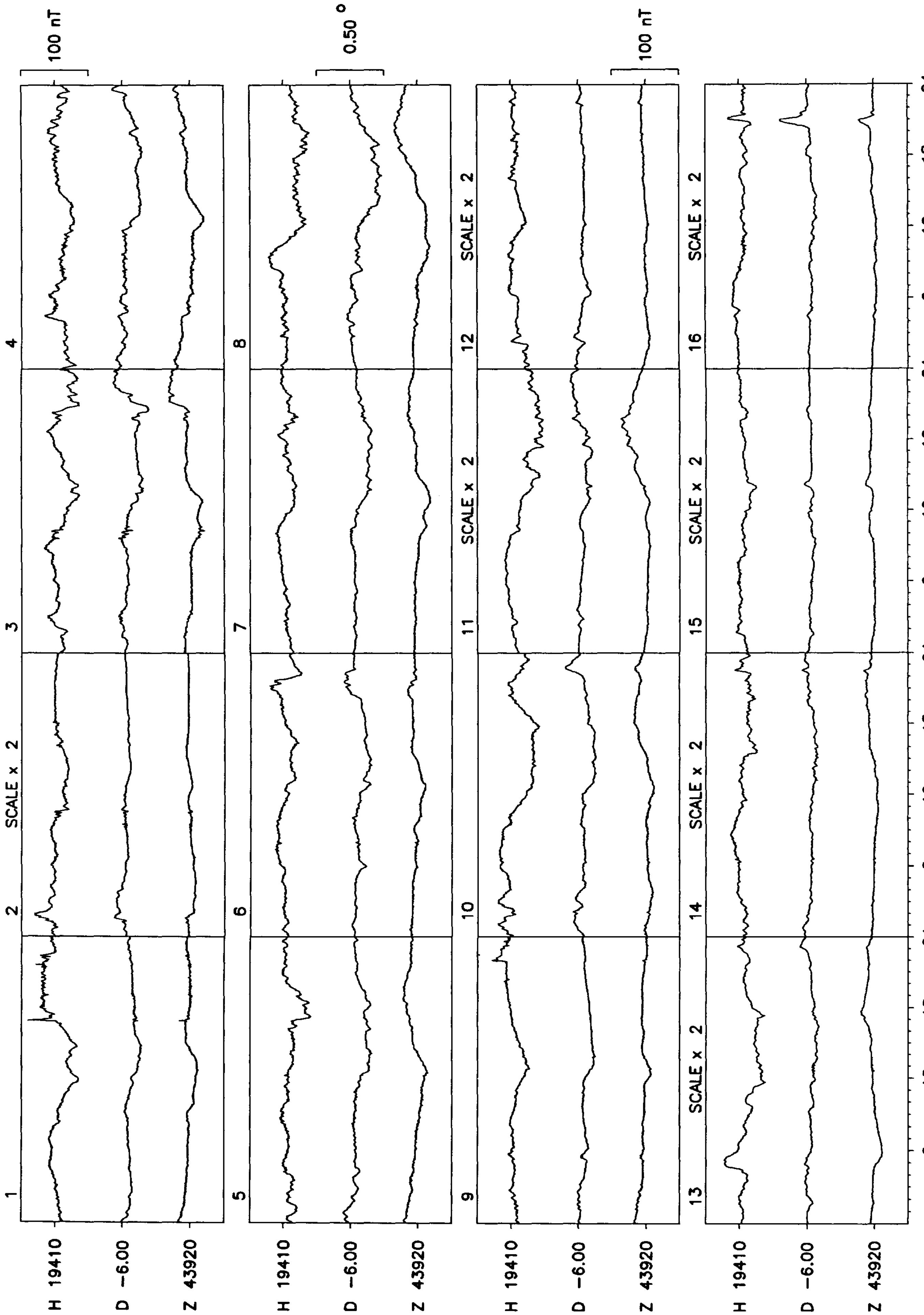


Annual mean values of H, D, Z & F at Eskdalemuir



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

Hartland 1992



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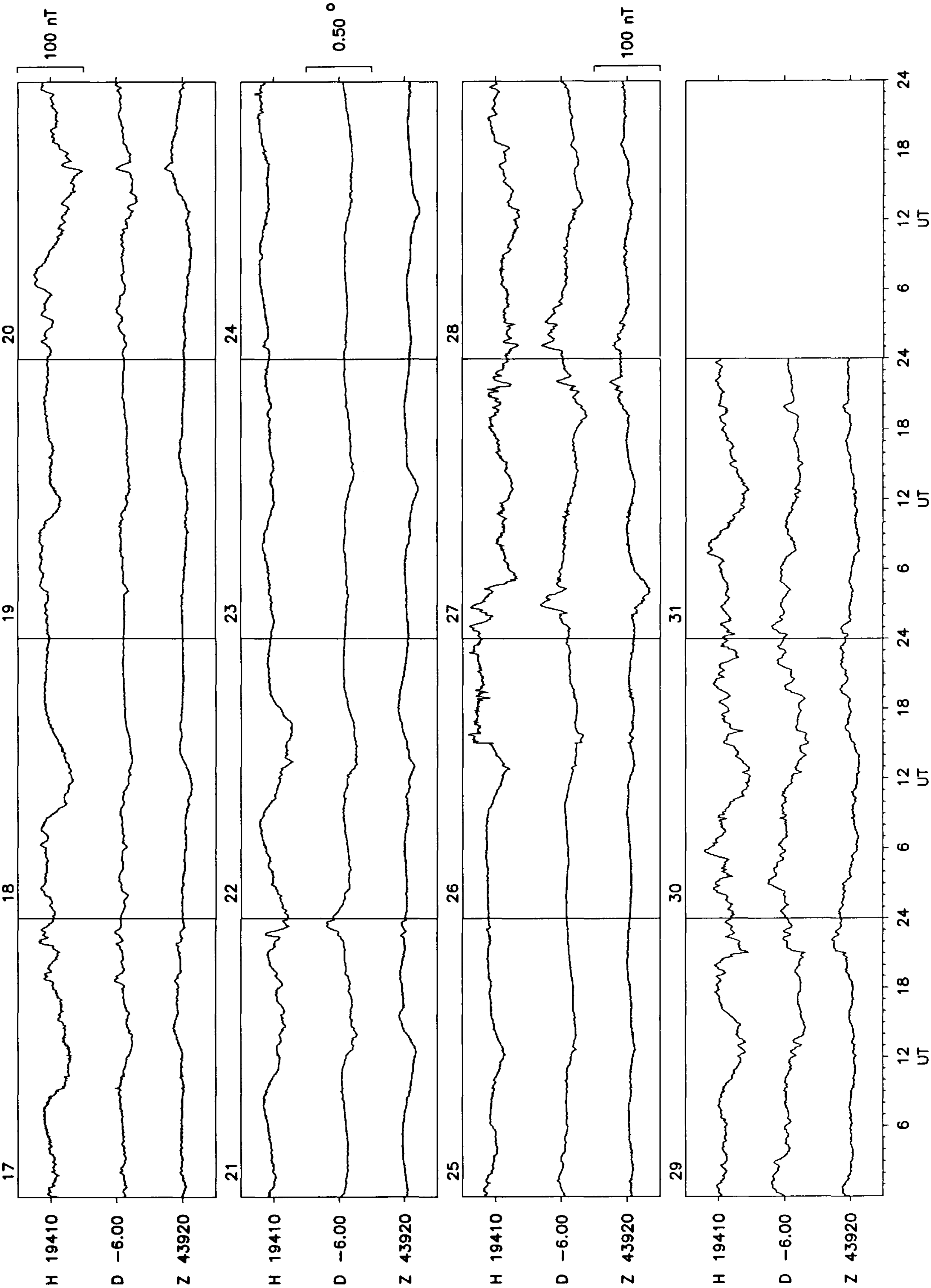

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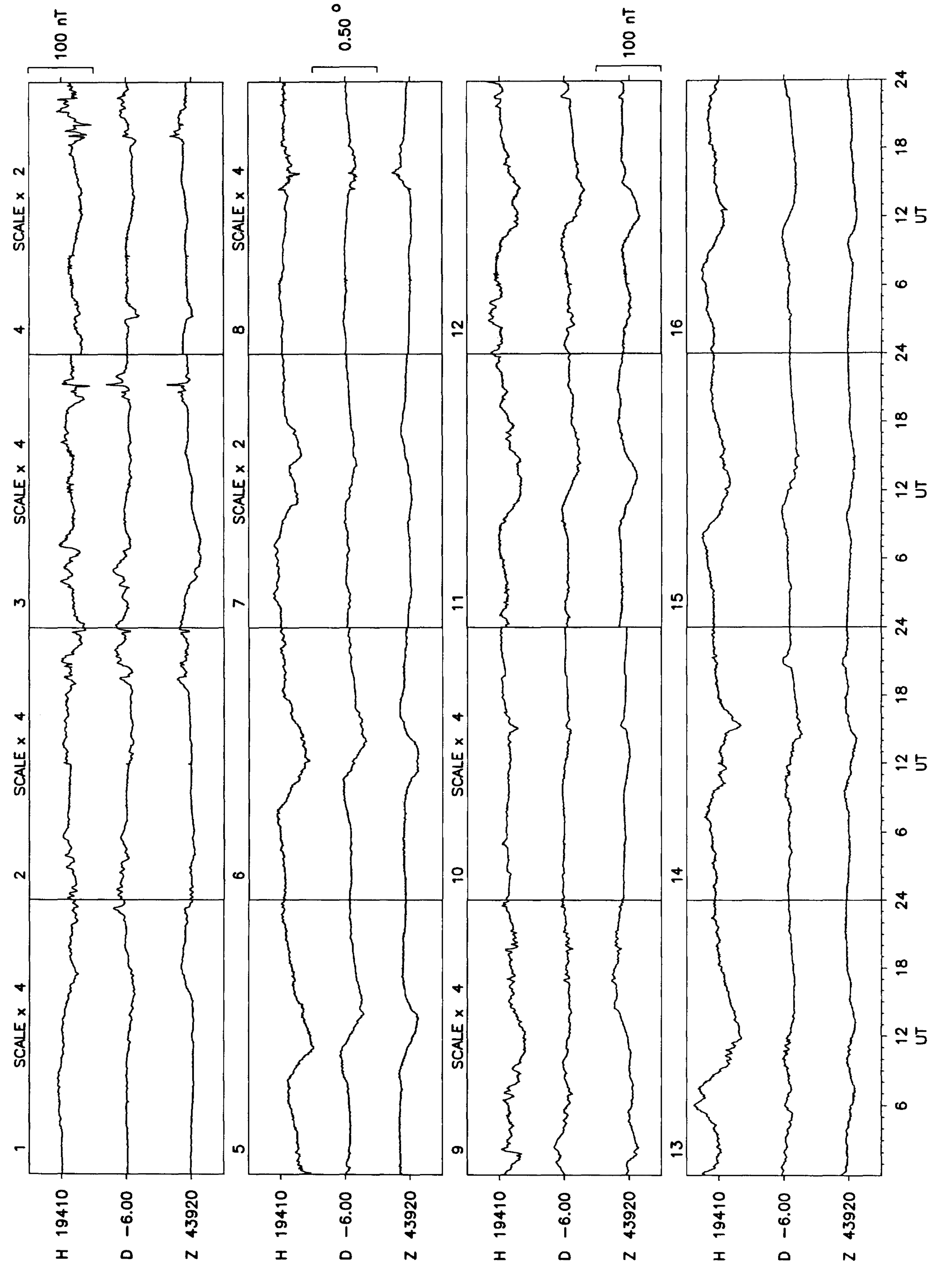
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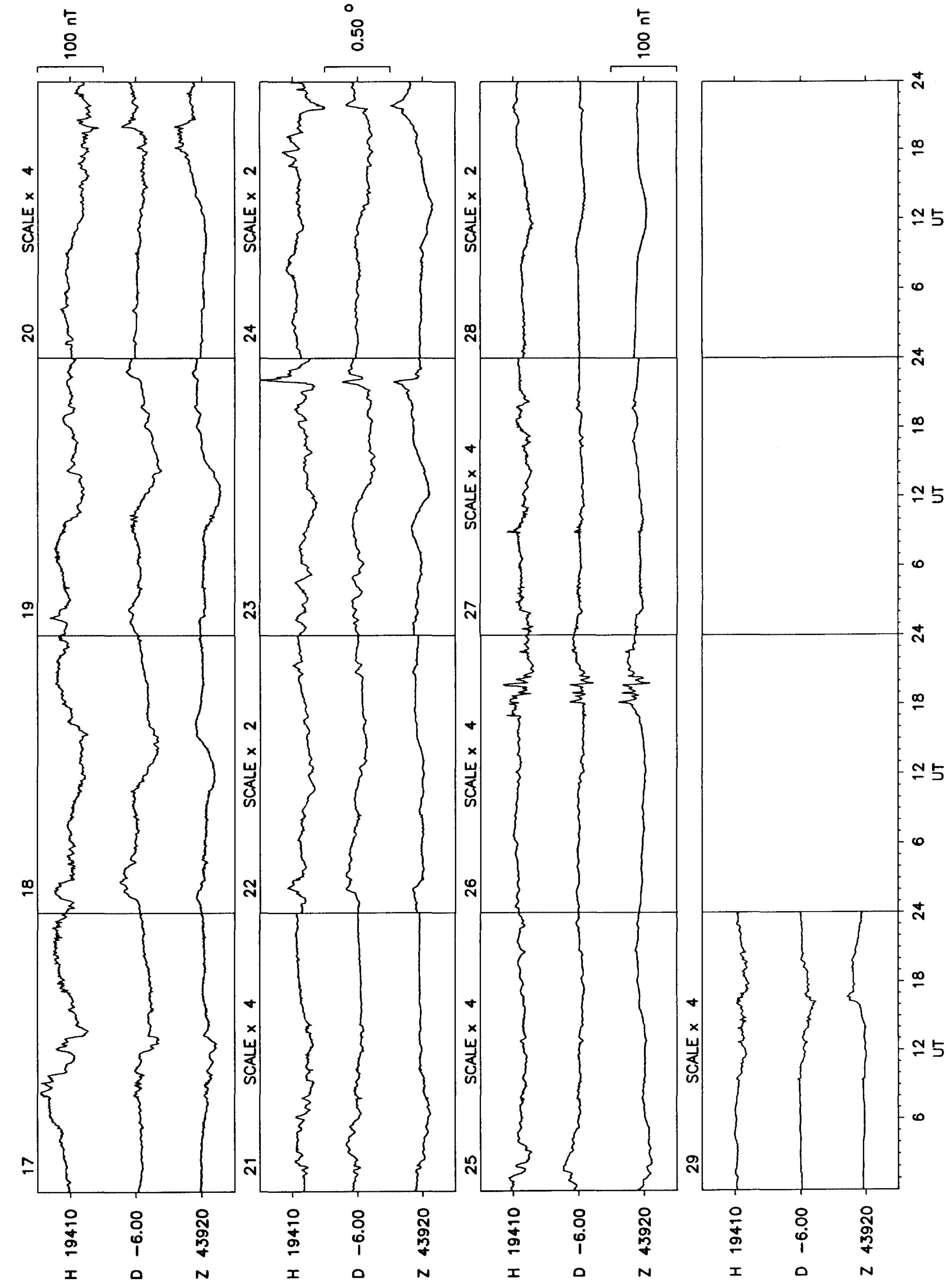
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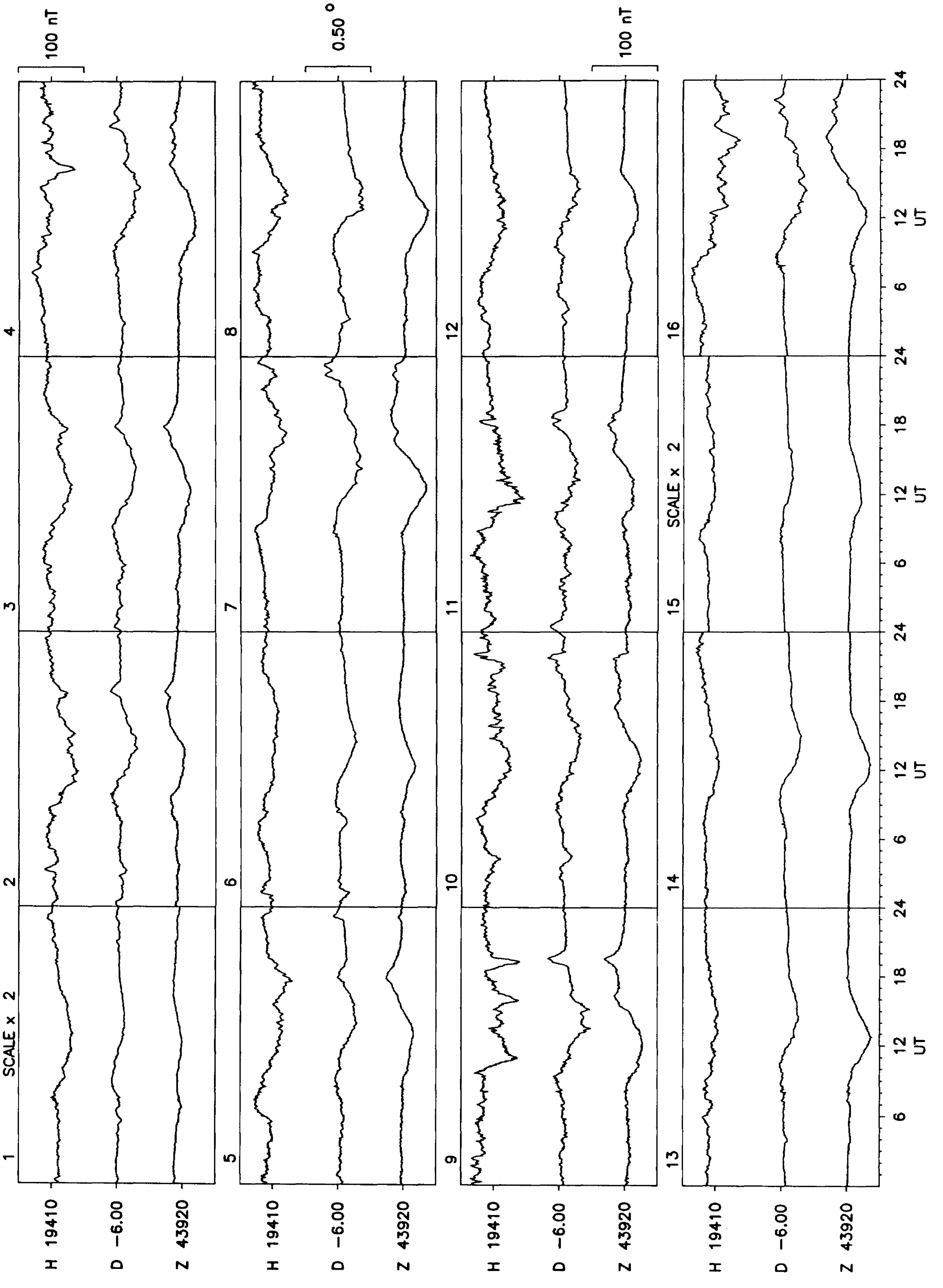

