

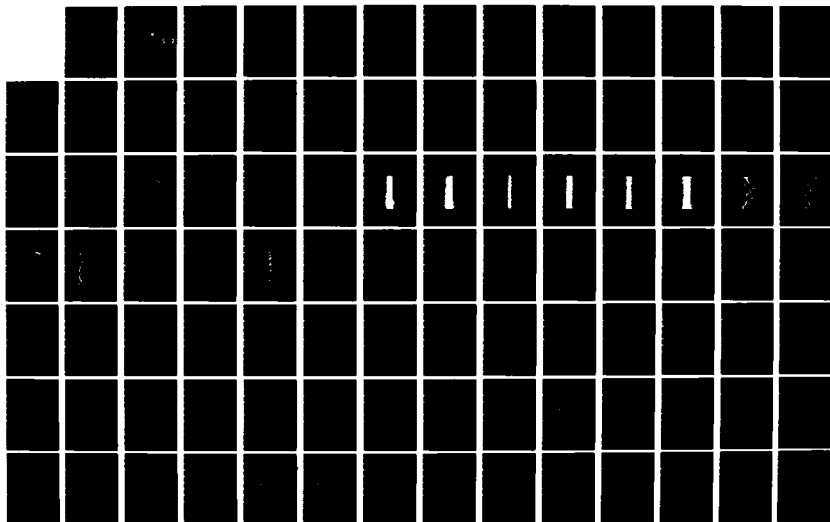
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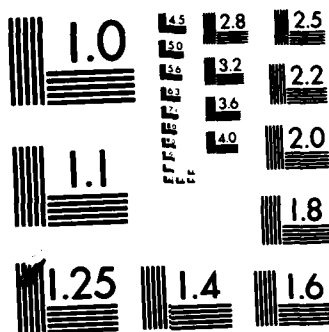
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THESIS

COHERENCE STUDY OF GEOMAGNETIC FLUCTUATIONS
IN FREQUENCY RANGE .04 - 0.6 HZ
BETWEEN REMOTE LAND SITES

by

Stephen John Anthony

December 1983

Thesis Advisor: Andrew R. Ochadlick, Jr.

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20. Abstract (continued)

Air Development Center, Warminster, Pennsylvania, between land sites 24.8 km apart. The NADC coherence values are lower (0.3 - 0.6)

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Coherence Study of Geomagnetic Fluctuations
in Frequency Range .04 - 0.6 Hz
Between Remote Land Sites

by

Stephen John Anthony
Lieutenant, United States Navy
B.S., University of Minnesota, 1973

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN PHYSICS

from the

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ABSTRACT

Fluctuations in the geomagnetic field were measured by three orthogonally mounted coil sensors at two land sites separated by 40 km. Computer generated voltage vs time and magnetic field vs time plots failed to reveal the presence of dominant micropulsations. A coherence study between the two sites revealed coherence values of 0.6 - 0.8 in the frequency range 0.04 - 0.6 Hz. This is compared to a coherence study completed at the Naval Air Development Center, Warminster, Pennsylvania, between land sites 24.8 km apart. The NADC coherence values are lower (0.3 - 0.6).

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I. INTRODUCTION

This thesis is part of an ongoing effort at the Naval Postgraduate School to analyze ULF geomagnetic noise and micropulsations. These variations in the geomagnetic field are of interest both from a geophysical and a military viewpoint. Applications of interest to the Navy are in the areas of magnetic detection of submarines, mine warfare and communications systems.

The specific objectives of this study were to install and operate a simultaneous data collection system at two separated land sites, to modify and adapt previously developed software for data analysis and to obtain spectral coherences between the two sites for background noise and/or micropulsations.

A coherence study of background noise with background noise, of micropulsation with micropulsation and of background noise with micropulsation between the two sites should further the understanding of the types and extent of the sources that produce these fluctuations.

The data collection sites were separated by a distance of 40 km (see Appendix A). One site was at La Mesa Village, near the Naval Postgraduate School campus, while the other was at the Chew's Ridge fire lookout. The latter was chosen for its remoteness from the local power grid.

II. BACKGROUND

A. MICROPULSATIONS

The frequency spectrum of the geomagnetic field observed on or near the earth's surface has a number of well defined peaks, corresponding to categories of regular geomagnetic micropulsations, as shown in Figure 2.1. These micropulsations are designated as Pc1, Pc2, ... Pc5.

Another category of micropulsations encountered is irregular pulsations. Unlike regular Pc micropulsations, which have relatively well defined frequencies, the Pi micropulsation consists of a spectral band of noise.

The source of these micropulsations appears to be magneto-hydrodynamic resonances in the earth's magnetosphere (Pc2 - Pc5), ion cyclotron wave-particle interaction in the magnetosphere (Pc1) and ionospheric currents perturbed by conductivity variations (Pi). References 1 and 2 give more detailed explanations of these mechanisms. Micropulsations are classified as follows:

1. Pc1: (0.2 - 5 Hz frequency)

Known as "Pearls", these micropulsations are generated by the cyclotron instability of energetic protons. They have been positively correlated with solar disturbances and occur during daylight hours in the auroral zone and

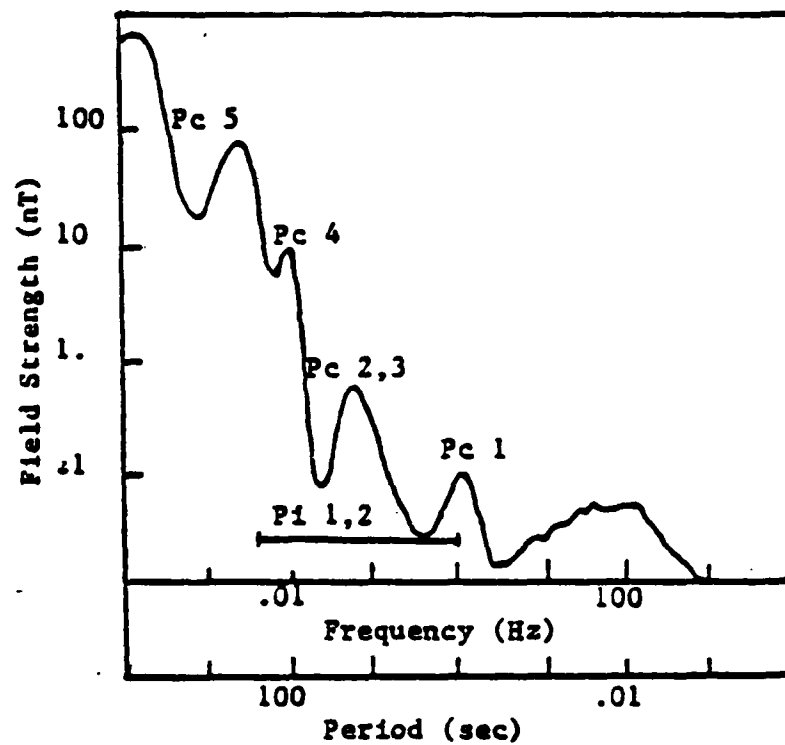


Figure 2.1 Field Strength of Micropulsations.

during night and early morning hours in the midlatitudes. Typical amplitudes are 0.05 - 0.1 nanotesla.

2. Pc2: (0.1 - 0.2 Hz frequency)

This is a diurnal phenomenon that shows some positive correlations with solar activity and the seasons. They usually decrease in their period as magnetic activity increases. Their average amplitude is 0.1 - 1 nanotesla.

3. Pc3: (0.022 - 0.1 Hz frequency)

These are similar to Pc2 pulsations except for the frequency range.

4. Pc4: (6.7 - 22 mHz frequency)

Sunspot activity appears to have an effect on Pc4 pulsations. Their frequency varies with the season and they have an average amplitude of 5 - 10 nanotesla.

5. Pc5: (1.7 - 6.7 mHz frequency)

These large scale pulsations occur during morning and evening with amplitudes of 10 - 100 nanotesla. Their duration shows a strong geomagnetic latitude dependence.

6. Pi1: (0.025 - 1 Hz frequency)

These pulsations usually occur at night and early morning and vary in intensity from 0.01 - 0.1 nanotesla. They demonstrate a positive correlation with auroral disturbances.

7. Pi2: (6.7 - 25 mHz frequency)

The amplitude of these pulsations ranges from 1 - 5 nanotesla. They usually occur during early morning hours but may continue throughout the night. The frequencies of these pulsations increase with increasing magnetic activity.

Geomagnetic micropulsations can be distinguished from the general noise background of the geomagnetic field. The micropulsation events rise out of the ever present background activity, reach an amplitude that can be large in comparison to the background level, and then finally disappear into the background. The Pc4 and Pc5 pulsations can last several hours. However, the Pc1 - Pc3 and Pi micropulsations have a maximum duration of approximately one hour but may last only a few minutes.

B. GEOMAGNETIC BACKGROUND NOISE

It has been speculated that the primary source of the geomagnetic background noise is fluctuations in the interplanetary magnetic field [Ref. 3]. If so, a source of such large spatial extent implies that the amplitude of the background noise may be less variable over the surface of the earth than the more locally generated micropulsations, and one could expect considerable spatial coherency of the background noise over the earth's surface.

David and Heirtzler [Ref. 4] studied the coherence of geomagnetic variations between two stations up to 550 km apart. The geomagnetic variations were separated into a background noise component and a micropulsation component. When two different micropulsation types occurred simultaneously, they were found to be incoherent with one another and with the background noise. It would thus appear that independent generation mechanisms exist for the background noise component and for micropulsations of different types. Also, the background component showed association with the solar quiet day magnetic variation (Sq). In particular, the spectrum amplitude of the background component increased as the strength of Sq increased.