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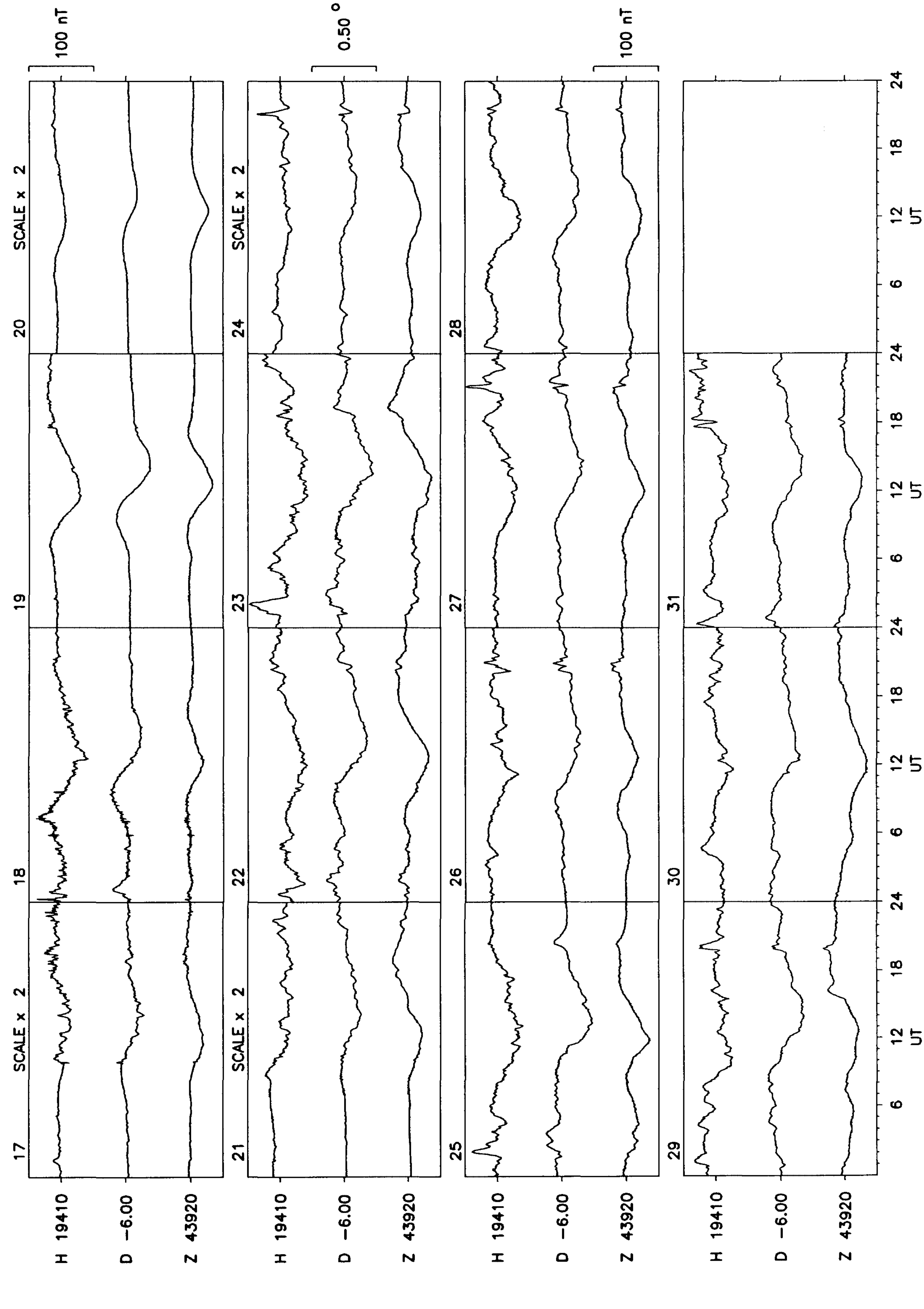

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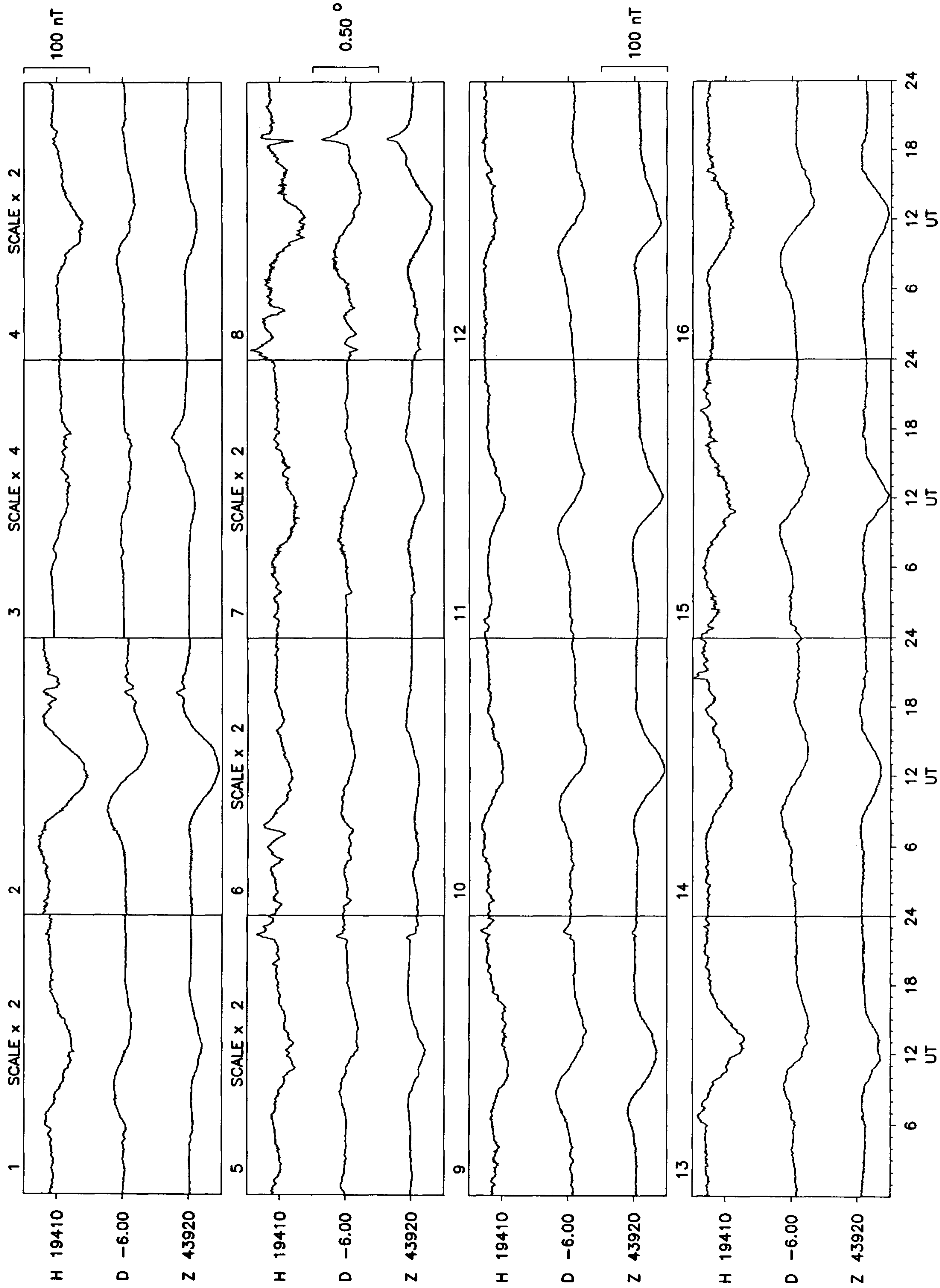

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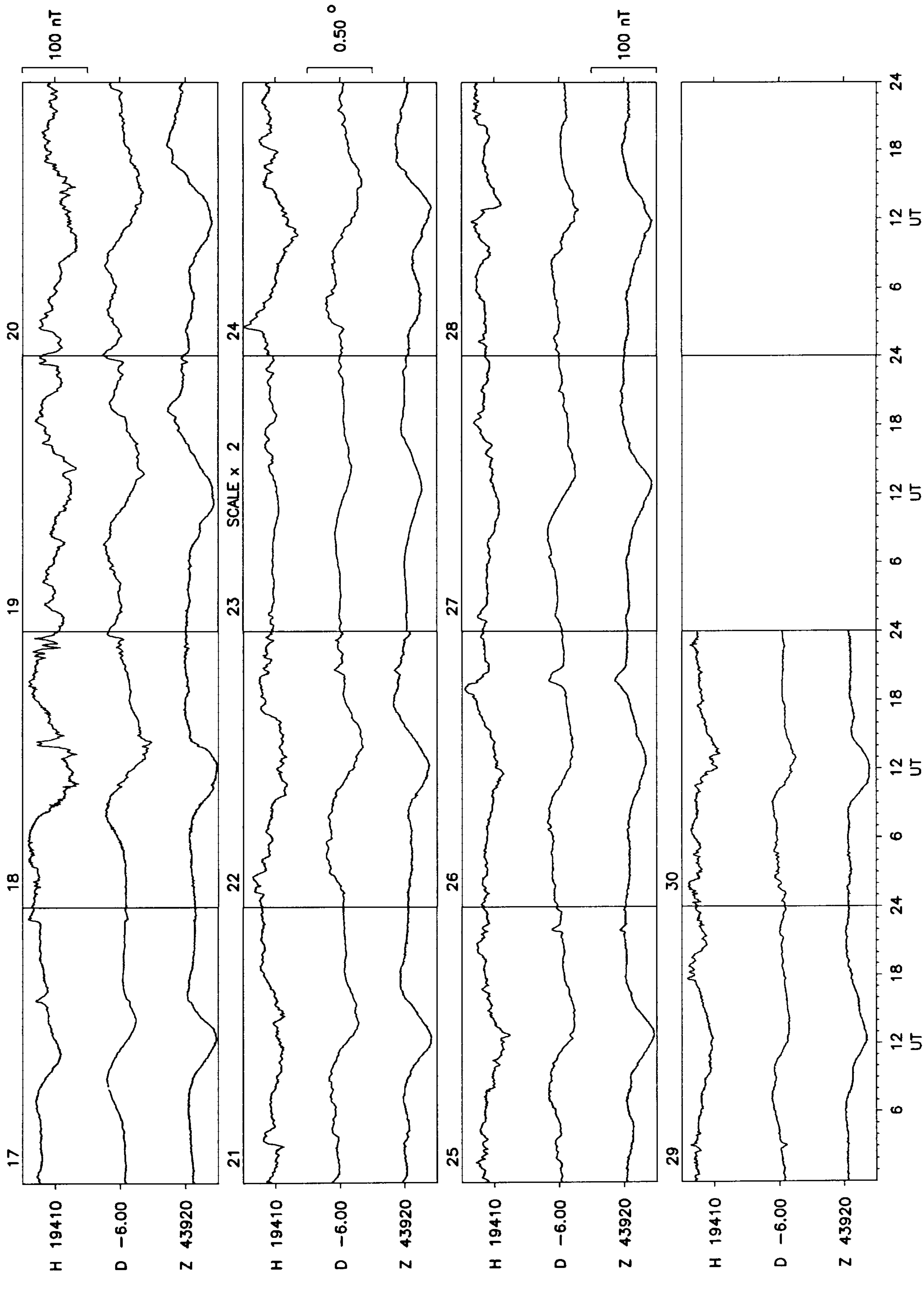
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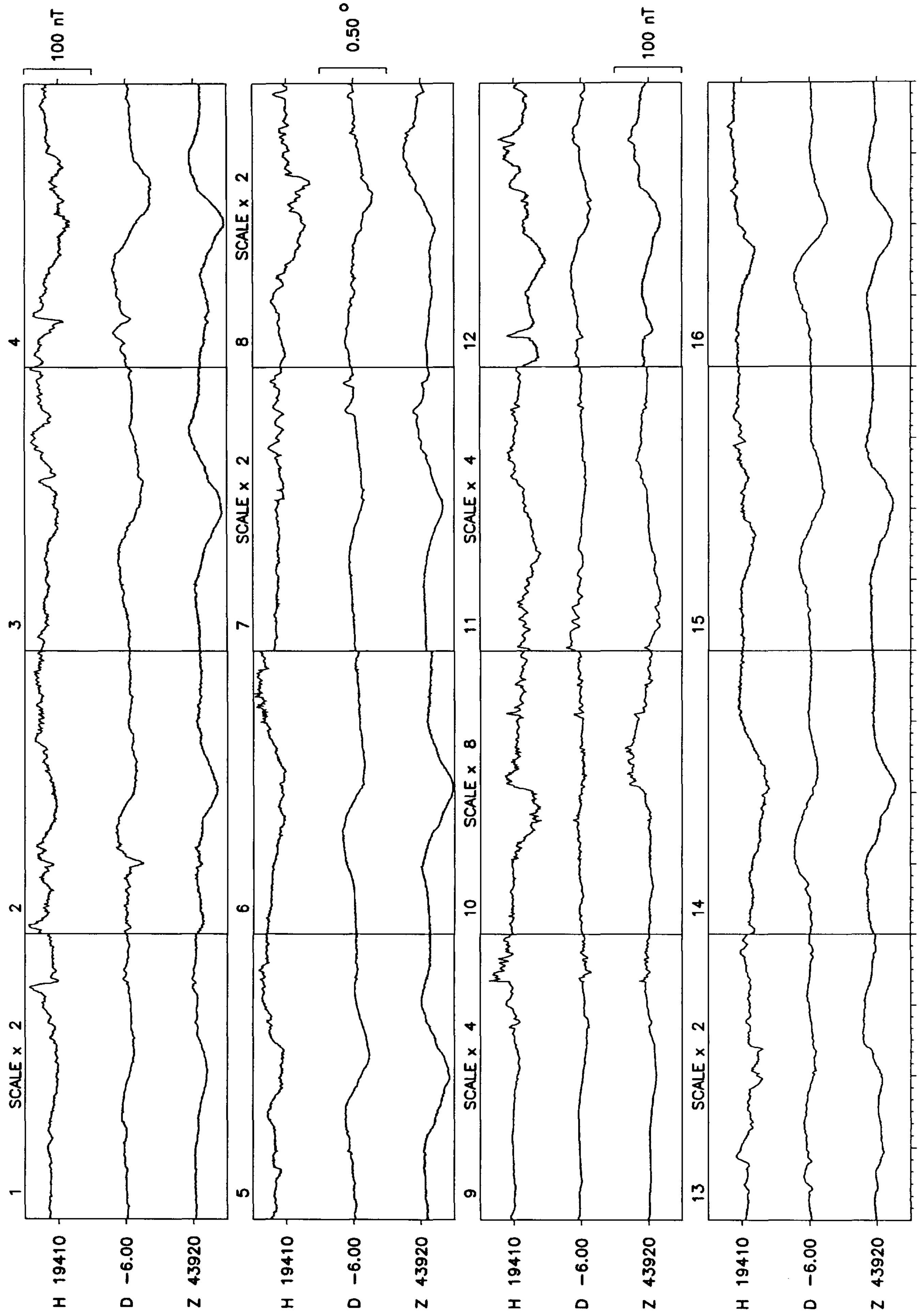

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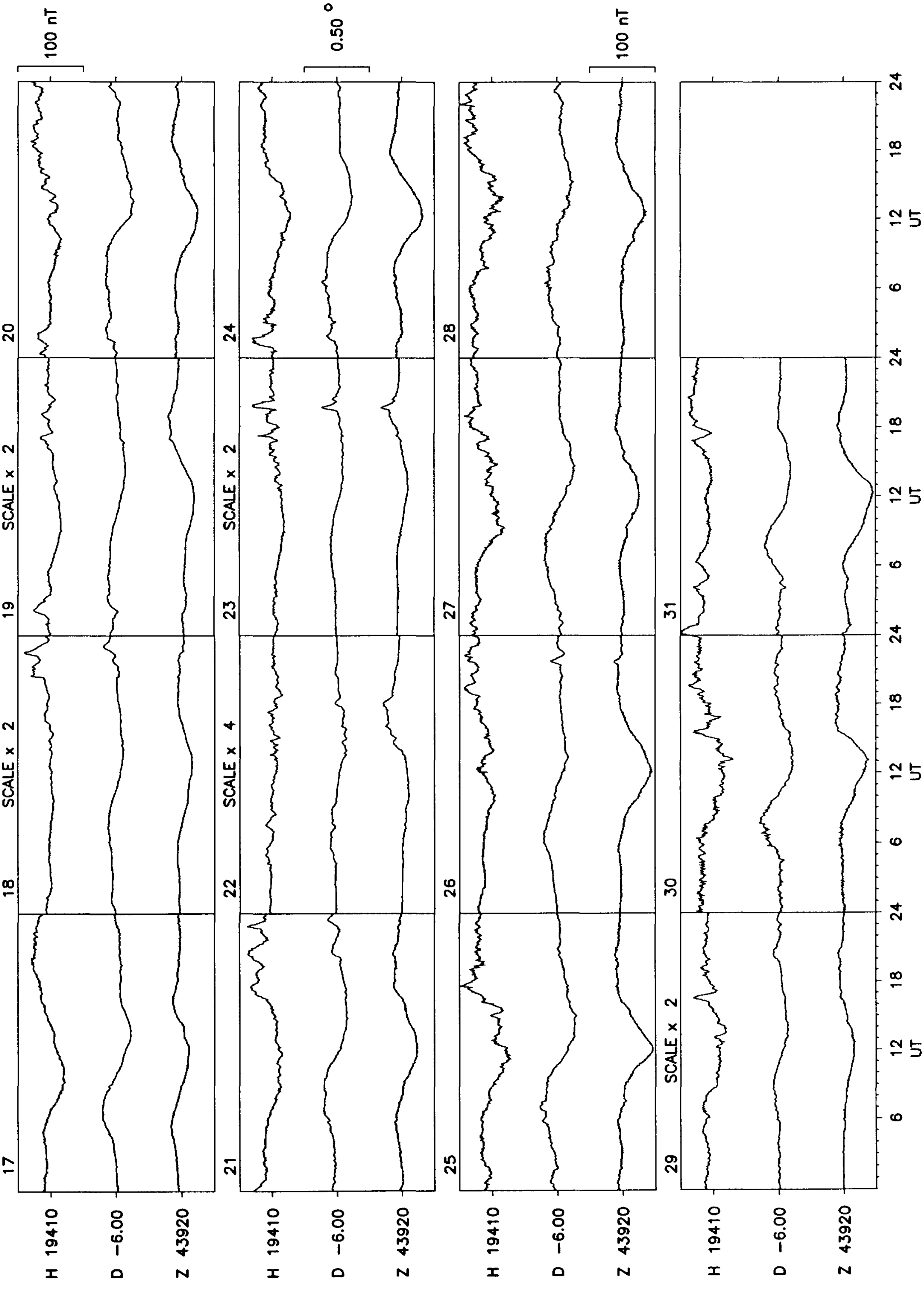
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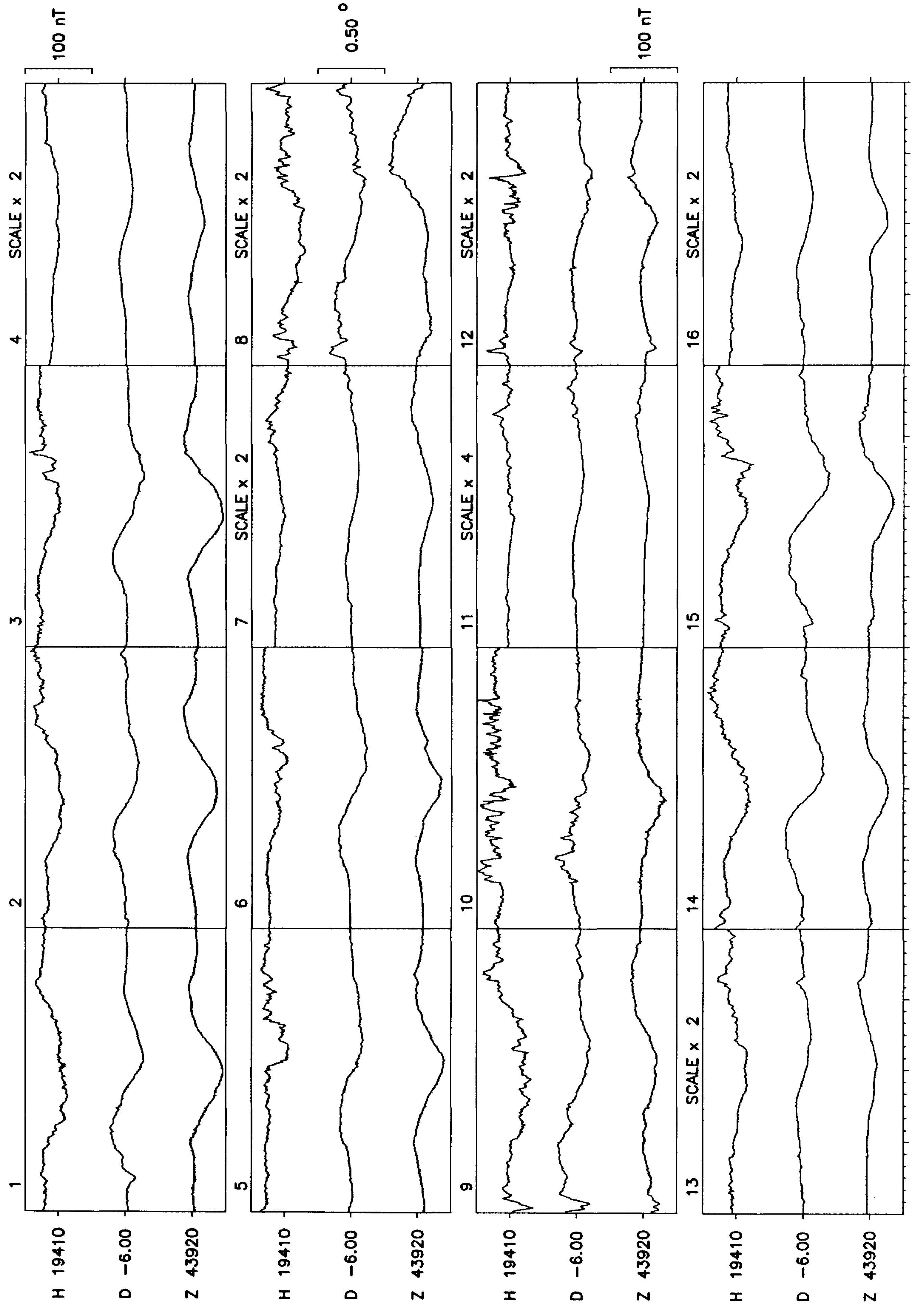
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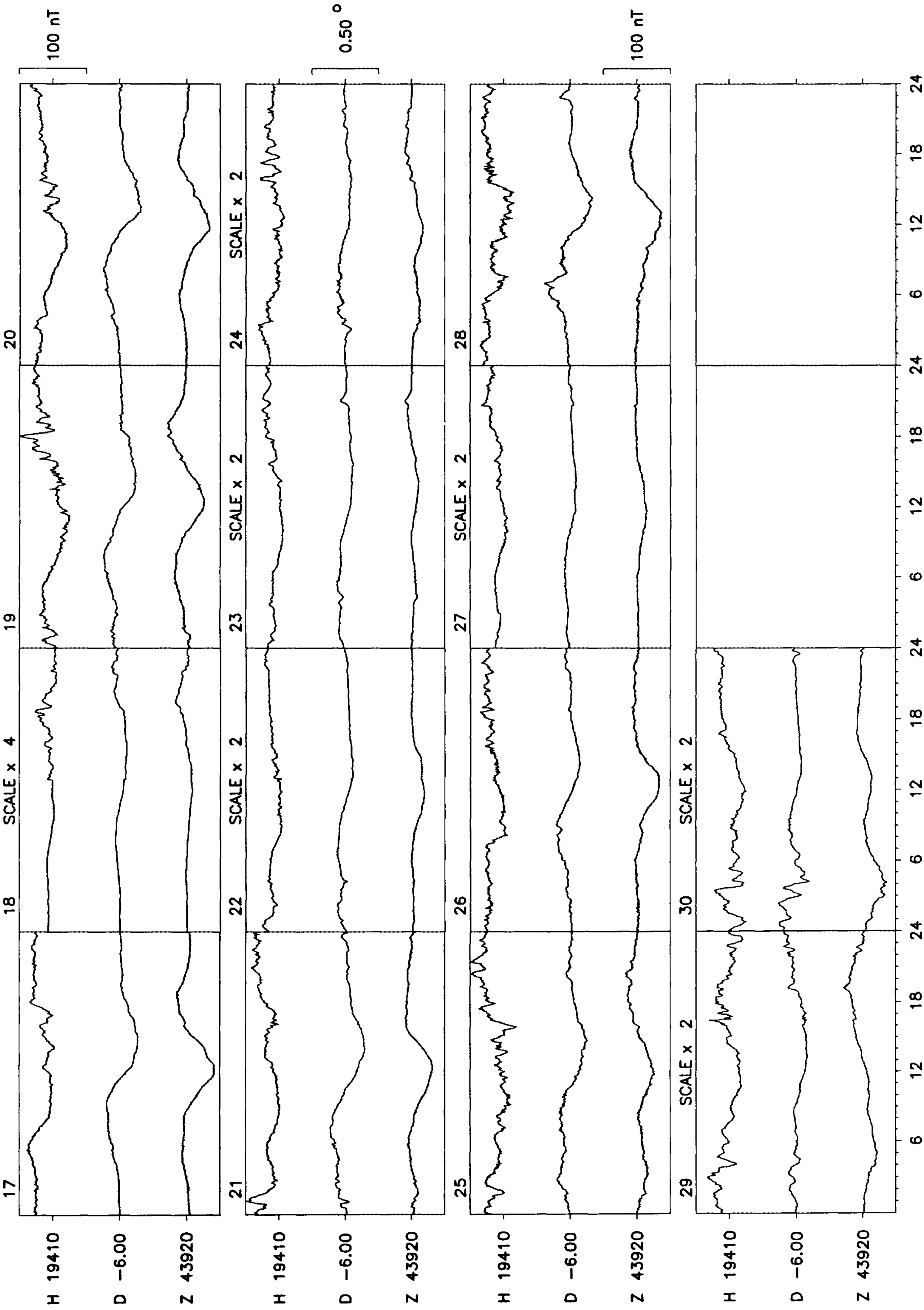