III. DATA COLLECTION SYSTEM

A. EQUIPMENT DESCRIPTION

The system used at both the Chew's Ridge and La Mesa Village sites is shown in Figure 3.1. The major components are:

- (1) Coil sensors
- (2) Preamplifiers
- (3) Signal conditioner
- (4) Pulse Code Modulation (PCM) encoder
- (5) WWV radio receiver
- (6) Tape recorder
- (7) Power source

For a geographical description of the two sites, see Appendix A.

1. Coil Sensors

Each coil is continuously wound with 5460 turns of 18 gauge copper magnet wire. It has an internal resistance of 9.31 Henries. At each site, the three coils were mounted orthogonally, with the x coil oriented towards magnetic north, the y coil towards magnetic east and the z coil vertically downwards.

2. Preamplifiers

The preamplifiers are model 13-10A low noise amplifiers manufactured by Dr. Allen Phillips of SRI

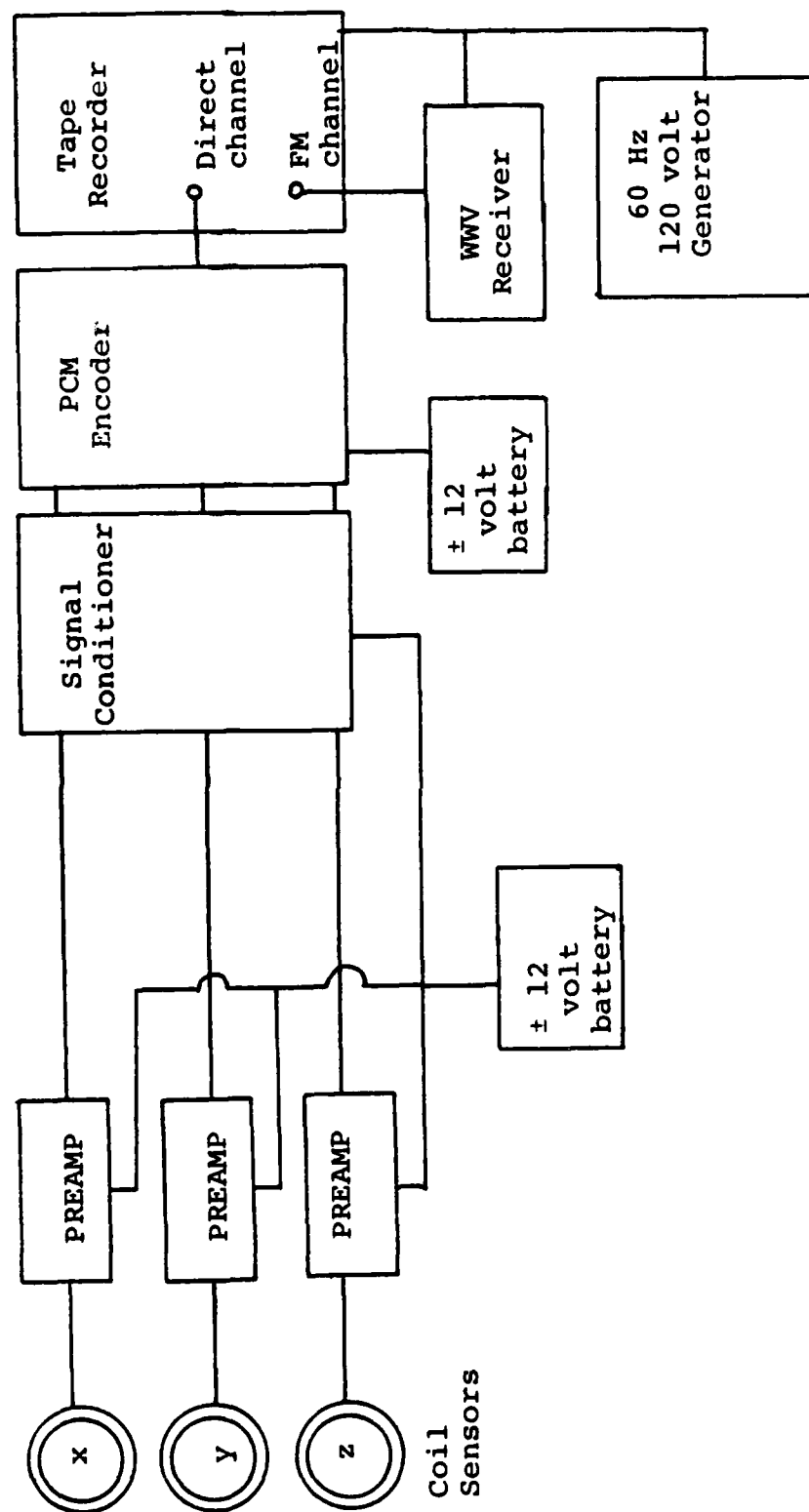


Figure 3.1 Block Diagram of Data Collection System.

International. The overall power gain is 60 dB for inputs less than 2.5 mV. A final stage low pass filter which provides a sharp cutoff at 20 Hz is provided. Each pre-amplifier has a DC offset potentiometer which must be adjusted to provide the correct zero-level at the output.

3. Signal Conditioner

The signal conditioner receives the analog signals from the preamplifiers, amplifies them by 30 dB and limits them to an amplitude of 7.5 volts.

4. PCM Encoder

The pulse code modulation (PCM) was designed and manufactured by Dr. Robert Lowe of Lowecom Incorporated and of the Scripps Institute of Oceanography in La Jolla, California. The encoder features 15 channel analog input capability with selectable sample rates of 2^n samples per second, where n is an integer value of 3 to 7. For the purposes of this thesis only 3 of the input channels were utilized (1, 2 and 3 for the x, y and z channels, respectively), and a sample rate of 64 samples per second was chosen to ensure adequate measurement of frequencies below 0.1 Hz. The encoder samples the analog signal from each channel at a rate of 64 Hz and assigns a pulse coded word with a decimal value between 0 and 4096 to each sample, corresponding to an amplitude of -5 to +5 volts. The output data is organized into frames, each

frame headed by a synch code word which is followed sequentially by the pulse coded samples from input channels 1 through 15. The synch code word is a pulse coded digital word with a decimal value of between 0 and 4096. This word is preselected and hardwired on the encoder circuit board. Reference F explains the PCM system in more detail.

5. WWV Radio Receiver

In order to ensure that the data from the two sites was analyzed simultaneously, an R-1051 B/URR radio receiver was used to monitor the WWV Universal Time broadcast at 20 MHz at each site. The broadcast gives the Universal Time at each minute by voice with each second marked by a tone.

6. Tape Recorder

Hewlett-Packard HP3964A/3968A tape recorders were used to record the PCM data and WWV broadcast on analog magnetic tape. The output from the PCM encoder was recorded on a direct channel (100 - 16000 Hz frequency response) and the WWV time signal was recorded on an FM channel.

7. Power Source

At the Chew's Ridge site the power source used was a 3500 watt, 60 Hz, 120 volt, gasoline powered, portable generator. The separation between the sensor coils and instrumentation was about 100 feet, and between the sensor coils and portable generator approximately 250 feet. Commercial 60 Hz power was available at the La Mesa Village site.

The preamplifiers, signal conditioners and PCM encoders were powered by rechargeable 18 amp-hour batteries (plus and minus 12 volts and ground).

B. PCM TO DIGITAL CONVERSION

The PCM data recorded on analog tape is played back into a PCM decoder which converts it to digital data. The digital data is recorded in 9-track, 800 bits per inch computer tape for subsequent analysis on the IBM 3033 mainframe computer. Appendix B contains a step-by-step procedure for the decoding process.

By listening to the FM channel carrying the WWV time signal over a speaker, the point on the analog PCM tape where it is desired to begin and stop the decoding process may be precisely determined. In this manner it is possible to obtain time synchronized digital computer tapes of data from the two sites.

IV. COMPUTER SOFTWARE

The computer programs used to analyze the data are written in Fortran IV programming language and are briefly discussed below. These programs are listed in Appendices C - G.

A. PROGRAM VOLTR

The VOLTR program reads data from a digital computer tape and generates a voltage vs time plot for each orthogonal axis. The data is read from the tape in blocks of 8192 frames (128 seconds) by the subroutine RD. This data, which is in integer form between 0 to 4096, is then normalized to represent voltages between ± 5 volts. The amount of data plotted is an integer increment of 128 seconds, the integer being from 1 to 8 and specified by the user.

B. PROGRAM VODIG

This program applies a 144 point double running average and a .04 - 0.6 Hz digital filter to the rough voltage and generates filtered voltage vs time plots for each axis. The digital filter simulates the pass band of an AN/SQ-81 magnetometer and was developed by Mike Huete of the Naval Postgraduate School. Reference 5 explains the filter in detail. The double running average smooths out any large noise "spikes" that may cause an unnatural oscillatory

response in the digital filters. It also acts as a low pass filter, removing frequencies greater than approximately 1 Hz.

C. MASS STORAGE PROGRAM

In order to compare simultaneous data from two different computer tapes, the data is read from one tape (La Mesa Village), normalized to voltage values and stored in the IBM 3033 Mass Storage System, where it is available for future recall.

D. PROGRAM MAGFLD

This program generates magnetic field vs time plots. The digital data is read from the computer tape and normalized to voltage values. A Fourier transform is performed on the data to enter frequency space. At this point the system transfer function, which converts the data from voltage to magnetic field values, is applied. References 6 and 8 detail the procedures used to determine the transfer function for each coil sensor-amplifier subsystem. After the transfer function has been applied, a second Fourier transform is performed to return the data to time space. A 144 point double running average is then applied to the magnetic field data to remove frequencies above about 1 Hz.