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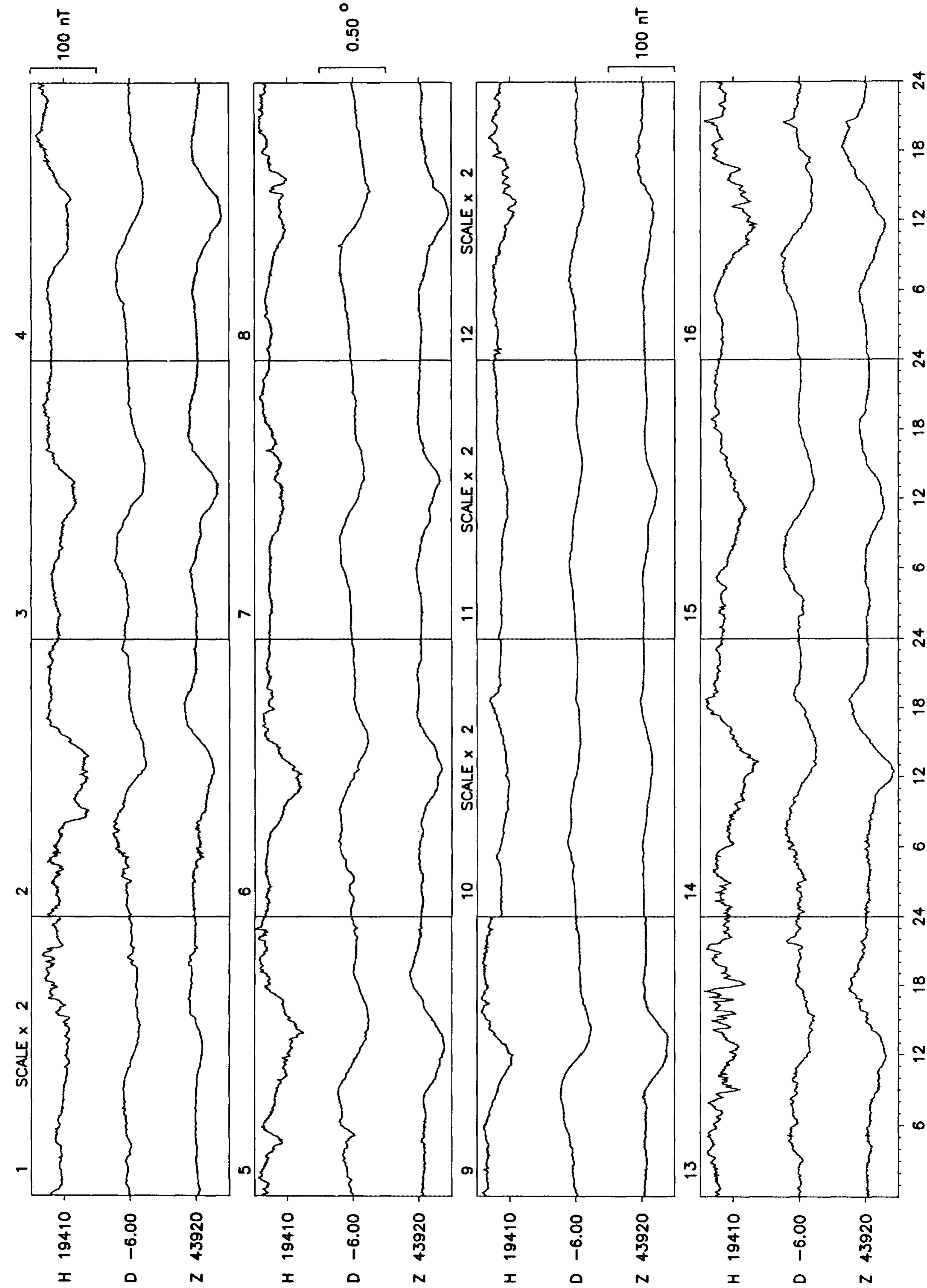
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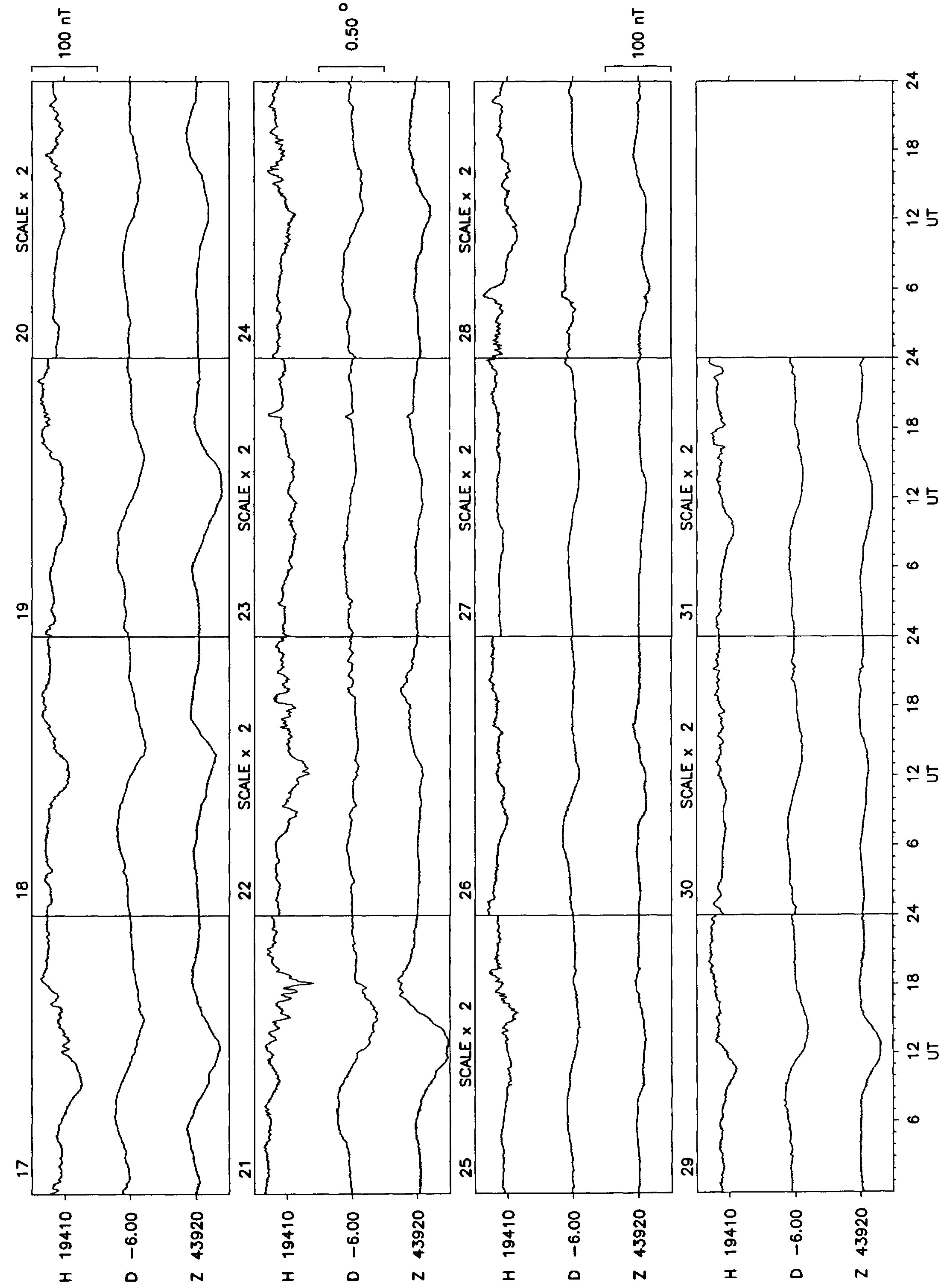
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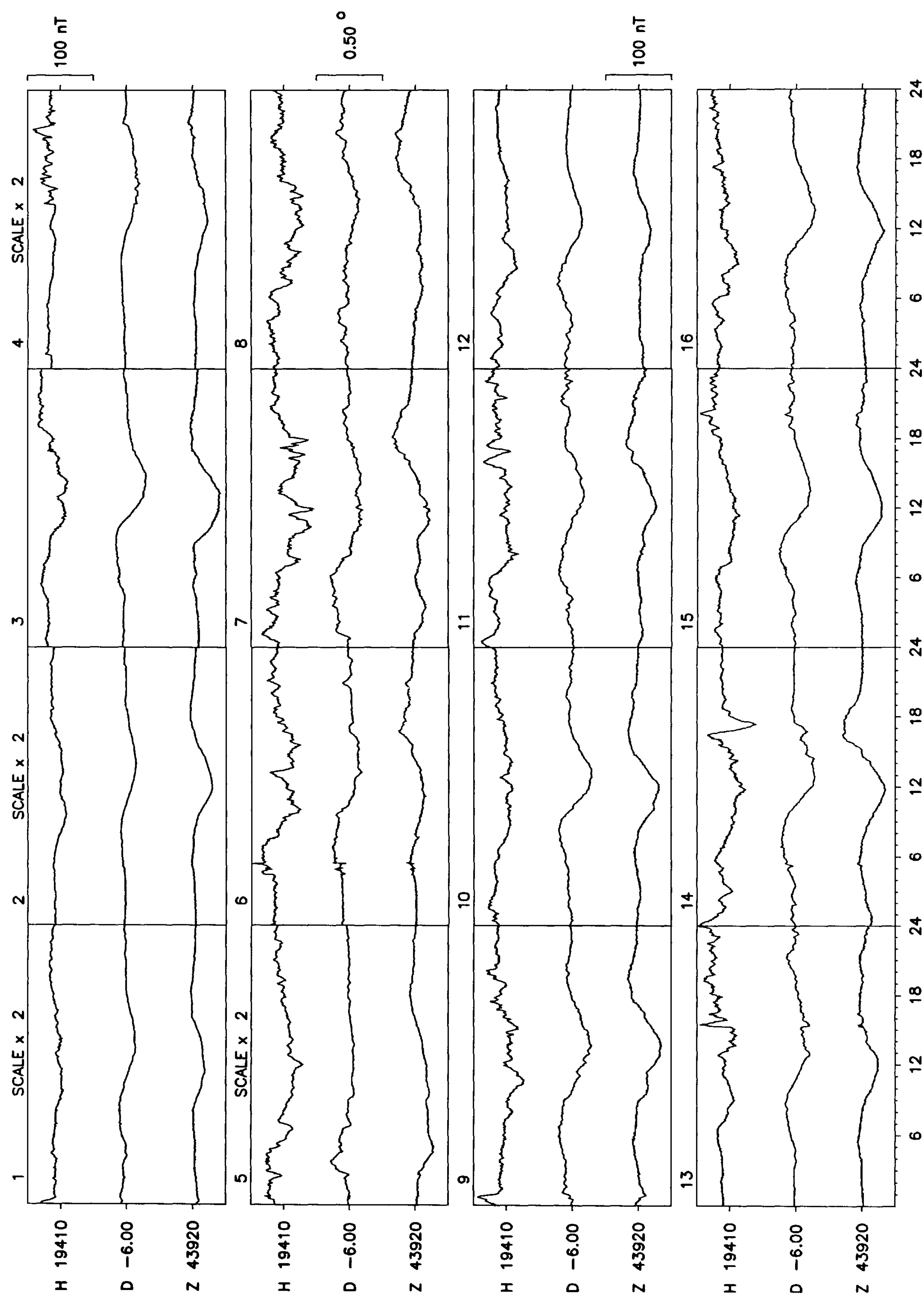

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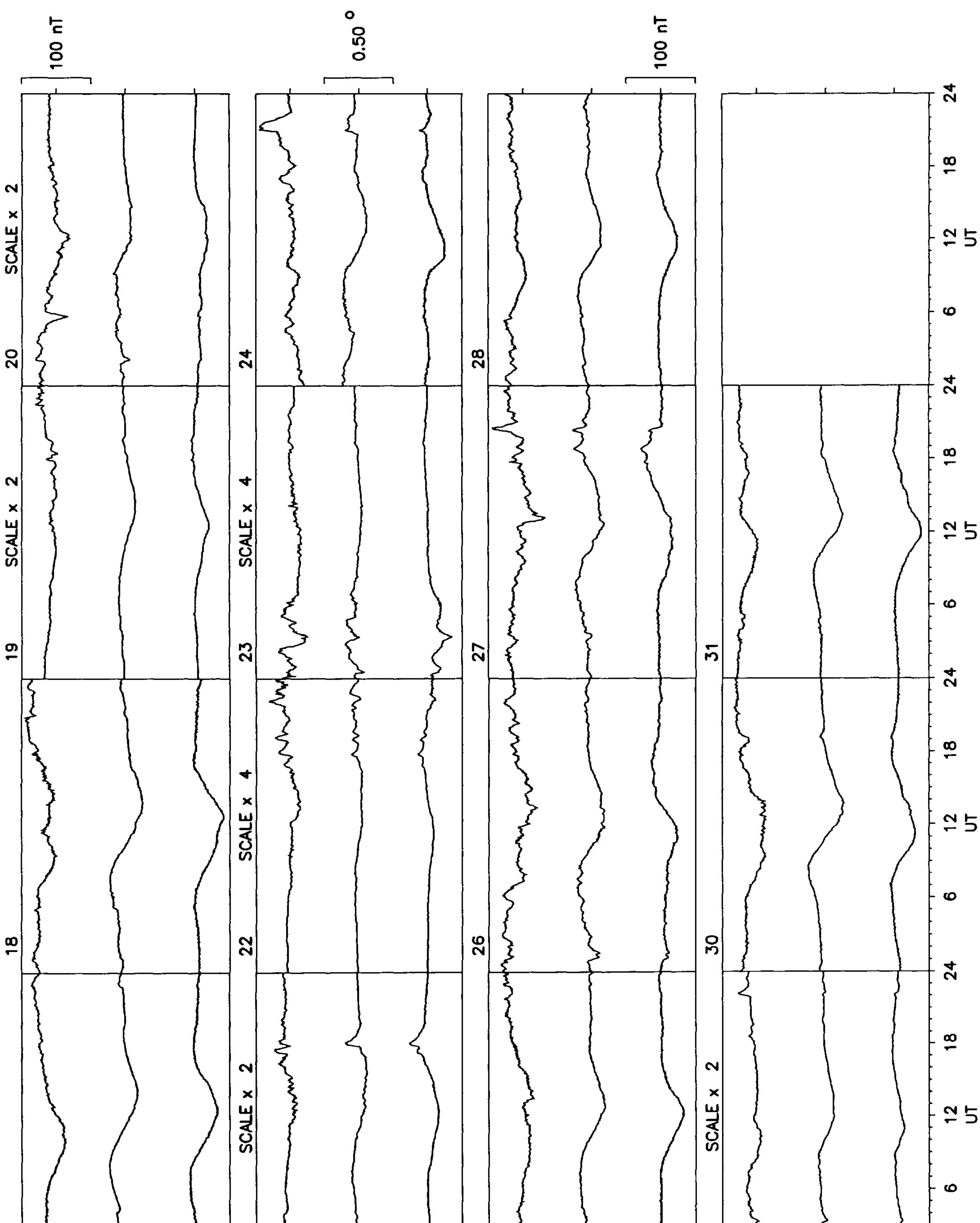
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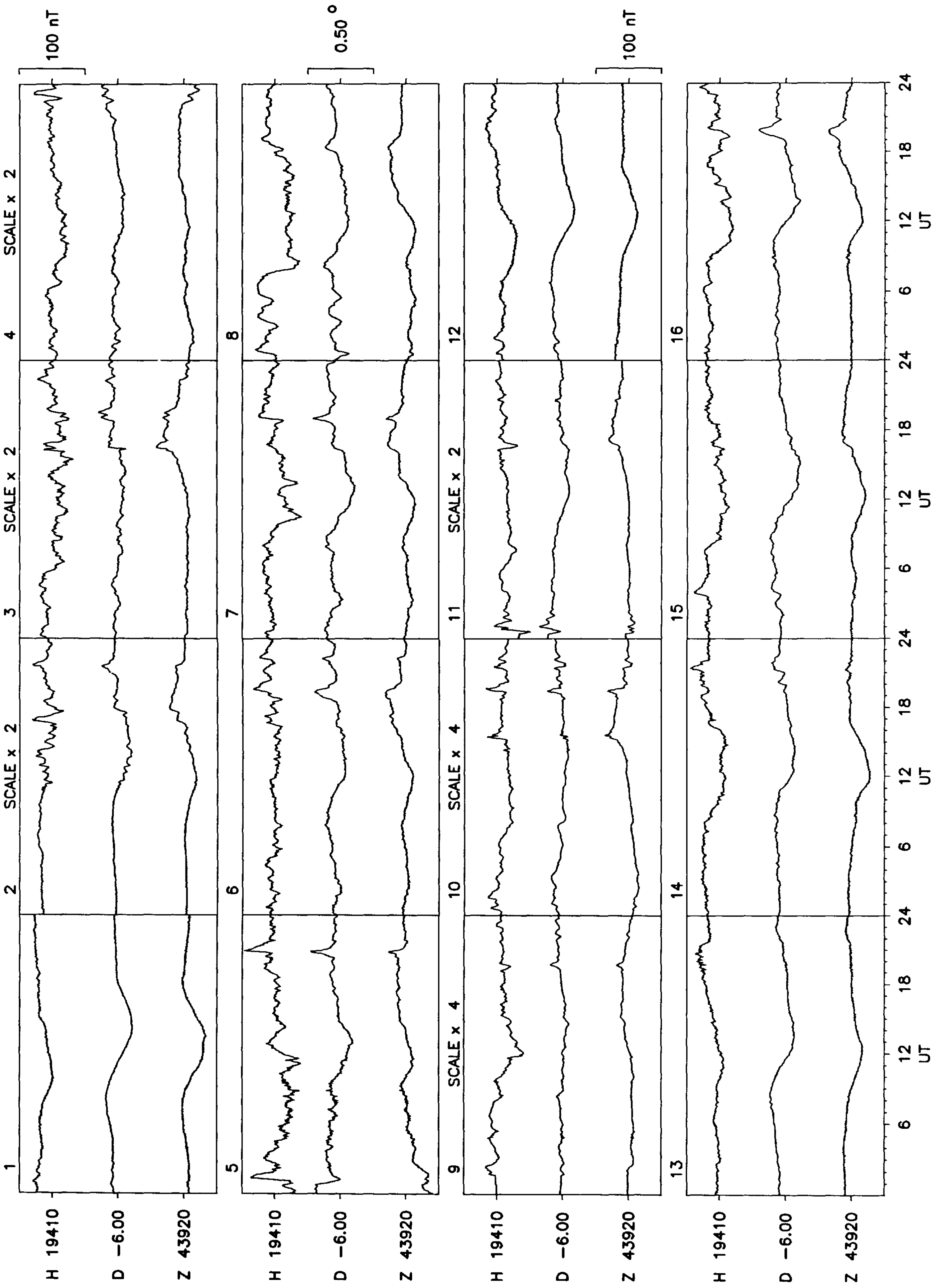
31
SCALE x 2
H 19410
D −6.00
Z 43920
6
12
18
24
UT