B. PROGRAM COHER

This program calculates the spectral coherence of the total field between the two sites and the power spectral densities of the total field at each site. The La Mesa Village data previously stored in the Mass Storage System is recalled, the corresponding Chew's Ridge data is read from a computer tape, and the two data sets manipulated simultaneously.

Referring to Figure 4.1, the total field was calculated as

$$\text{total field} = x \cos \theta_d + z \sin \theta_d$$

where θ_d is the magnetic dip angle, which in the Monterey area is 60° .

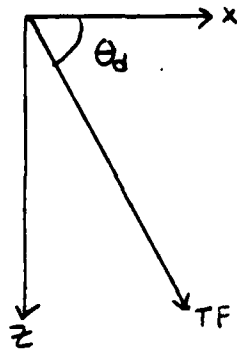


Figure 4.1 Total Field Diagram

The coherence between two signals $a(t)$ and $b(t)$ is

$$\text{coherence} = \frac{a(t) \circ b(t)}{\sqrt{a(t) \circ a(t)} \sqrt{b(t) \circ b(t)}} = \frac{A(F) B^*(F)}{\sqrt{a(F) A^*(F)} \sqrt{B(F) B^*(F)}}$$

where ' $\circ$ ' indicates the correlation separation, '*' indicates

the complex conjugate is taken and $A(F)$ and $B(F)$ are the Fourier transforms of $a(t)$ and $b(t)$, respectively.

In the program, a Fourier transform of the data into frequency space was performed and an average of 20 blocks of data (128 seconds per block) was taken to obtain the final coherence values.

V. TESTING OF PCM SYSTEM AND SOFTWARE

In order to ensure that the PCM system and VOLTR program faithfully reproduced the input signals, sinusoidal, triangular and square waves were input to the PCM encoder by a Wavetek signal generator, as shown in Figure 5.1, and the PCM signal recorded on analog tape. The signal generator output was also monitored by a chart recorder and voltmeter. The analog tape was then decoded and voltage vs time plots were generated by the VOLTR program.

Table 5.1 shows the relationship between the amplitude of the signal generator output and the amplitude of the VOLTR plots (Figure 5.2) at various frequencies for the sinusoidal signal.

As can be seen from Table 5.1, the error between the chart record and the computer plot is less than two percent. Similar results were obtained for the triangular and square wave on all three channels.

Extensive testing of the Mass Storage program, and the digital filter algorithm employed in the VODIG program, is documented in References 6 and 7, respectively.

The program COHER was tested by analyzing a section of data against itself. Data from a computer tape was read into the mass storage system by the Mass Storage program. The same section of data was read from the tape by

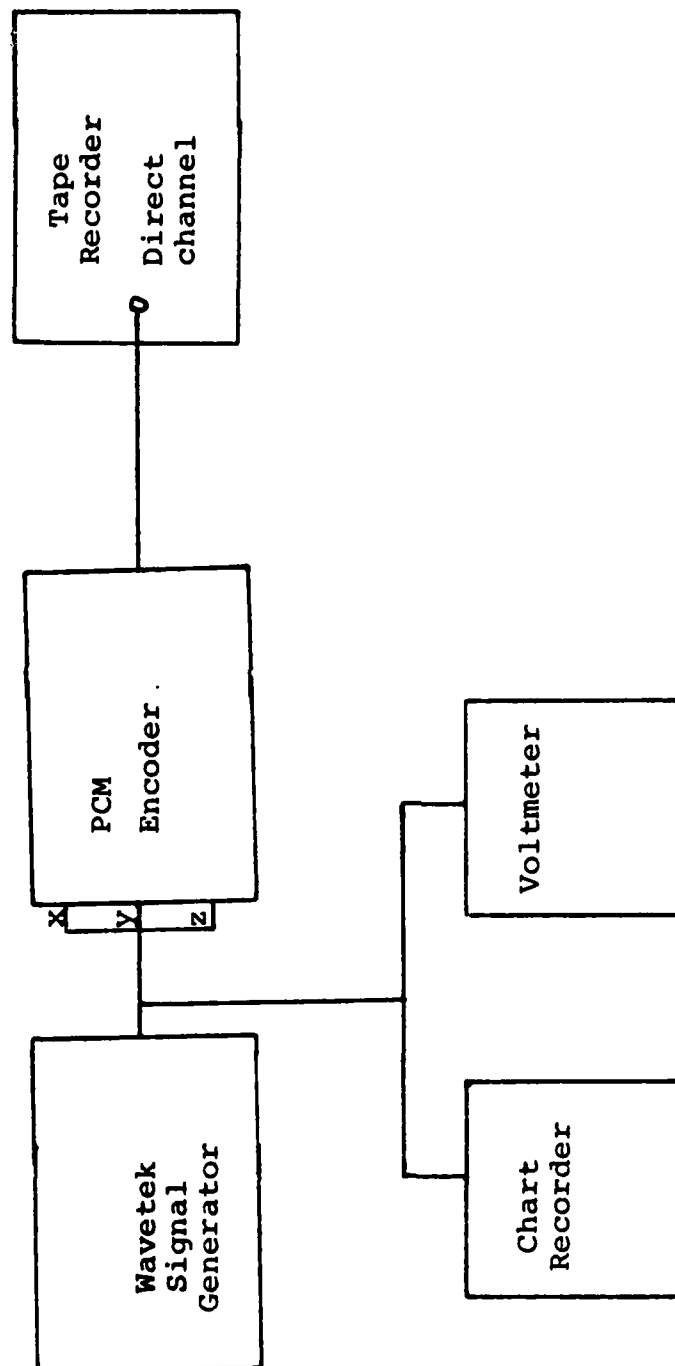


Figure 5.1 Block Diagram of Test System.

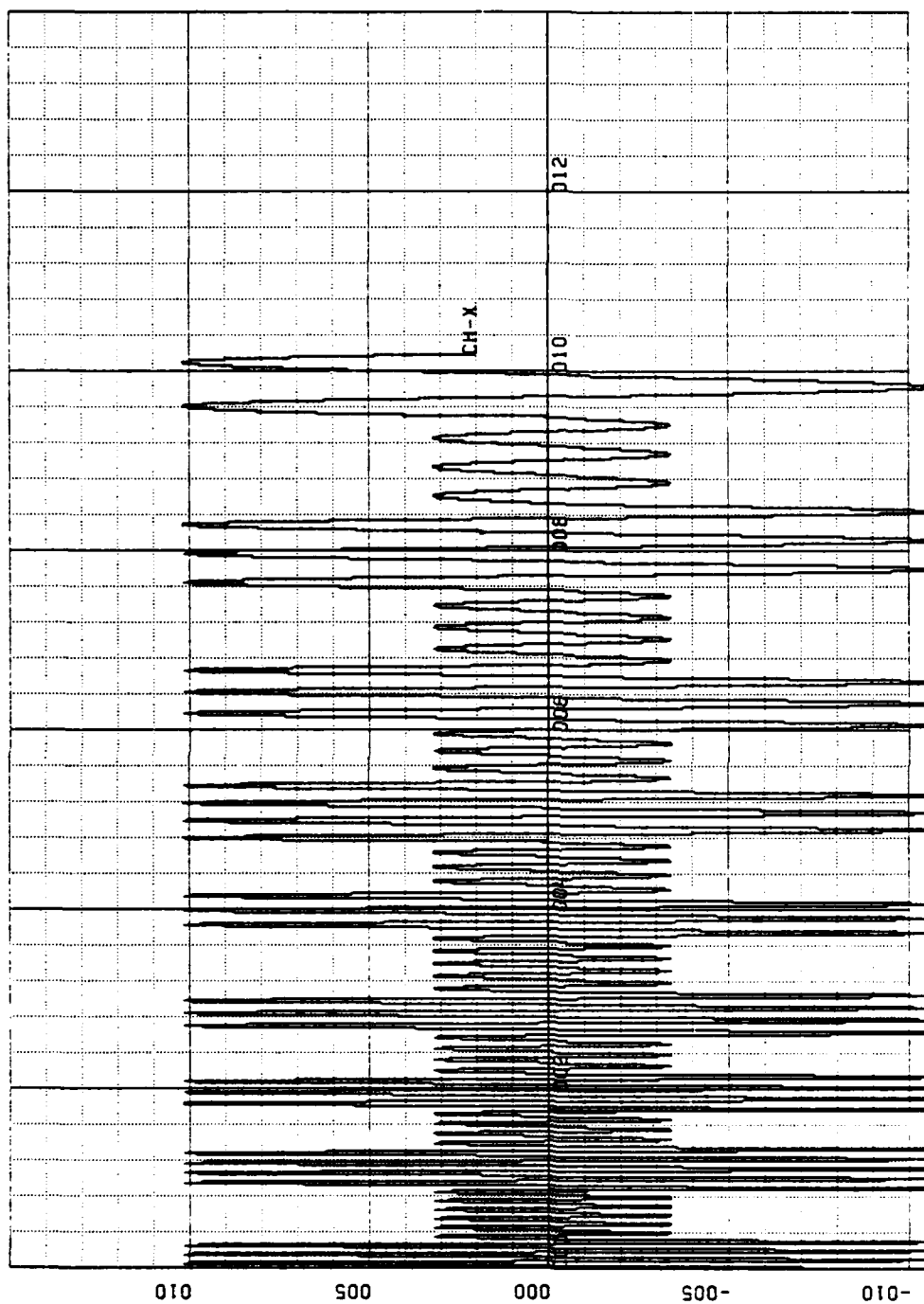


Figure 5.2 Test Voltage, Voltage (0.5 volts/inch) vs Time (200 seconds/inch).