100 nT
0.50°
100 nT
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 4
SCALE x 2
1
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H 19410
D -6.00
Z 43920
UT
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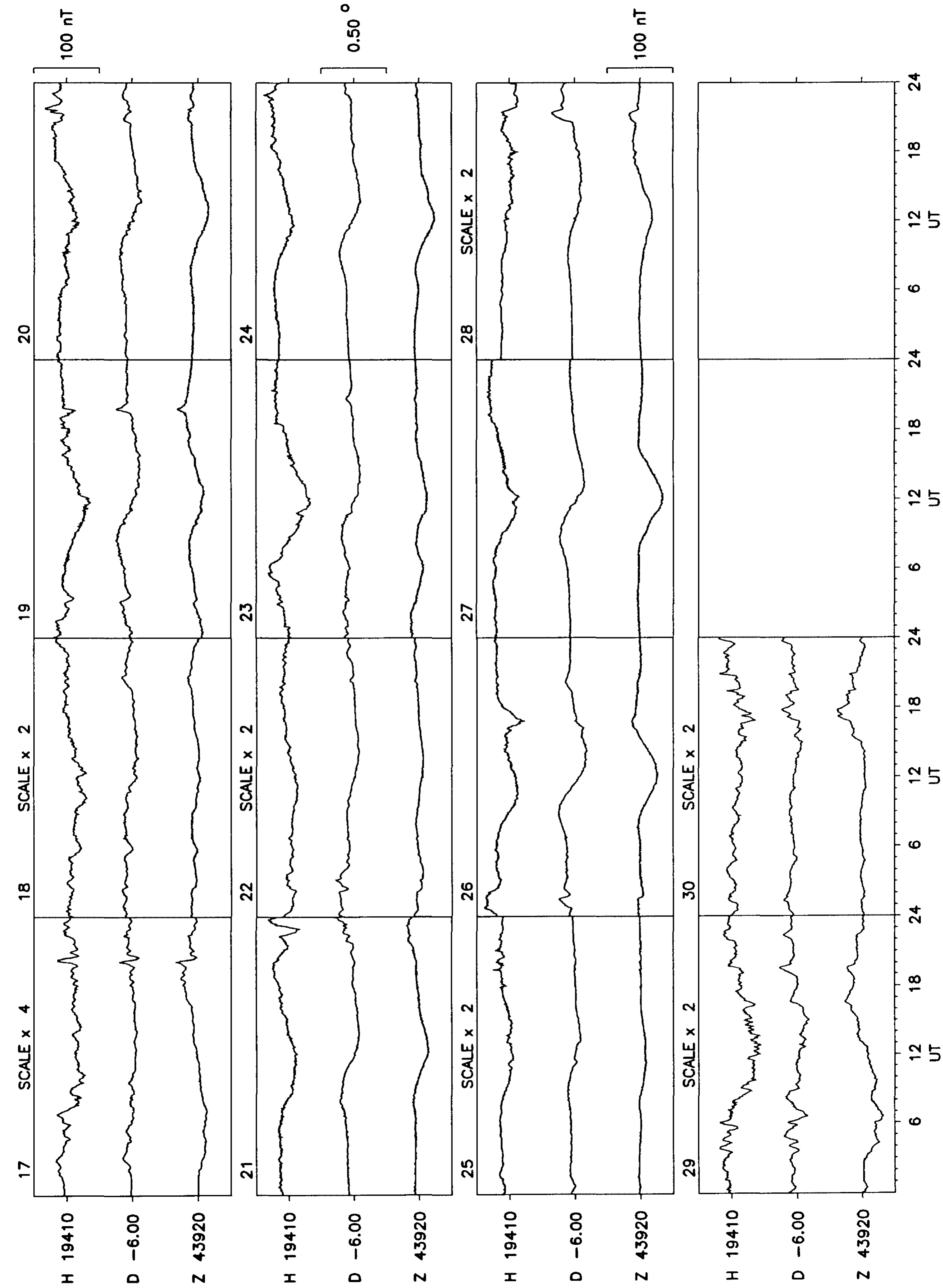
100 nT
0.50 °
100 nT
17
SCALE x 4
18
SCALE x 2
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SCALE x 2
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25
SCALE x 2
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27
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SCALE x 2
29
SCALE x 2
30
SCALE x 2
H 19410
D -6.00
Z 43920
6
12
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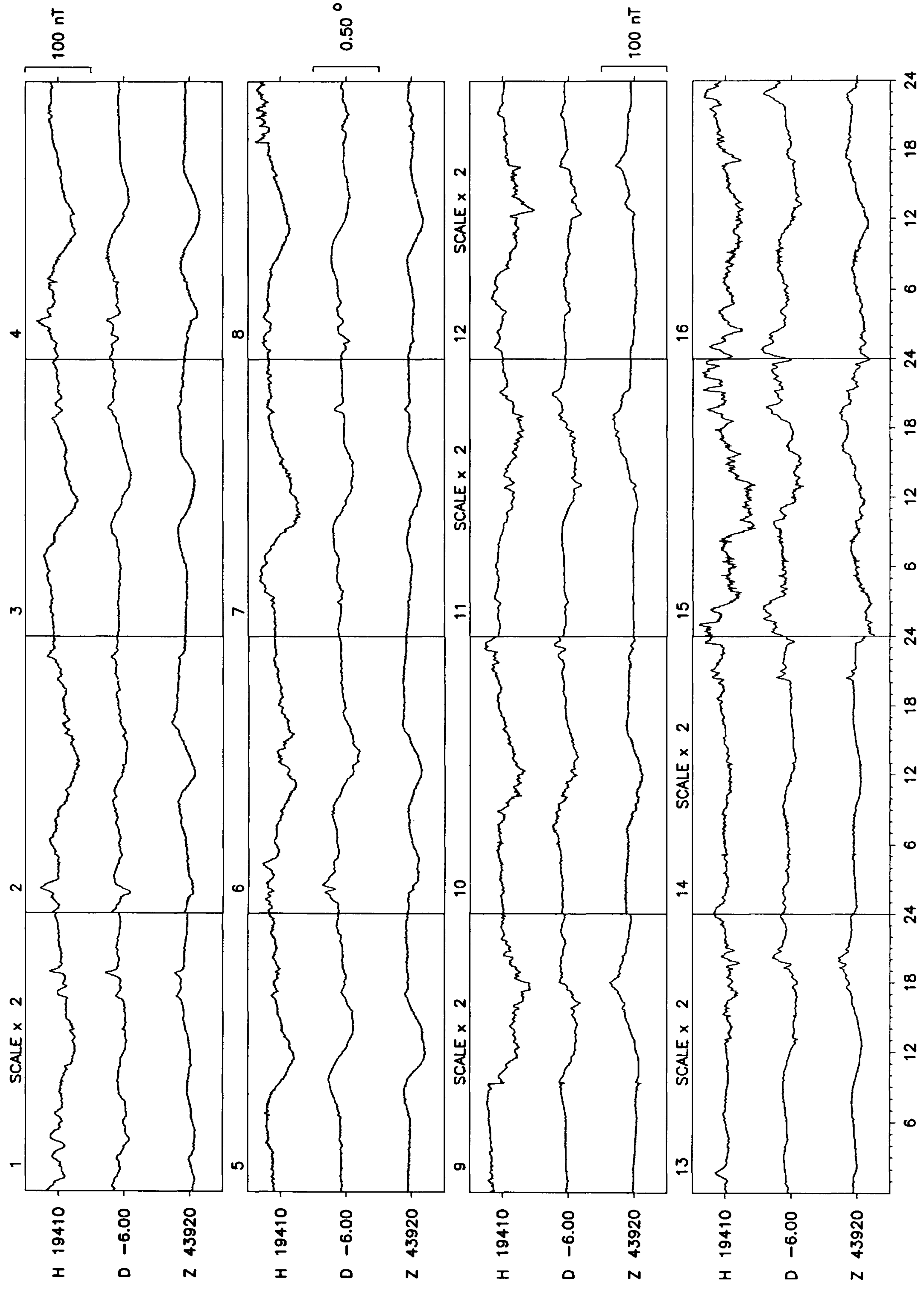
24
UT


100 nT
0.50 °
100 nT
H 19410
D −6.00
Z 43920
SCALE x 2
UT
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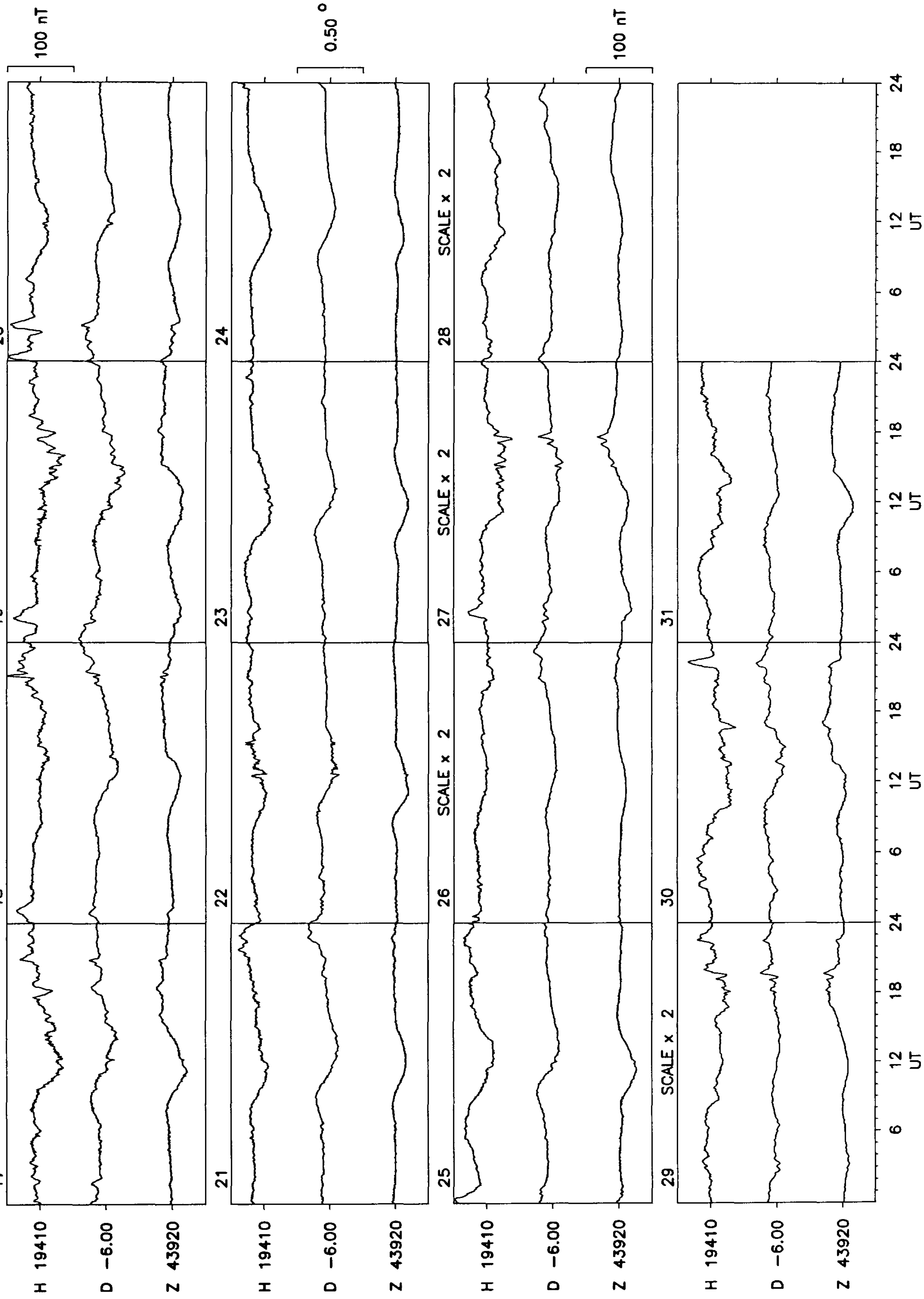
100 nT
0.50 °
100 nT
17
18
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31
SCALE x 2
SCALE x 2
SCALE x 2
SCALE x 2
H 19410
D −6.00
Z 43920
H 19410
D −6.00
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H 19410
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Z 43920
H 19410
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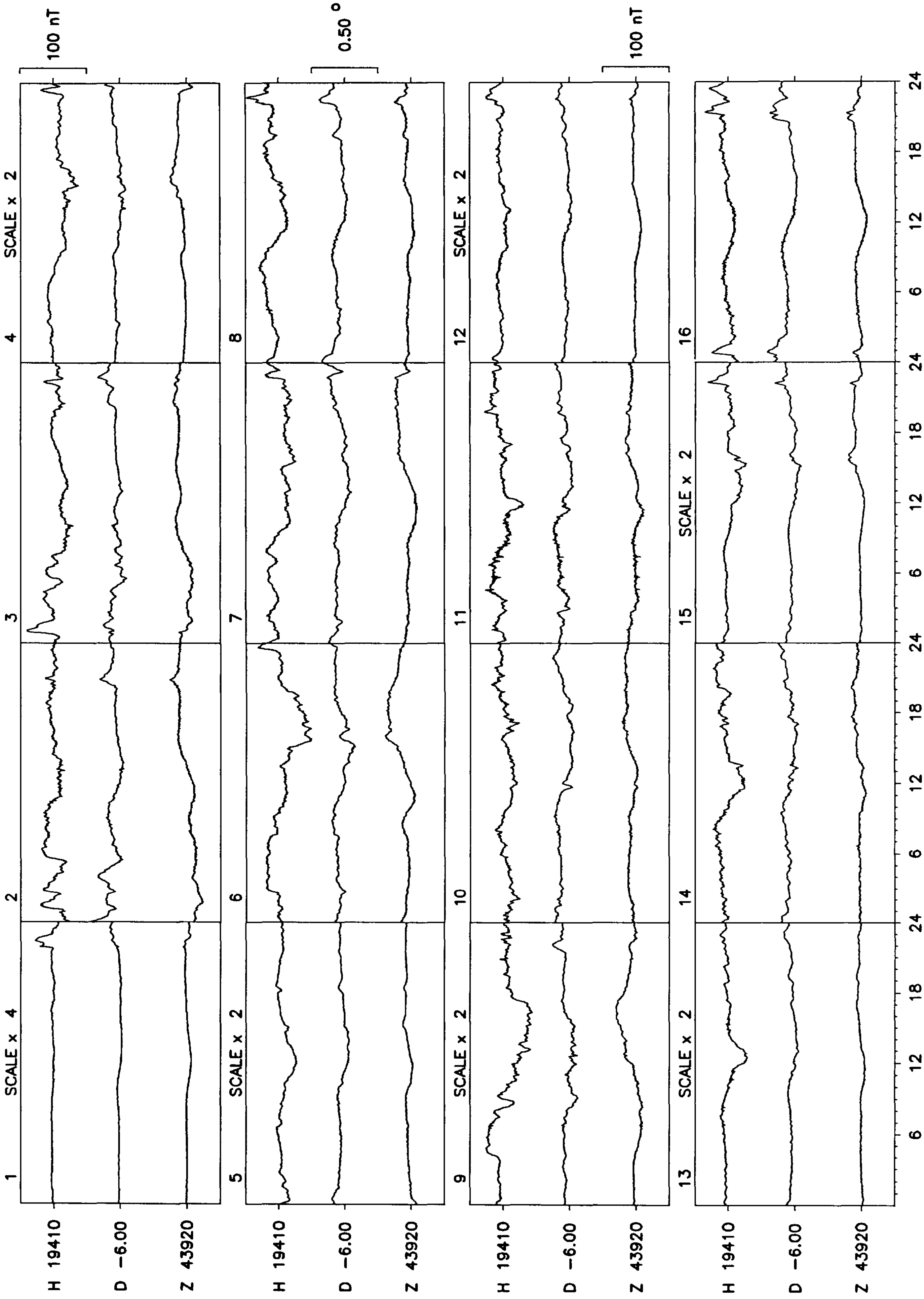
100 nT
0.50 °
100 nT
SCALE x 4
SCALE x 2
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H 19410
D -6.00
Z 43920
UT
6
12
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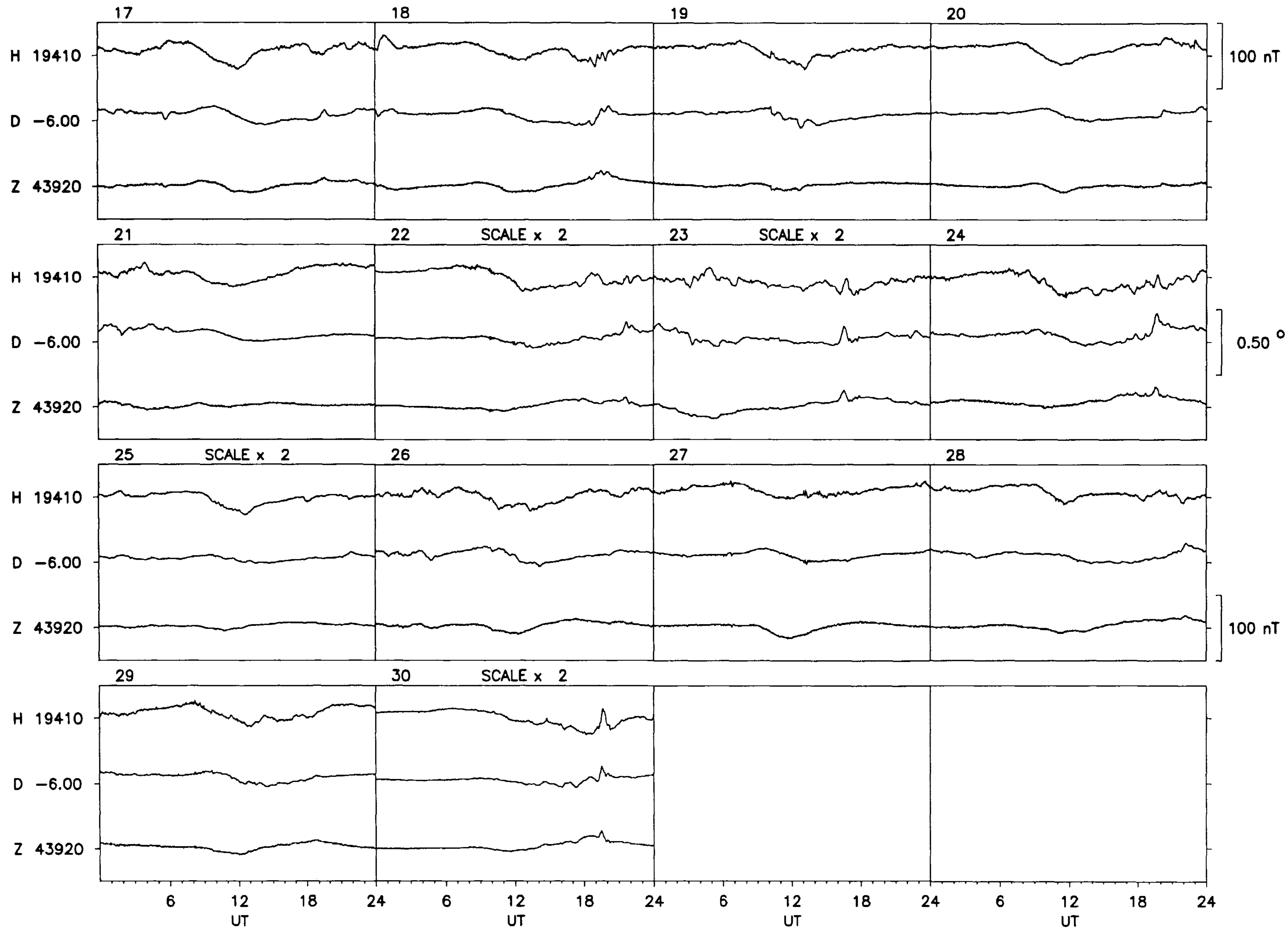
24