TABLE 5.1

MEASURED AND COMPUTER GENERATED VOLTAGE VALUES

<u>Freq (Hz)</u>	<u>Chart Record (volts)</u>		<u>Computer Plot volts</u>		<u>Error %</u>	
	<u>Large Amplitude Oscillations</u>	<u>Small Amplitude Oscillations</u>	<u>Large Amplitude Oscillations</u>	<u>Small Amplitude Oscillations</u>	<u>Large</u>	<u>Small</u>
0.10	2.10 ± .01	0.67 ± .01	2.08 ± .01	0.66 ± .01	1.0	1.5
0.09	2.09	0.67	2.08	0.66	0.5	1.5
0.08	2.09	0.67	2.08	0.66	0.5	1.5
0.07	2.09	0.67	2.08	0.66	0.5	1.5
0.06	2.09	0.67	2.08	0.66	0.5	1.5
0.05	2.10	0.67	2.08	0.66	1.0	1.5
0.04	2.10	0.67	2.08	0.66	1.0	1.5
0.03	2.10	0.67	2.08	0.66	1.0	1.5
0.02	2.11	0.67	2.08	0.66	1.4	1.5
0.01	2.11	0.67	2.08	0.66	1.4	1.5

the COHER program and analyzed with the data recalled from mass storage. The COHER program generated a coherence vs frequency of 1 as expected (Figure 5.3).

Reference 8 mentioned the presence of "cross-talk" between the channels of the PCM encoder. This was noticed on computer generated plots on a channel whose input jack was left open while making measurements at a field site. To test for "cross-talk", a signal from the Wavetek signal generator was fed into all three channels of the PCM encoder, as in Figure 5.1. One of the channels was disconnected from the Wavetek and the input jack left open. Then the input jack was grounded, and then finally the Wavetek signal was reconnected. Figure 5.4 is a rough voltage vs time plot for the sequence. It can be seen that while the input jack was open a signal did appear on the channel but disappeared while the input jack was grounded. The "cross-talk" mentioned in Reference 8 was actually the open input jack acting as a "pickup" antenna.

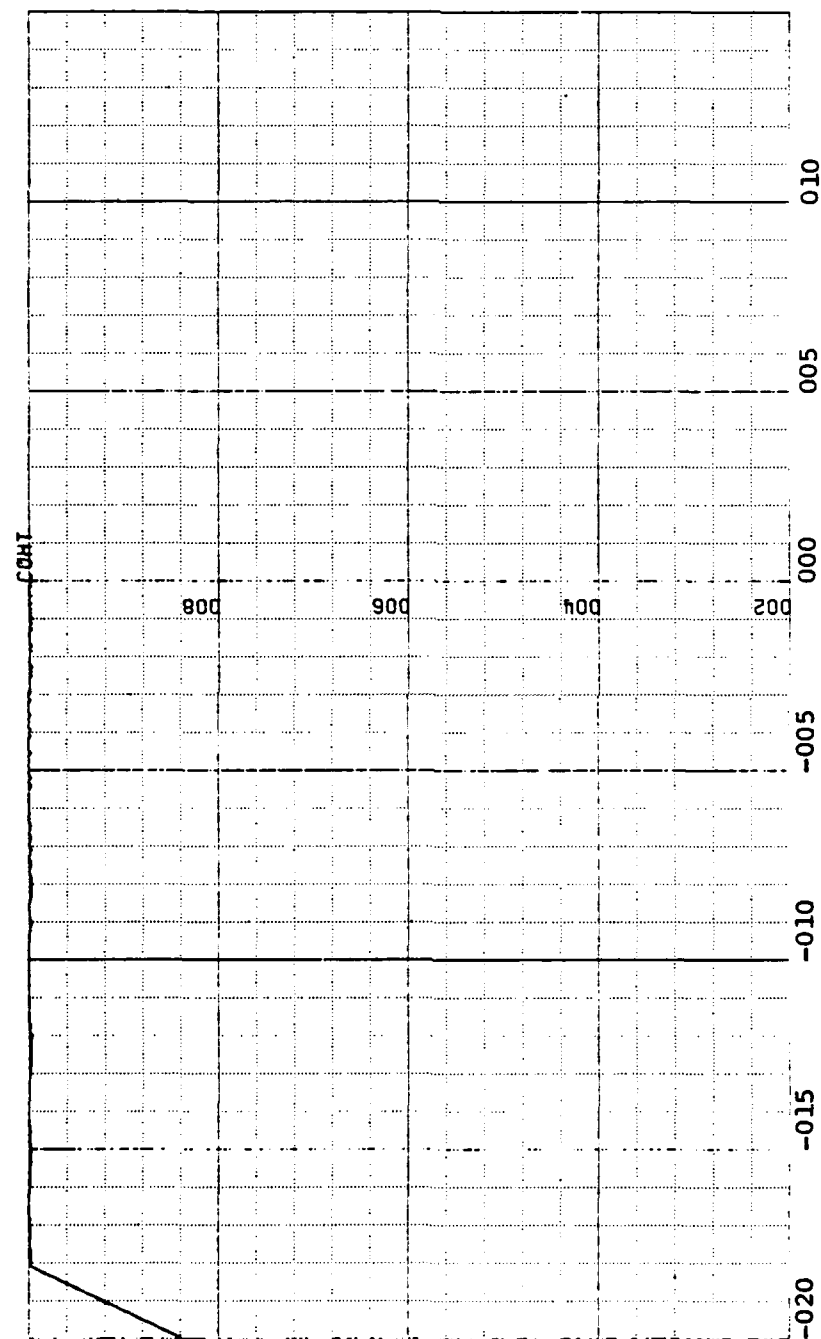


Figure 5.3 Coherence Test, Coherence (0.2 units/inch) vs Log

Frequency (0.5 log Hz/inch).

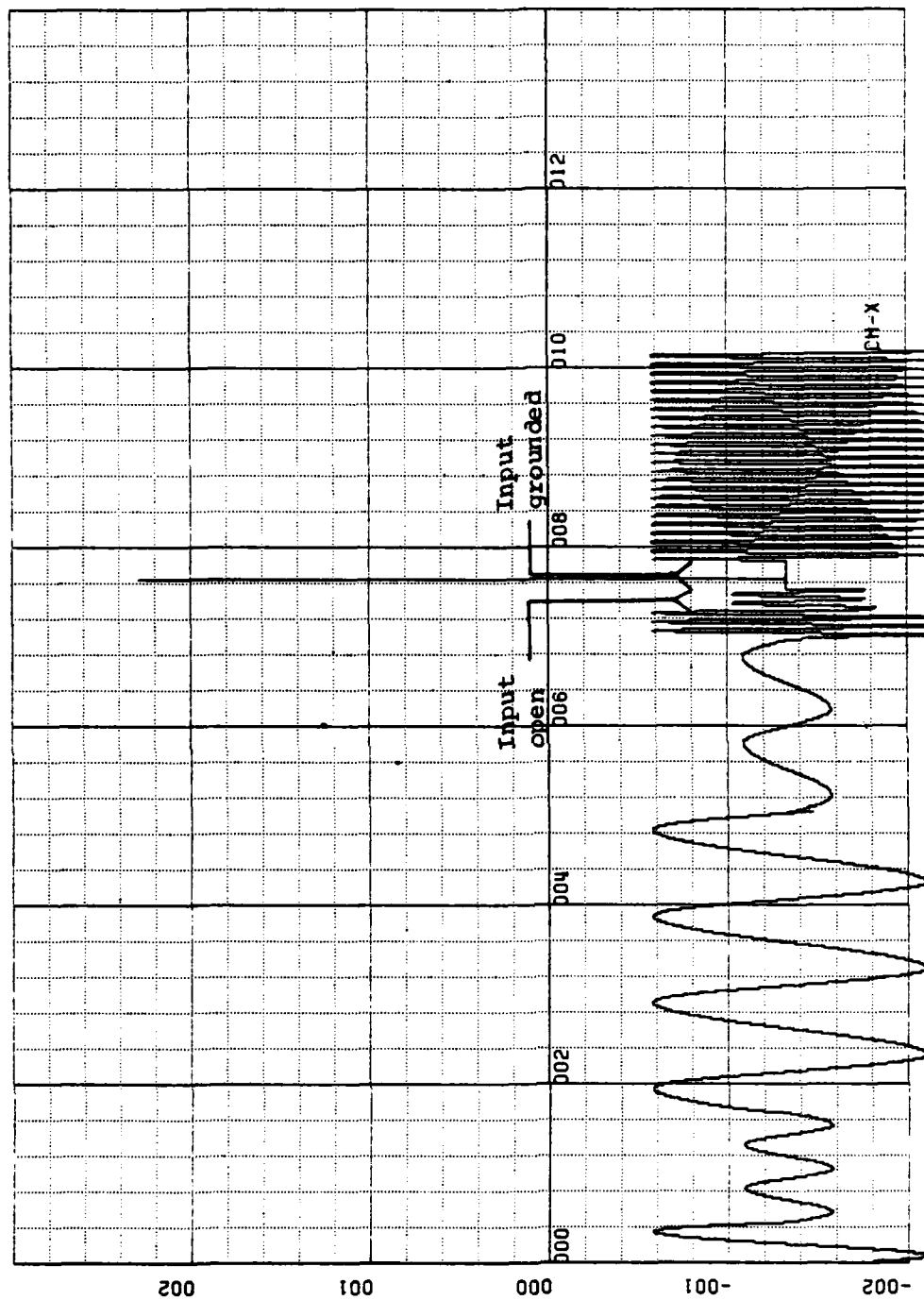


Figure 5.4 Test Voltage, Voltage (1 volts/inch) vs Time (200 seconds/inch).

VI. EXPERIMENTAL RESULTS

Data was taken on 4 August 1983 between 1300 and 1845 local time. Beginning and ending the recording of the analog tapes was coordinated between the two sites over PRC-77 radios. Since it proved difficult to communicate between the two sites directly (because of intervening hills), a person using a radio with a large whip antenna at the Naval Postgraduate School directed the simultaneous starting and ending of data recording at the two sites.

On the voltage and magnetic field plots, the units labeled on the vertical scale are arbitrary and only the peak-to-peak variations should be considered.

A. ROUGH VOLTAGE PLOTS

Figures 6.1 - 6.6 show the rough voltage plots for the La Mesa Village site. These signals are totally obscured by 60 Hz noise. Figures 6.7 - 6.12 show the Chew's Ridge rough voltage plots. Here the 60 Hz noise is a site as remote as Chew's Ridge (to escape the 60 Hz power grid) is thus justified.

B. FILTERED VOLTAGE PLOTS

Figures 6.13 - 6.30 show typical filtered voltage vs time plots for both sites. Visual inspection failed to

reveal the presence of any large amplitude micropulsations or of any clear one-to-one correspondence in simultaneous sections of data.

C. MAGNETIC FIELD PLOTS

Figures 6.31 - 6.45 show typical magnetic field vs time plots for both sites. Magnetic field variations at the La Mesa site are approximately one nanotesla; variations at the Chew's Ridge site are slightly greater, 2 - 4 nanotesla.

D. COHERENCE PLOTS

Figures 6.46 - 6.57 show coherence vs frequency plots for individual axes and for the total field. The coherence generally has values between 0.6 - 0.8 indicating a moderate degree of commonality in the geomagnetic variations at the two sites.

These coherence plots can be compared with coherence vs frequency plots generated from background geomagnetic variation data taken at the Naval Air Development Center in 1979. The separation between the NADC data collection sites was 24.8 km. Figures 6.58 - 6.60 show these plots. In general, the coherence values from the NADC data are less than the coherence values found in our measurements. However, the amplitudes of geomagnetic variations are

probably influenced by factors such as the state of the ionosphere and magnetosphere and the stage of the solar cycle.

The NADC data was averaged over a period of two hours while our data was averaged over a period of 40 minutes.

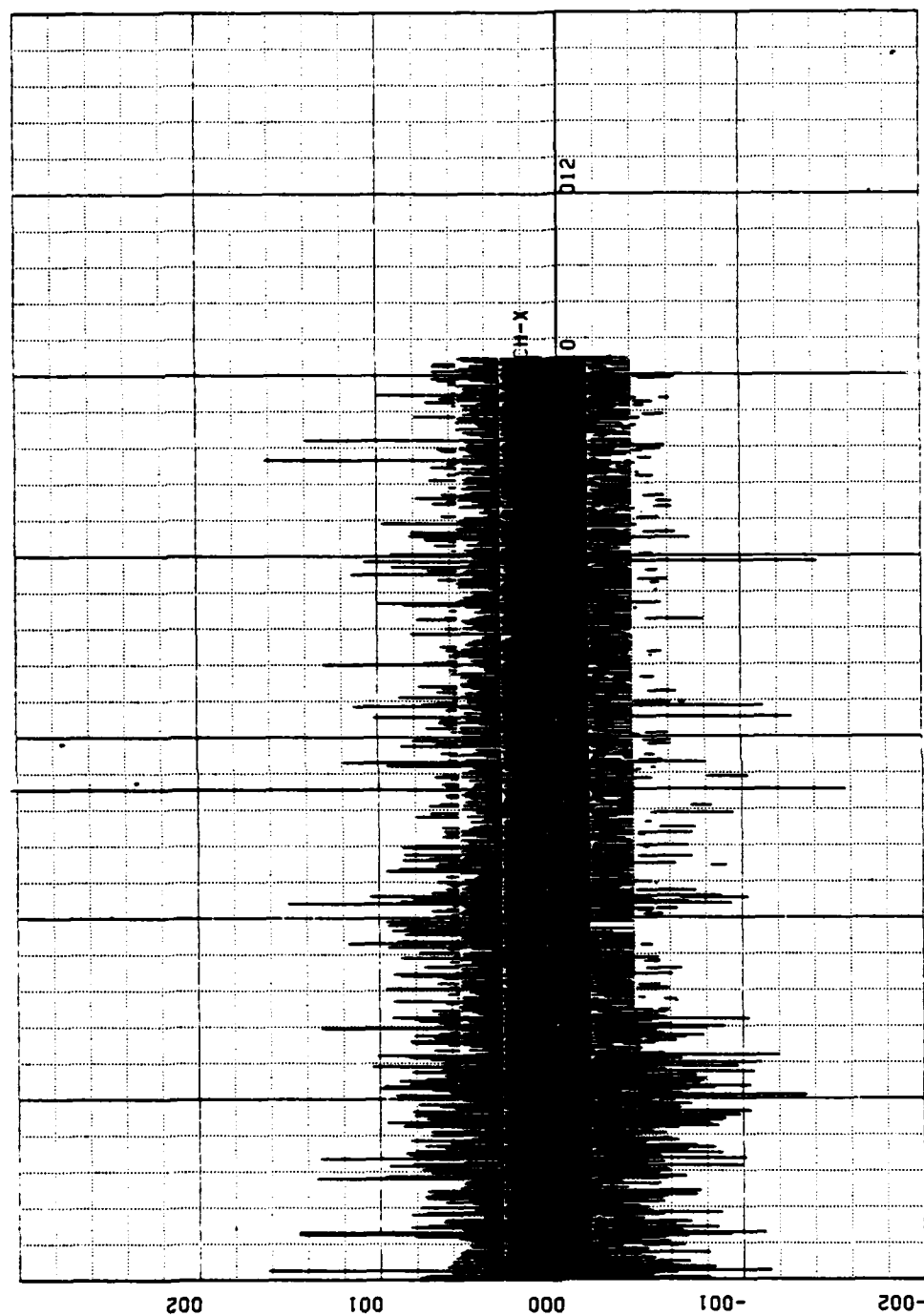


Figure 6.1 X Coil Voltage

La Mesa Village, 1359 - 1416 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

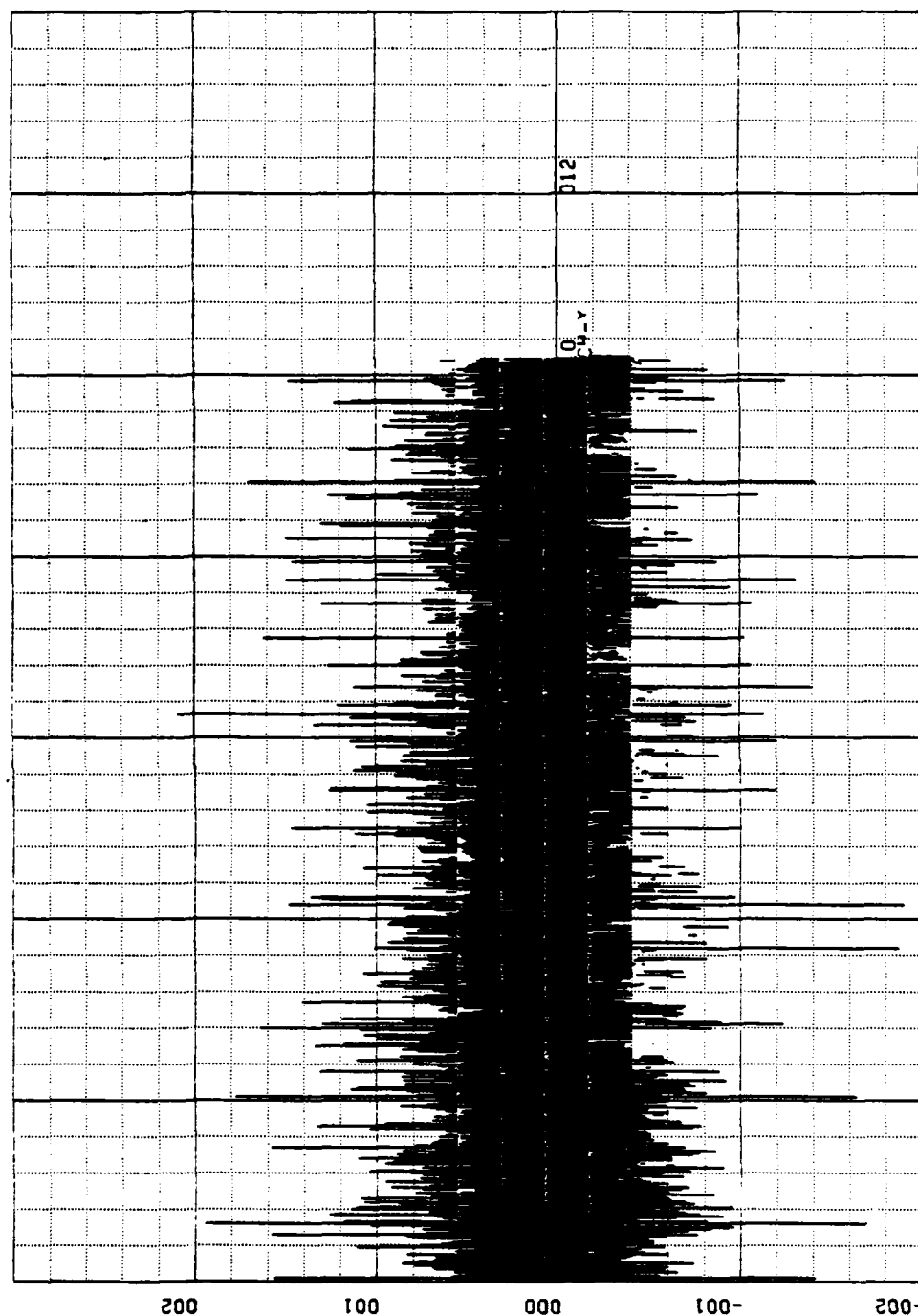


Figure 6.2 Y Coil Voltage

La Mesa Village, 1359 - 1416 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