17
18
19
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21
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SCALE x 2
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SCALE x 2
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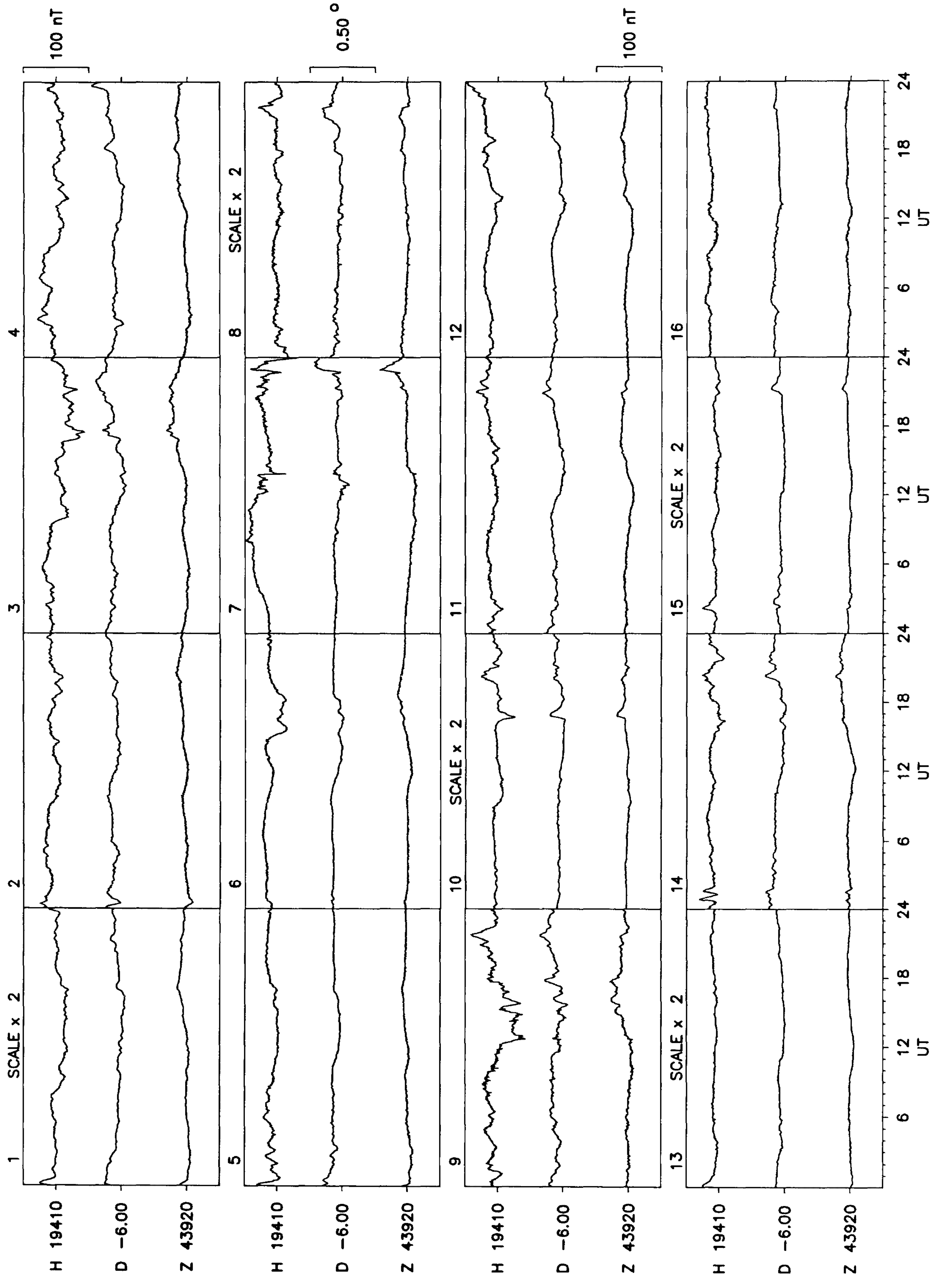
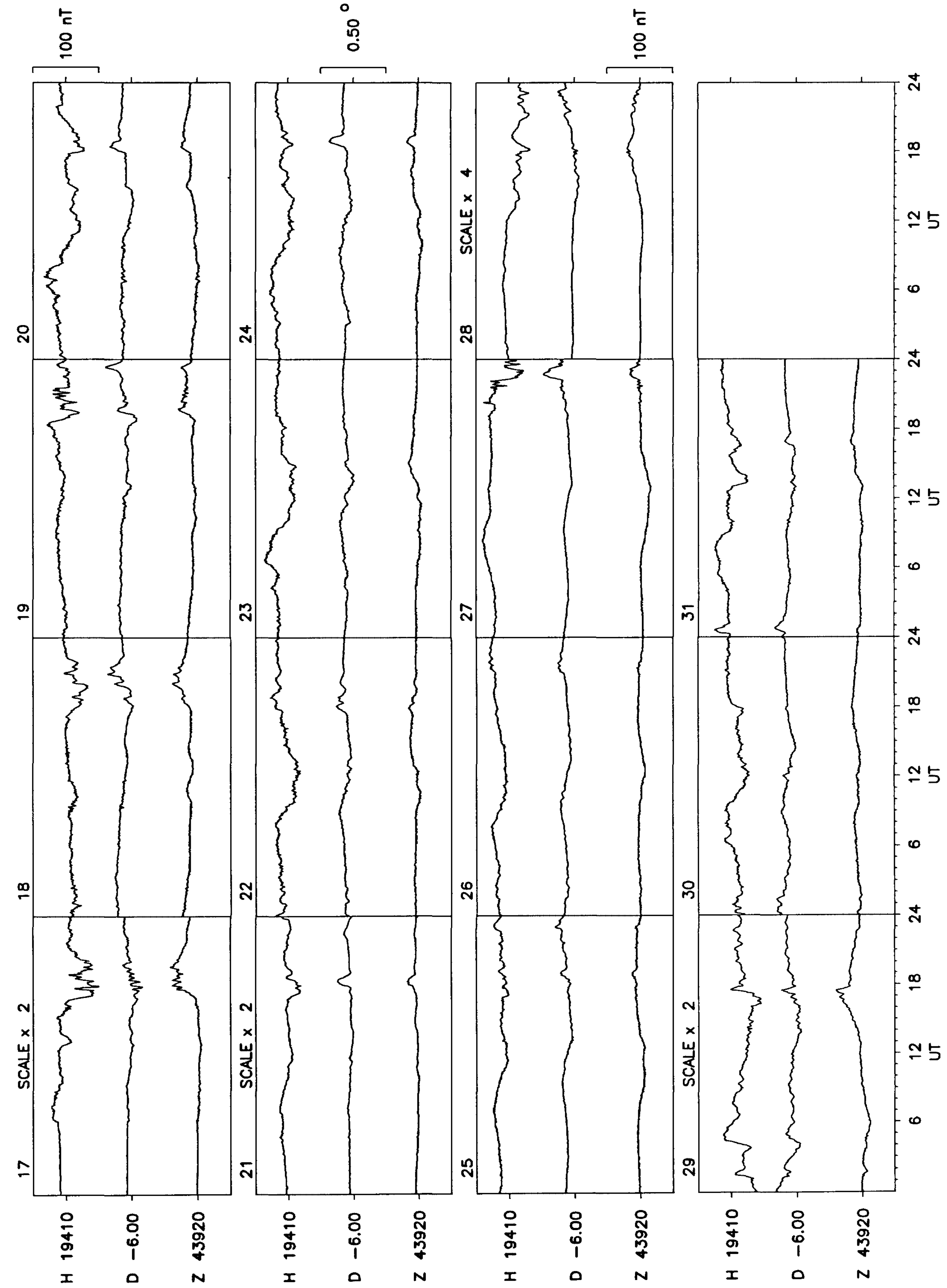
25
SCALE x 2
26
27
28
29
30
SCALE x 2
H 19410
D −6.00
Z 43920
100 nT
0.50 °
100 nT
6
12
18
24
UT

HA 11 92


100 nT
0.50 °
100 nT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SCALE x 2
H 19410
D -6.00
Z 43920
6
12
18
24
UT


100 nT
0.50 °
100 nT
17
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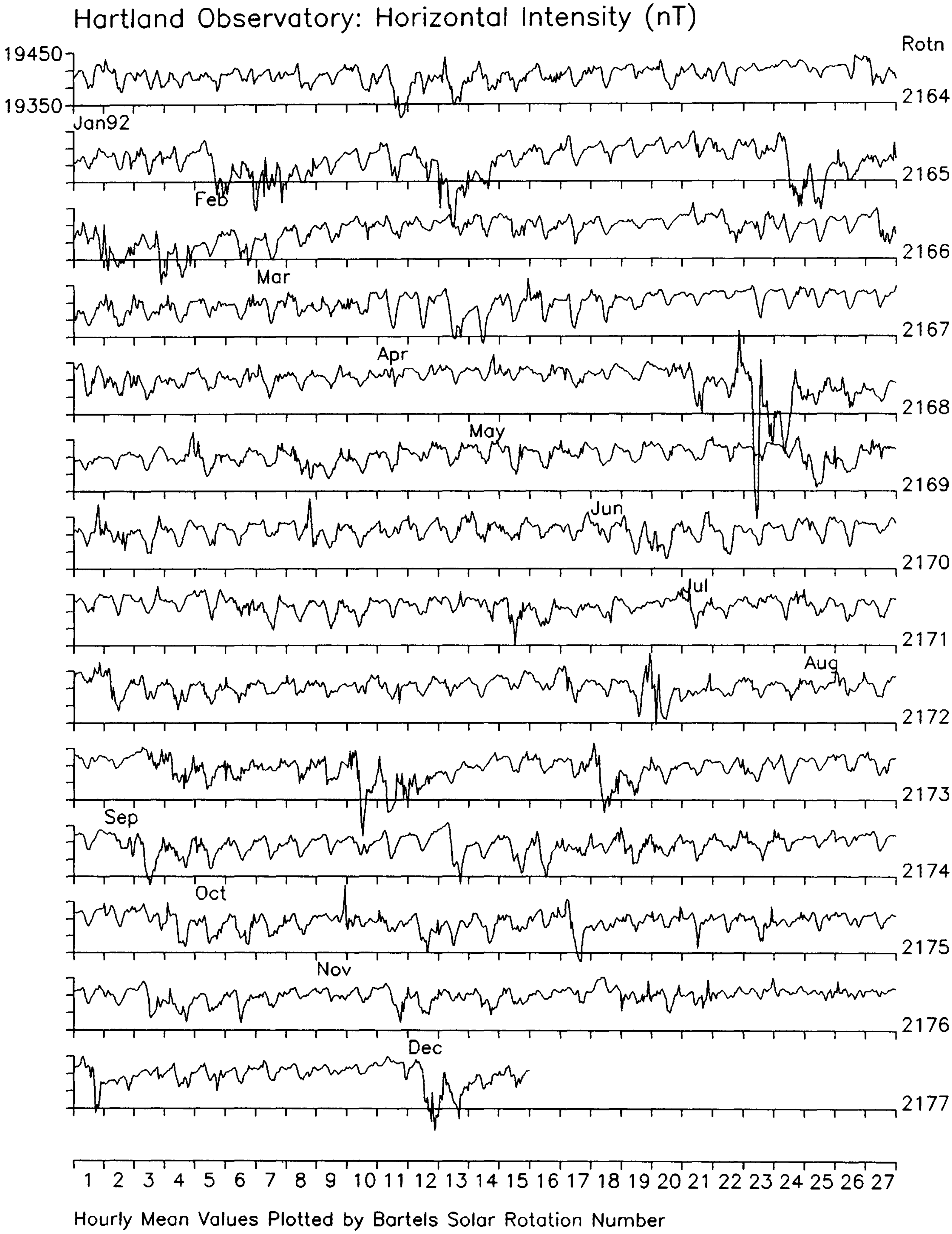
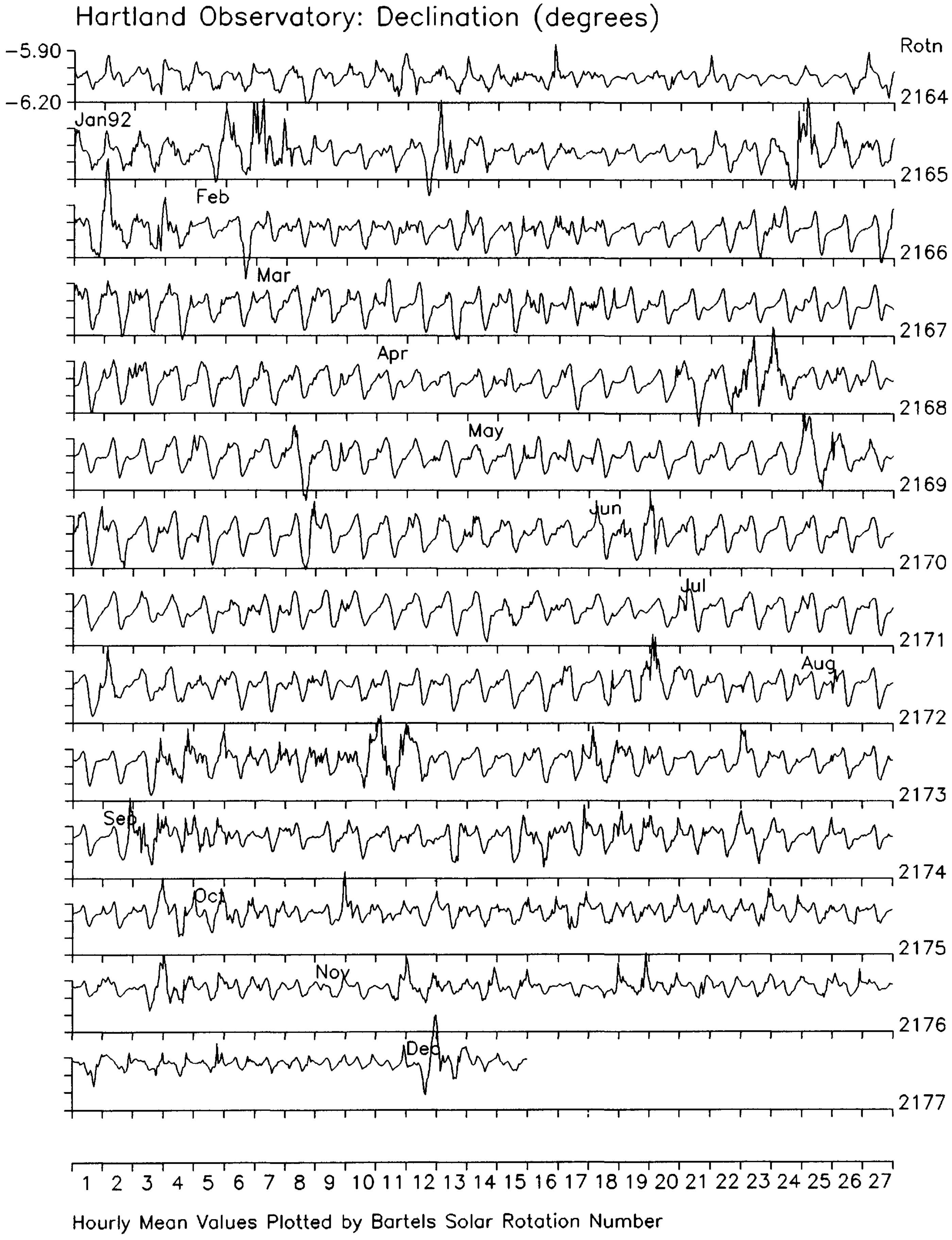
26
27
28
29
30
31
SCALE x 2
SCALE x 2
SCALE x 4
SCALE x 2
H 19410
D −6.00
Z 43920
H 19410
D −6.00
Z 43920
H 19410
D −6.00
Z 43920
H 19410
D −6.00
Z 43920
6
12
18
24
UT