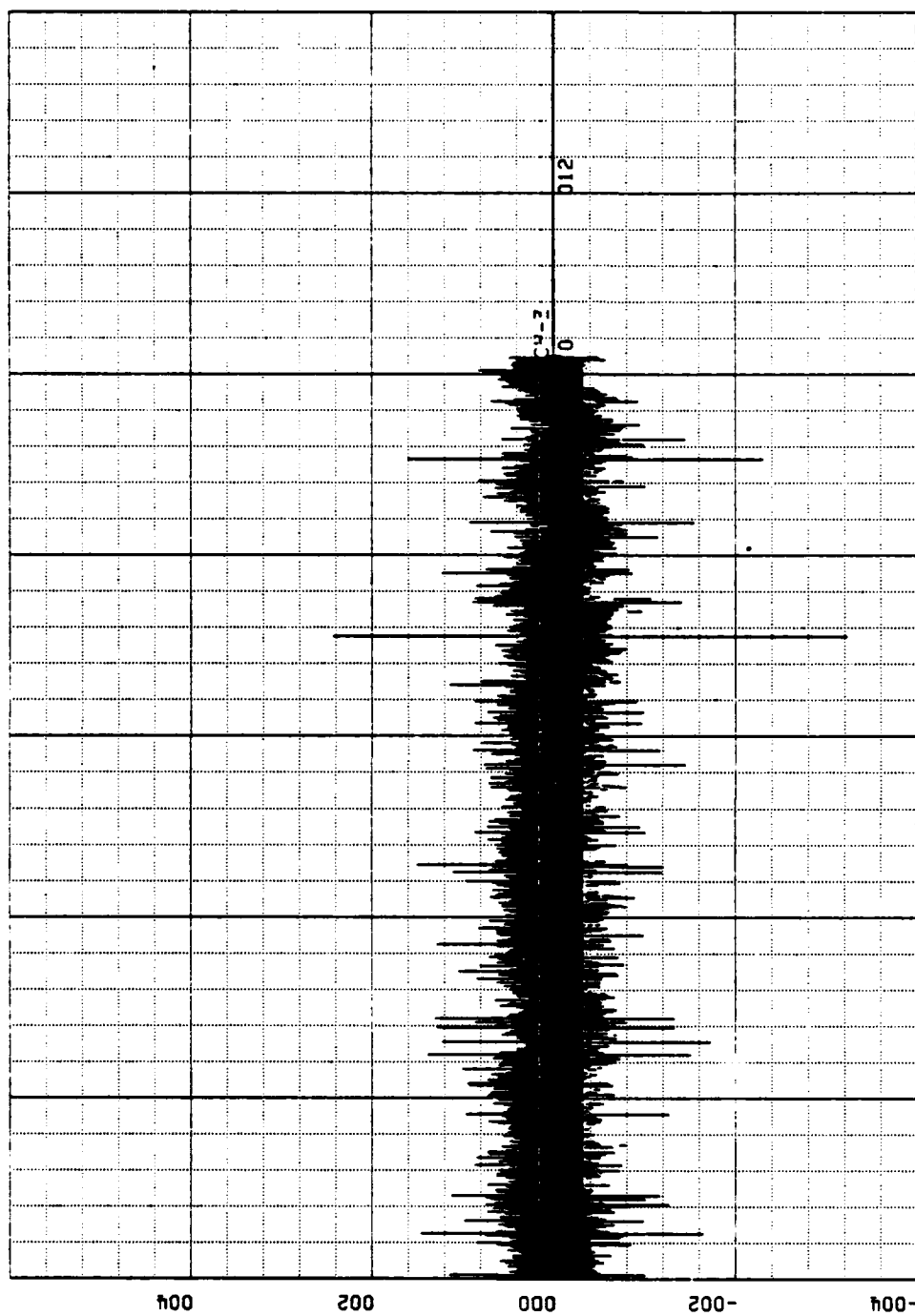


Figure 6.3 Z Coil Voltage

La Mesa Village, 1359 - 1416 Local
Voltage (2 volts/inch) vs Time (200 seconds/inch).

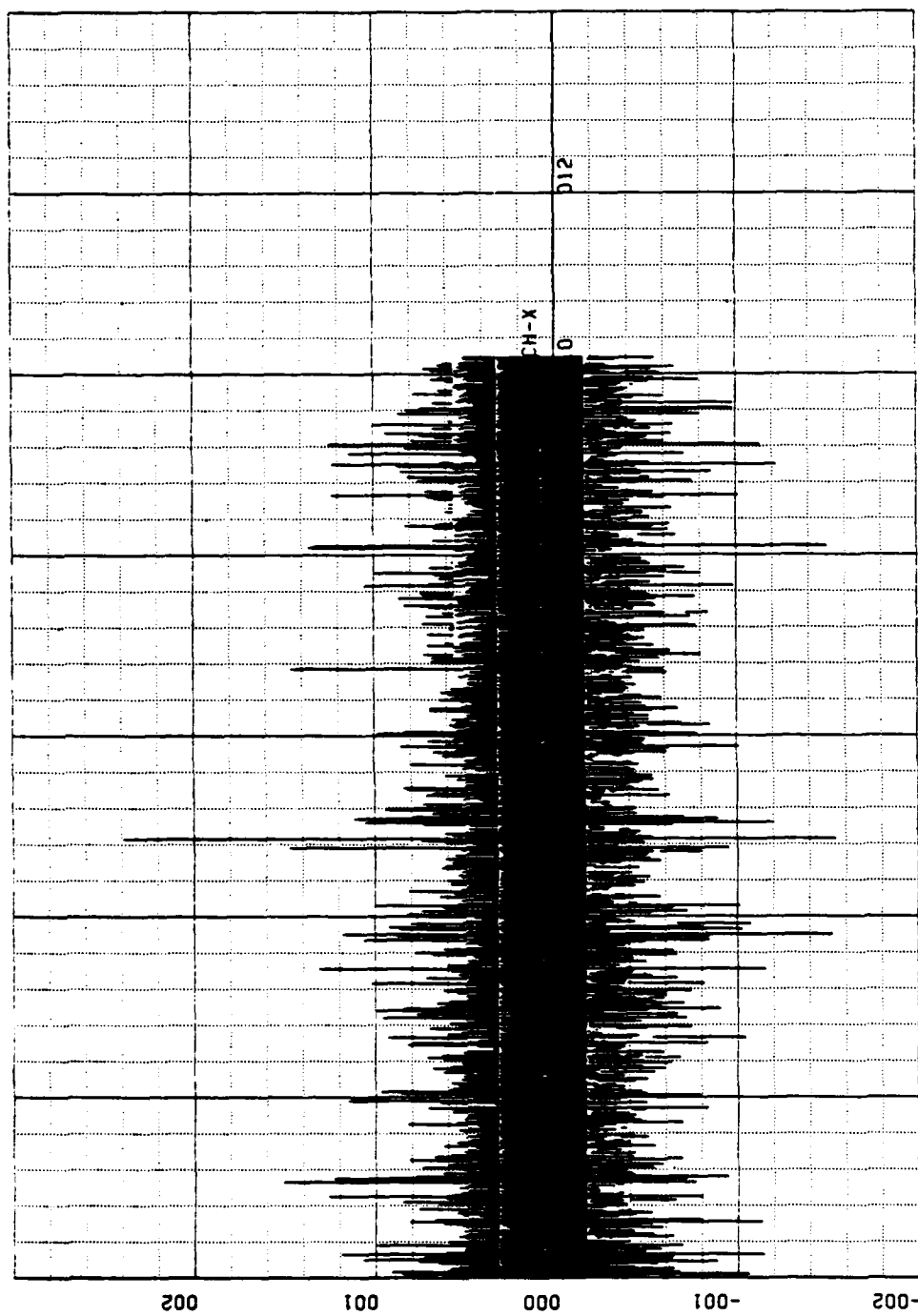


Figure 6.4 X Coil Voltage

La Mesa Village, 1500 - 1517 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