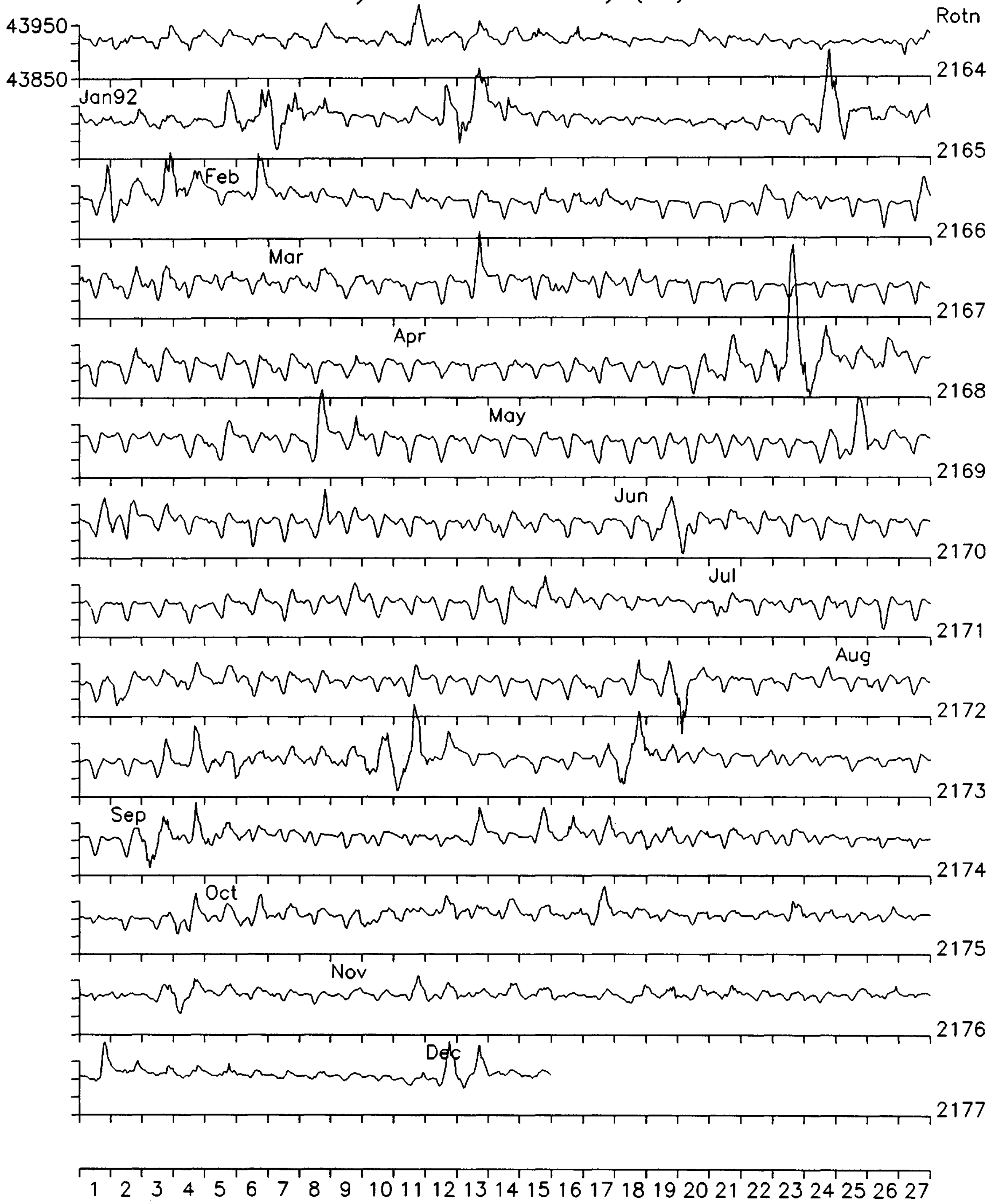
HA 12 92


Hartland Observatory: Horizontal Intensity (nT)
19450
19350
Rotn
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
Jan92
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
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

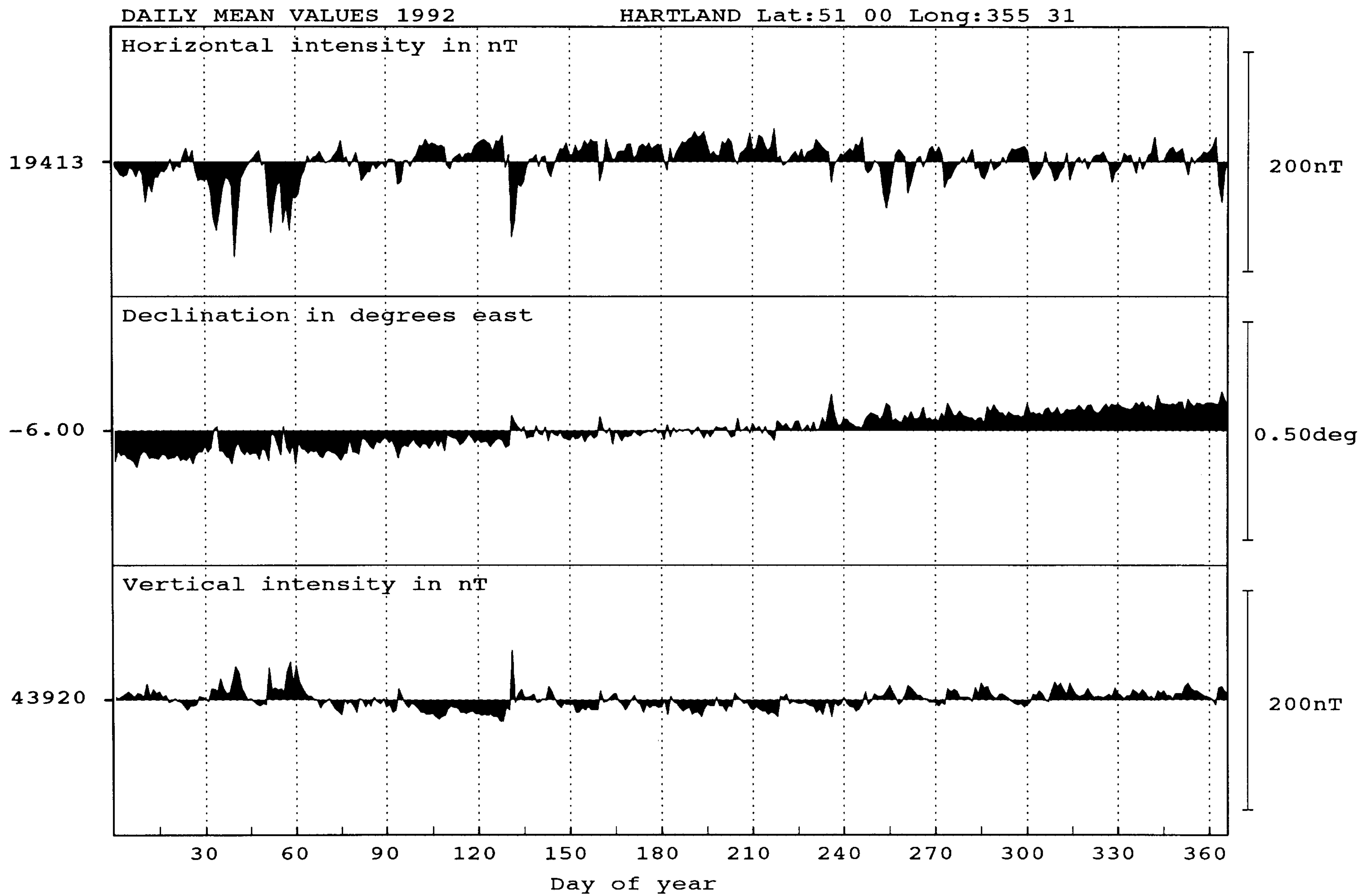


Hartland Observatory: Declination (degrees)
-5.90
-6.20
Rotn
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
Jan92
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Hourly Mean Values Plotted by Bartels Solar Rotation Number

Hartland Observatory: Vertical Intensity (nT)



Hourly Mean Values Plotted by Bartels Solar Rotation Number



DAILY MEAN VALUES 1992
HARTLAND Lat:51 00 Long:355 31
Horizontal intensity in nT
Declination in degrees east
Vertical intensity in nT
19413
-6.00
43920
200nT
0.50deg
200nT
30
60
90
120
150
180
210
240
270
300
330
360
Day of year

Monthly and annual mean values for Hartland 1992

Month	D		H	I		X	Y	Z	F
Jan	-6	3.3	19404	66	9.9	19296	-2047	43922	48017
Feb	-6	2.2	19385	66	11.4	19278	-2039	43931	48018
Mar	-6	2.2	19412	66	9.3	19304	-2041	43918	48017
Apr	-6	1.4	19419	66	8.6	19312	-2038	43911	48013
May	-6	0.4	19413	66	9.2	19306	-2031	43918	48017
Jun	-6	0.1	19423	66	8.5	19317	-2031	43916	48019
Jul	-5	59.7	19428	66	8.1	19322	-2029	43914	48020
Aug	-5	58.9	19421	66	8.6	19315	-2024	43915	48018
Sep	-5	57.8	19410	66	9.5	19305	-2017	43922	48020
Oct	-5	57.5	19412	66	9.4	19307	-2015	43923	48021
Nov	-5	56.7	19411	66	9.6	19307	-2010	43926	48024
Dec	-5	56.0	19416	66	9.2	19312	-2007	43926	48026
Annual	-5	59.7	19413	66	9.3	19307	-2028	43920	48019

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

Hartland Observatory K Indices 1992

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3122 2423	2233 4446	2342 1223	2342 2223	1231 2353	3421 2111	3322 3444	4322 3212	1100 1110	4443 3453	1122 2326	4233 3423
2	4434 2321	5533 4366	3323 2232	1111 1231	3441 1222	1111 1222	3443 2212	1111 1221	1214 4534	4322 1222	4433 2143	3212 2222
3	3223 3244	6664 4557	2332 1432	1244 4543	2111 3332	1111 2421	1211 2221	1111 2221	3434 4554	1121 2132	4433 2133	3213 2434
4	3333 2234	3532 2254	2222 2443	1233 3232	3412 3311	1111 1122	0211 1122	2111 3443	4343 3335	2331 1011	2323 3434	4332 2334
5	3222 2332	2012 2201	2232 2433	3234 3224	1211 2211	2112 3321	2322 2223	5443 4233	5334 3243	1111 1321	4223 3232	3211 1211
6	2332 3244	1112 3211	3131 1111	4443 2322	1111 2222	0111 2311	2211 2321	1323 3333	3322 2343	4312 2311	3221 3433	1011 2331
7	1112 3232	3323 4411	1122 2334	2344 3321	2221 3344	1211 1344	0111 2211	3343 4442	4334 3343	1221 2231	3232 2324	1121 4135
8	2333 3342	3332 5543	2322 4222	3343 3252	3343 4544	5343 4445	1112 2321	2333 3332	4342 2332	3211 0132	4221 2234	4333 3455
9	2211 2013	6555 5455	3234 4442	1211 1213	3212 3565	5332 3332	1111 1211	3223 3431	4456 5454	2235 3543	3455 4434	3333 3424
10	3312 3244	3433 4532	2324 3334	2111 1111	4576 7576	1444 4332	1221 1231	2112 2222	5553 4665	1123 2113	3224 2333	2223 2543
11	3323 4453	2112 2222	4334 3441	2100 1111	6554 5443	2413 3455	1111 1111	3342 2433	5333 3433	3213 4454	3334 3332	3211 2233
12	4344 3333	3322 2213	2324 3311	1111 1211	4311 2333	5233 4532	3222 3433	2222 1111	2211 1122	3443 5433	3333 3234	2101 3233
13	3534 3324	3332 1111	1222 2110	1222 2111	3334 4223	2311 3243	2443 4444	0111 3433	1111 1022	3321 3464	3224 4333	4212 2212
14	4233 3434	1123 3333	1111 1112	1221 1232	2211 1011	3111 1222	3432 3331	4312 2521	1121 2233	4333 2255	3223 3332	3211 1243
15	3233 4232	1121 2200	1132 2222	3212 2322	1111 1320	3221 2432	3322 1221	2221 1232	2322 2321	4434 4344	3222 3445	4322 2324
16	1333 3366	1111 2211	1132 3333	1111 2211	1111 1120	1221 1121	1122 3442	2232 2212	2222 2243	4333 3324	4221 1144	1321 2111
17	3112 2233	1224 4223	3215 5444	1100 1312	1111 1111	1111 2321	3111 2220	2201 1112	5565 4365	3223 3343	2311 3132	0032 4653
18	3222 1000	4324 2312	4343 3322	2223 4224	3111 1345	1111 3565	2211 1211	2212 2222	3444 4244	3111 3334	3111 1341	2112 1343
19	0211 2211	3233 4334	1010 1211	3332 3344	4311 2442	3112 3442	2110 0222	1111 3333	3322 2241	4224 4433	1123 3110	1112 2244
20	3332 3422	4435 5475	0010 1121	4333 3323	3211 3223	1221 3312	2201 2433	4535 4322	1112 2123	4423 2211	1111 1122	1232 2332
21	2001 2224	5555 4232	1134 4444	3321 3221	2121 1333	4220 1322	1222 3352	2222 3551	1111 1124	1111 1224	3221 1101	0212 2454
22	3111 2210	4343 4243	4333 2243	3322 2333	2545 5543	4422 3212	3444 4443	1233 4555	4522 2233	3211 3312	1123 3444	2122 2331
23	1111 1111	3331 2225	4434 4244	2110 2333	2221 3452	3321 3343	3433 3243	6653 5333	2222 2121	2111 1122	4532 3533	1222 3221
24	1011 1102	2233 4445	3323 2445	4322 2333	3222 2212	3533 3433	2211 2322	2222 1344	1011 1123	1110 1102	1122 2243	2222 2241
25	3111 2111	6543 4344	4324 3243	2322 3223	3222 3432	3322 3433	1112 4442	2101 2112	3124 3243	4113 2122	3223 3223	1001 2233
26	0101 2333	3334 4575	1333 2243	2221 2143	1111 3233	2231 2232	1111 1221	3232 2222	3211 1321	3232 2244	2312 2122	1111 1113
27	5432 2234	5455 4552	2211 2344	2110 1322	2222 3332	2112 2343	1011 1234	2222 4342	1111 2111	4434 3644	1121 2102	1011 1124
28	4422 3232	2122 2123	3222 2223	2123 3122	2233 3333	2343 3323	3442 3323	2311 1113	1111 2355	5233 1424	1212 1123	3222 5466
29	3332 4334	2225 5553	3332 3343	2211 1232	3342 3543	4532 4554	1111 1111	5331 1123	4554 4554	4343 3454	1121 2121	5533 4543
30	4433 4343		2323 3222	3223 2212	2432 3433	5643 2423	3112 3333	1111 2121	4333 4554	3222 3424	0112 2353	3223 3221
31	3342 3332		4212 2433		3321 1321		2111 2434	1101 1111		2222 3212		3222 3311

DAILY aa INDICES

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	23	50	22	25	25	17	33	17	4	43	31	30
2	43	75	18	10	22	9	32	8	38	16	34	17
3	28	131	21	53	17	12	11	9	73	12	25	29
4	33	45	26	23	23	7	9	26	55	11	41	28
5	22	11	23	27	12	12	16	46	42	10	27	14
6	25	14	12	31	9	9	10	31	26	19	23	12
7	15	32	19	28	24	20	7	43	37	15	24	35
8	36	74	21	37	53	62	11	28	32	14	20	47
9	13	113	41	11	49	28	7	21	112	45	61	38
10	27	45	30	8	189	36	10	14	94	18	29	33
11	40	13	38	6	77	40	6	28	45	42	30	17
12	38	20	21	8	23	48	22	14	10	48	27	19
13	46	17	12	12	33	22	38	18	10	40	30	17
14	42	22	8	12	7	13	25	31	14	41	22	20
15	29	8	17	16	9	20	12	14	16	54	36	28
16	50	7	25	8	6	8	26	16	21	35	21	14
17	20	35	48	8	5	10	10	8	92	25	16	56
18	12	25	34	31	24	43	8	10	44	21	15	19
19	13	28	6	30	24	21	7	17	23	37	15	23
20	26	107	7	30	15	15	17	47	13	20	8	23
21	15	94	39	18	15	14	25	36	12	13	12	31
22	14	41	29	23	56	19	52	58	26	18	37	16
23	7	25	40	17	25	20	32	77	13	9	45	18
24	8	49	36	22	13	36	15	21	8	5	24	17
25	10	68	29	17	22	30	20	9	22	17	25	11
26	15	74	24	18	13	16	8	19	16	28	15	9
27	36	85	21	12	21	21	11	26	7	59	10	18
28	23	14	19	18	25	26	26	11	30	34	15	64
29	29	62	30	12	37	62	7	23	79	41	11	59
30	37		19	20	30	47	18	12	55	27	28	20
31	27		24		17		20	8		16		22
Monthly Mean Value	25.9	47.7	24.5	19.7	29.7	24.7	17.7	24.1	35.7	27.0	25.2	25.9

Annual Mean Value for 1992 = 27.2

SIs and SSCs

Day	Month	UT		Type	Quality	H(nT)	D(min)	Z(nT)
1	1	16	45	SSC	A	43	- 1.6	11
9	1	21	52	SSC	A	23	- 0.7	4
26	1	14	58	SSC*	A	31	- 3.5	4
1	2	06	06	SSC*	B	11	- 3.5	-8
2	2	11	53	SSC*	A	33	5.8	21
8	2	14	27	SSC*	A	41	- 9.9	- 19
17	2	08	05	SSC*	B	11	1.7	
20	2	01	09	SSC*	A	37	- 3.1	6
26	2	16	57	SSC	B	82	- 5.6	11
29	2	09	19	SSC*	A	11	4.7	7
17	3	09	50	SSC*	B	- 26	5.6	- 7
9	5	19	57	SSC*	C	123	5.9	40
10	5	06	21	SSC*	C	- 58	11.9	- 19
26	5	12	03	SI	C	11		
10	6	04	02	SSC*	B	13	-3.6	5
18	6	12	52	SSC	B	35	-3.6	6
4	8	14	09	SSC	C	33	- 3.1	5
6	8	04	24	SSC*	B	16	- 2.1	3
6	8	05	18	SI*	B	- 17	5.9	11
13	8	15	14	SI*	B	23	- 3.8	8
9	9	01	39	SSC	B	27	- 4.7	5
8	10	18	39	SSC*	B	22	- 0.7	5
9	10	09	12	SSC*	C	- 40	- 4.3	- 12
1	11	21	46	SSC*	A	72	- 4.3	9
4	11	13	12	SSC	B	7	- 3.9	- 4
07	12	07	54	SSC*	C	- 6		
07	12	13	46	SSC	B	- 42	1.7	- 6
17	12	06	15	SSC*	B	9	- 1.3	3

Notes

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

The quality of the event is classified as follows :

A = very distinct

B = fair, ordinary, but unmistakable

C = doubtful

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

SFEs

Day	Month	Universal Time Start		Maximum		End		H(nT)	D(min)	Z(nT)
7	7	16	07	16	11	16	18	9	-0.4	-3
8	7	09	44	09	50	09	58	-4	1.7	2
9	7	16	10	16	22	16	29	-9	1.2	

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

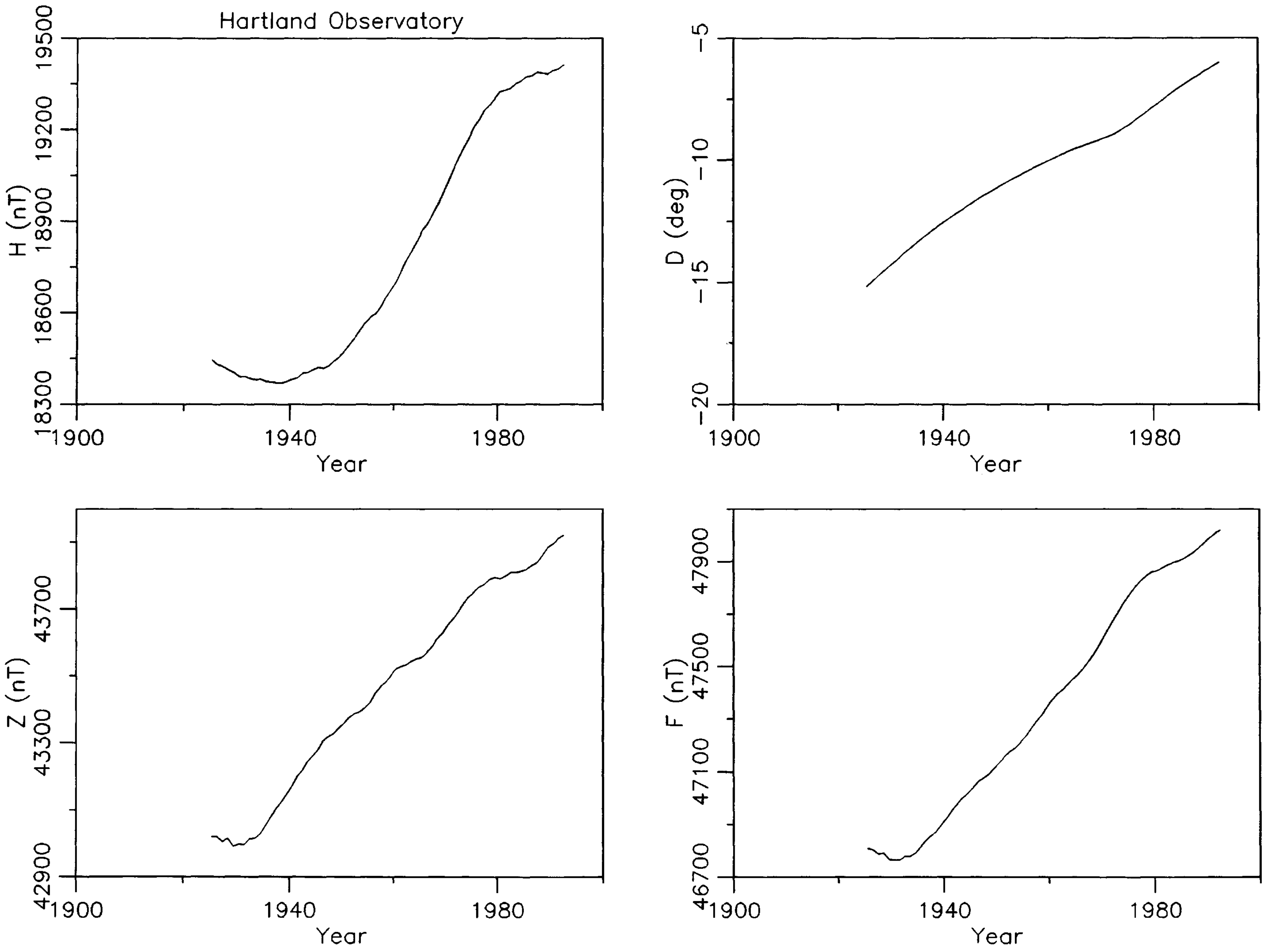
Hartland

	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

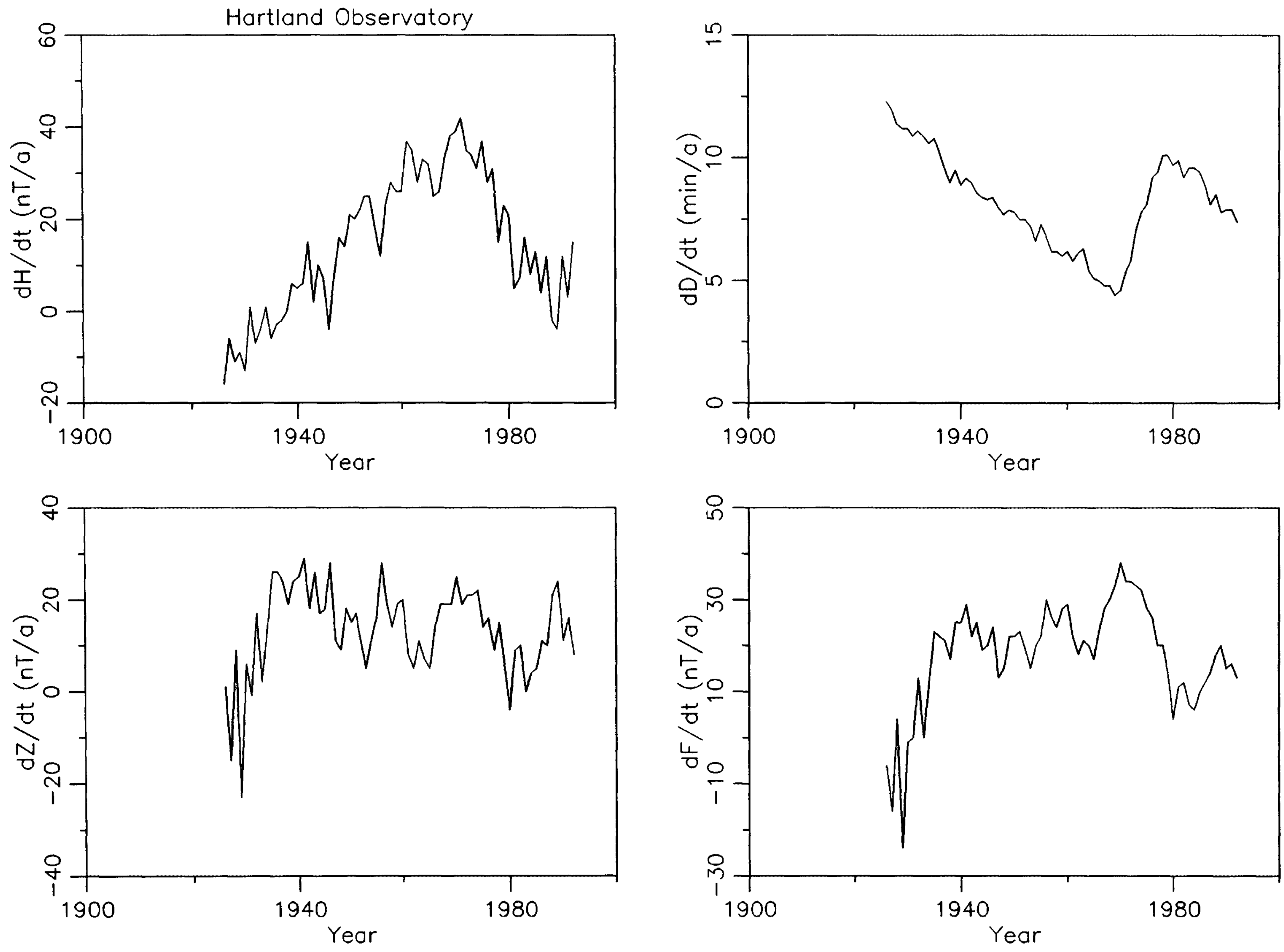
	Year	D		H	I		X	Y	Z	F
	1981.5	-7	33.9	19335	66	10.2	19167	-2546	43777	47857
	1982.5	-7	24.7	19342	66	10.1	19180	-2495	43787	47869
	1983.5	-7	15.1	19358	66	9.0	19203	-2443	43787	47876
	1984.5	-7	5.5	19366	66	8.6	19218	-2391	43791	47882
	1985.5	-6	56.1	19379	66	7.9	19237	-2340	43796	47892
	1986.5	-6	47.3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

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

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



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



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

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Cover photos

Front
Lerwick Observatory (Photo Mr A J Gair)

Back
The daily geomagnetic index DRX from Lerwick Observatory plotted by Bartels rotation for the years 1983–92

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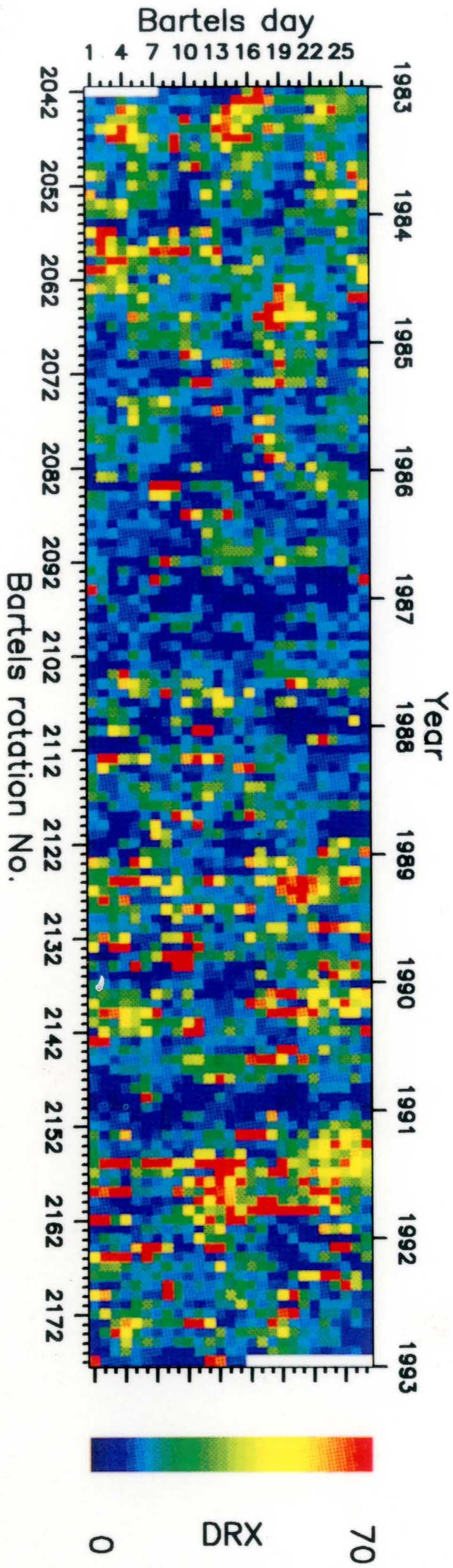

GEOMAGNETIC BULLETINS

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

4 Magnetic results 1970 Eskdalemuir, Hartland and Lerwick observatories

5 Magnetic results 1971 Eskdalemuir, Hartland and Lerwick observatories

6 Annual mean values of the geomagnetic elements since 1941

7 Magnetic results 1972 Eskdalemuir, Hartland and Lerwick observatories

8 Spherical harmonic models of the geomagnetic field

9 Magnetic results 1973–77 Eskdalemuir, Hartland and Lerwick observatories

10 Annual mean values of the geomagnetic elements

11 Magnetic results 1978–79 Eskdalemuir, Hartland and Lerwick observatories

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

13 Magnetic results 1980 Eskdalemuir, Hartland and Lerwick observatories

14 Magnetic results 1981 Eskdalemuir, Hartland and Lerwick observatories

15 Magnetic results 1982 Eskdalemuir, Hartland and Lerwick observatories

16 Magnetic results 1983, 1984 Eskdalemuir, Hartland and Lerwick observatories

17 Magnetic results 1985 Eskdalemuir, Hartland and Lerwick observatories

18 Magnetic results 1986 Eskdalemuir, Hartland and Lerwick observatories

19 Magnetic results 1987–89 Lerwick, Eskdalemuir and Hartland observatories

20 Magnetic results 1990 Lerwick, Eskdalemuir and Hartland observatories

21 Magnetic results 1991 Lerwick, Eskdalemuir and Hartland observatories

22 Magnetic results 1992 Lerwick, Eskdalemuir and Hartland observatories

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