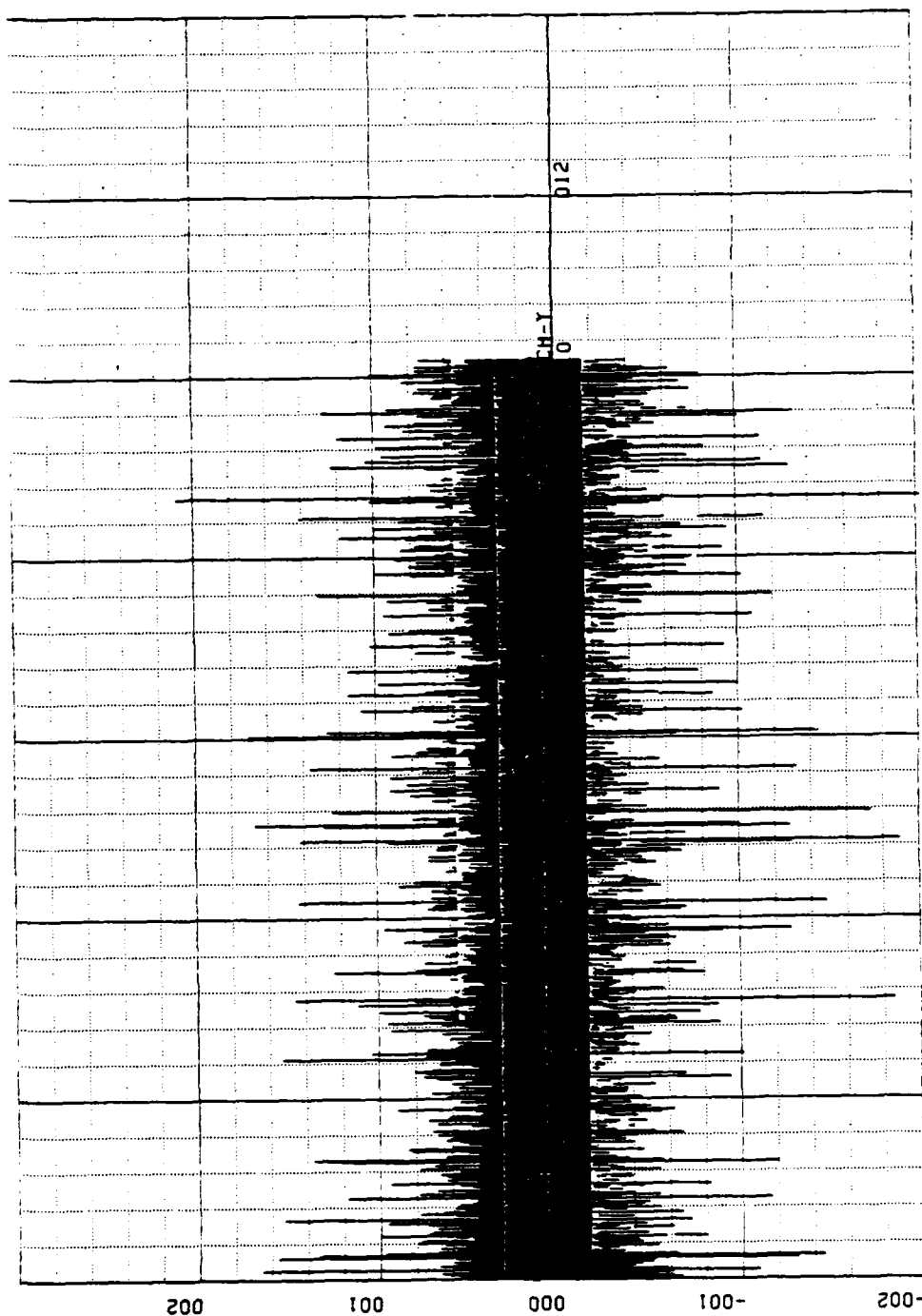


Figure 6.5 Y Coil Voltage
 La Mesa Village, 1500 - 1517 Local
 Voltage (1 volt/inch) vs Time (200 seconds/inch).

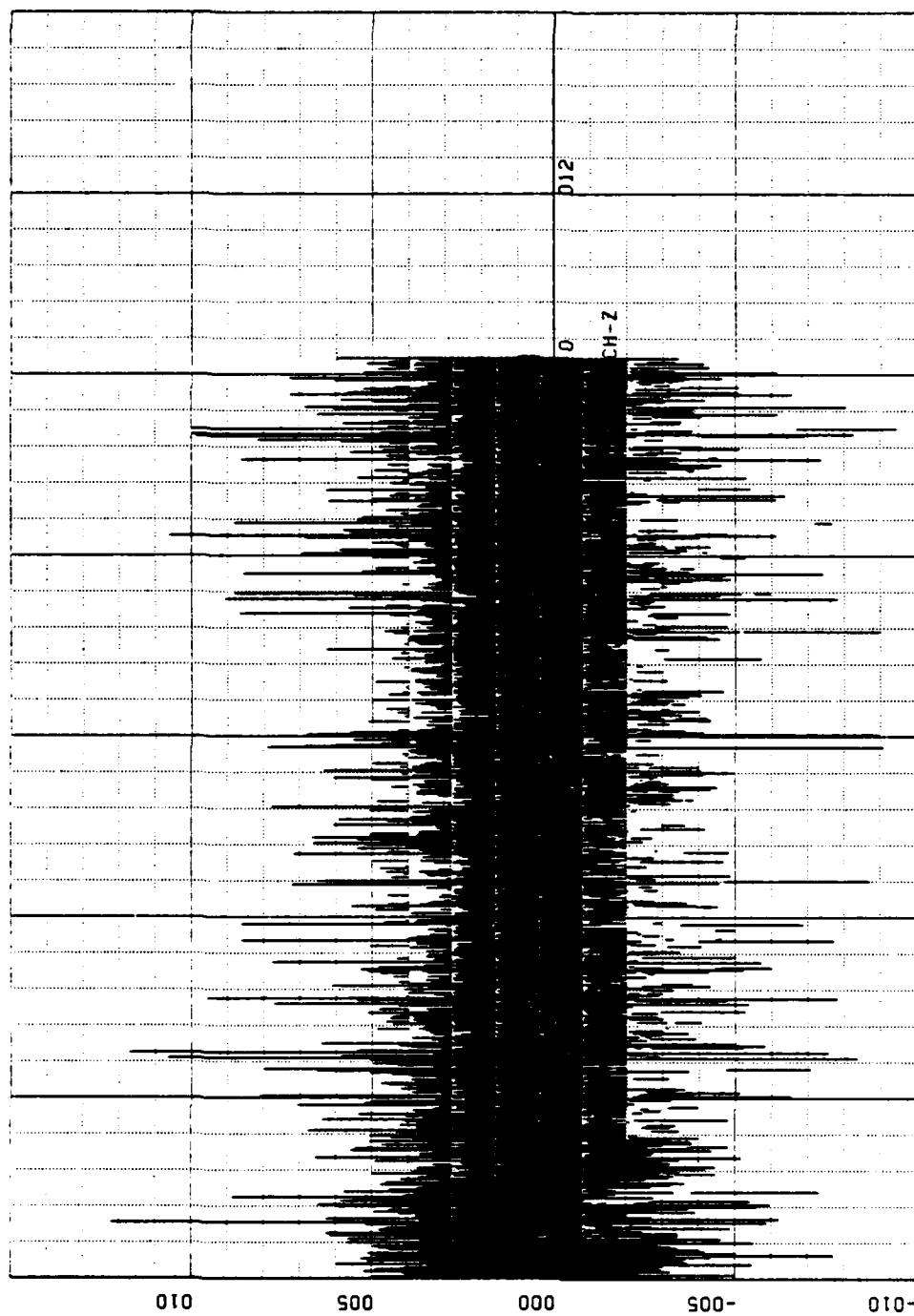


Figure 6.6 Z Coil Voltage

La Mesa Village, 1500 - 1517 Local

Voltage (0.5 volts/inch) vs Time (200 seconds/inch).

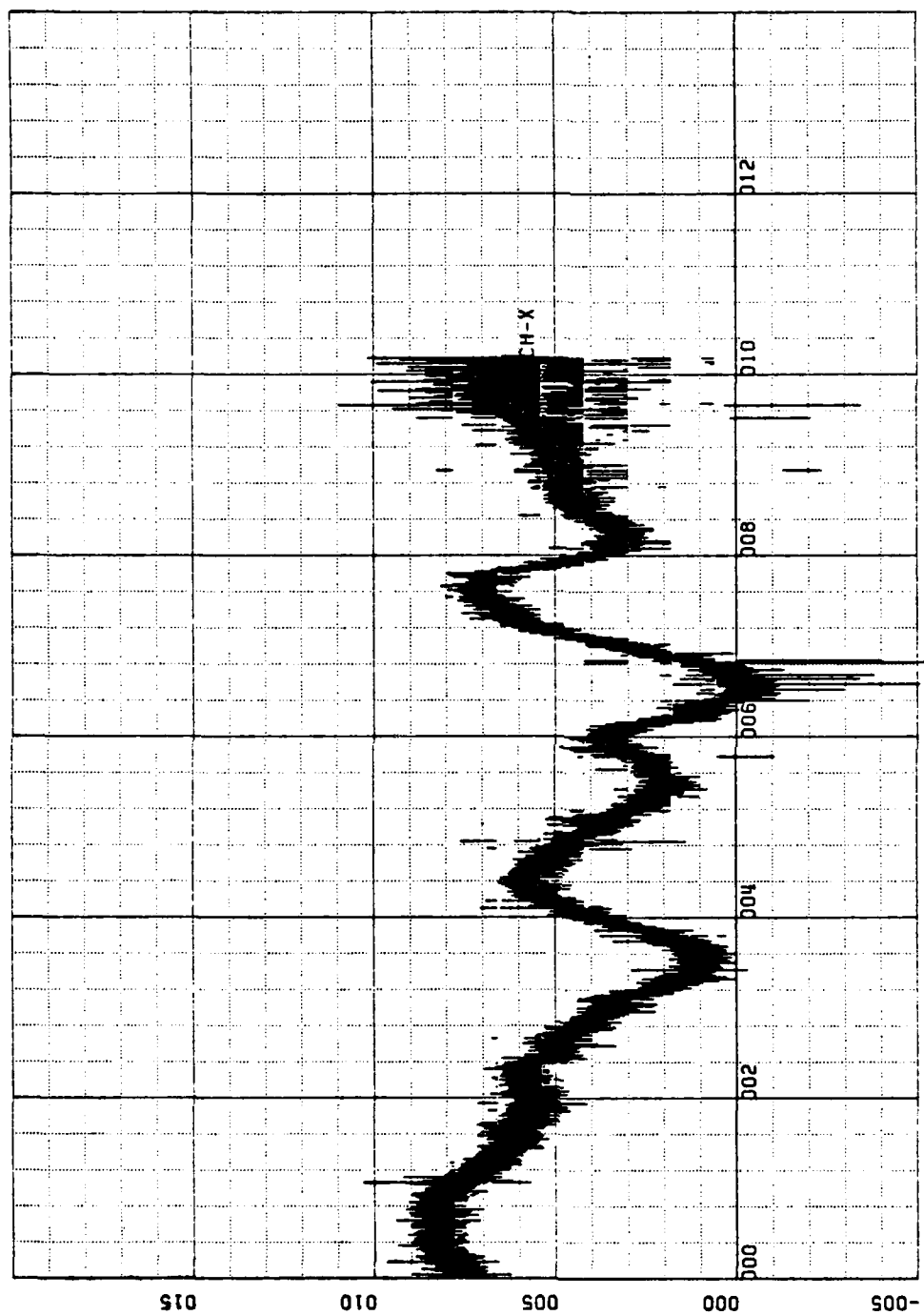


Figure 6.7 X Coil Voltage

Chew's Ridge, 1500 - 1517 Local

Voltage (0.5 volts/inch) vs Time (200 seconds/inch).

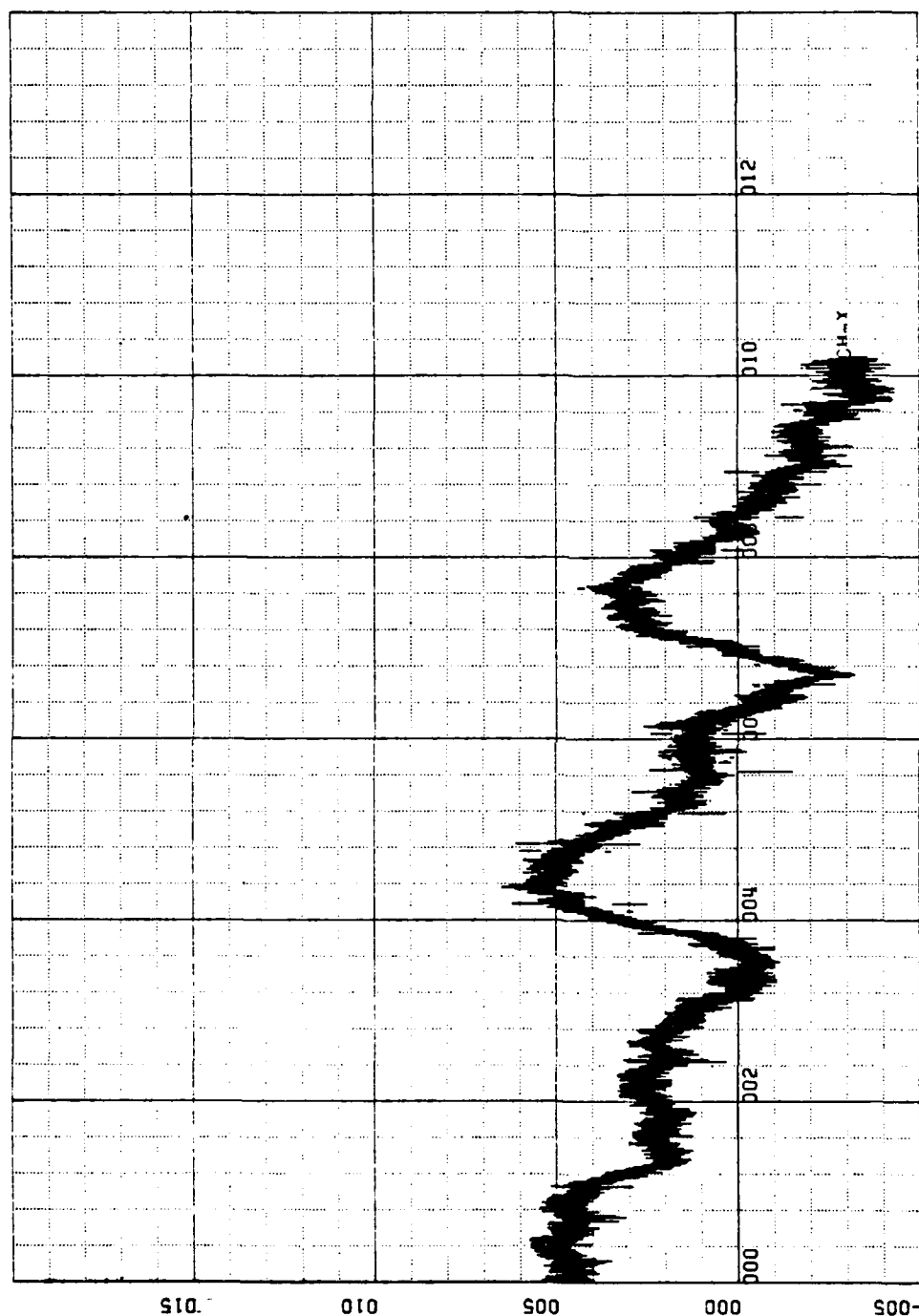


Figure 6.8 Y Coil Voltage

Chew's Ridge, 1500 - 1517 Local

Voltage (0.5 volts/inch) vs Time (200 seconds/inch).

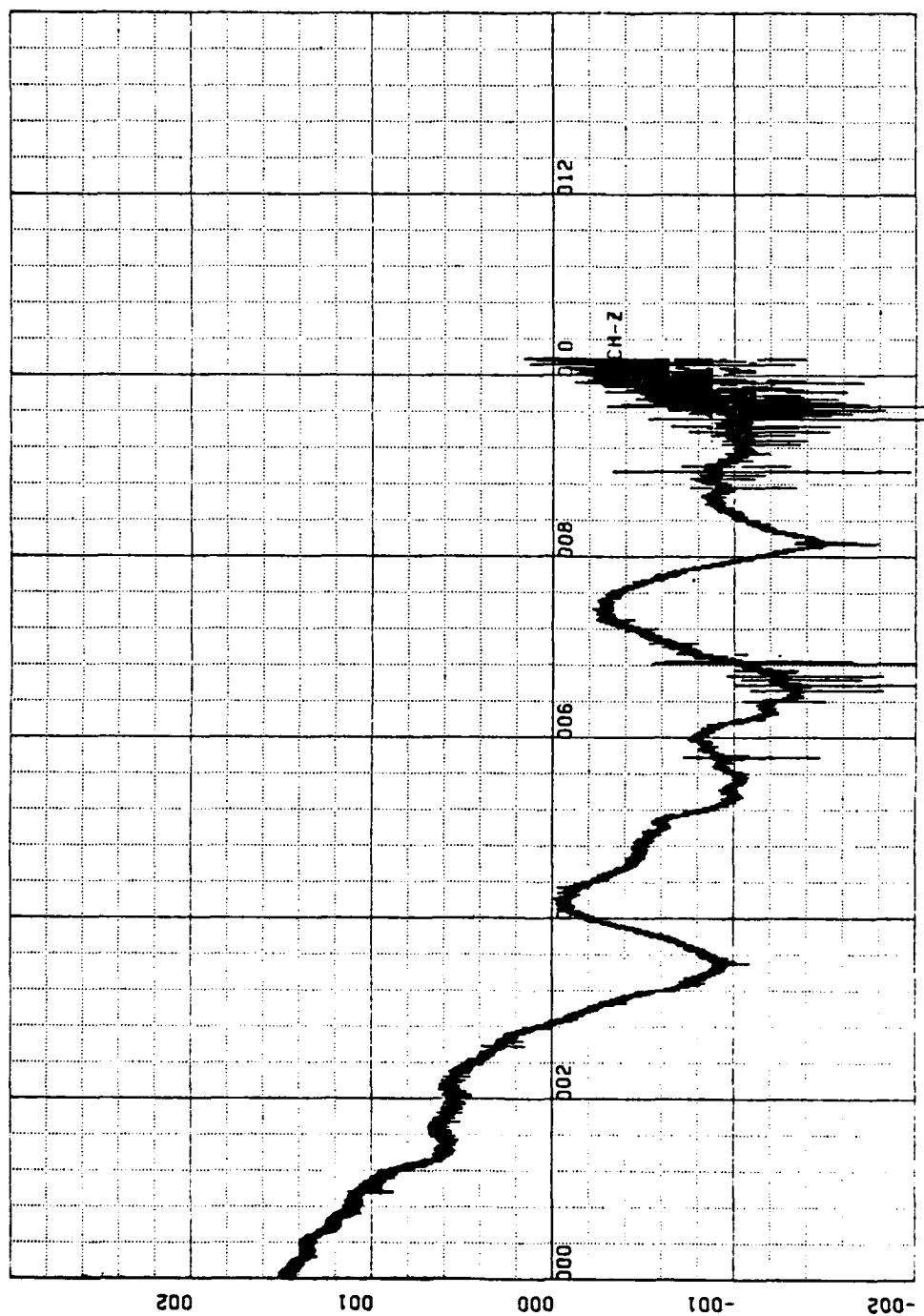


Figure 6.9 Z Coil Voltage

Chew's Ridge, 1500 - 1517 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

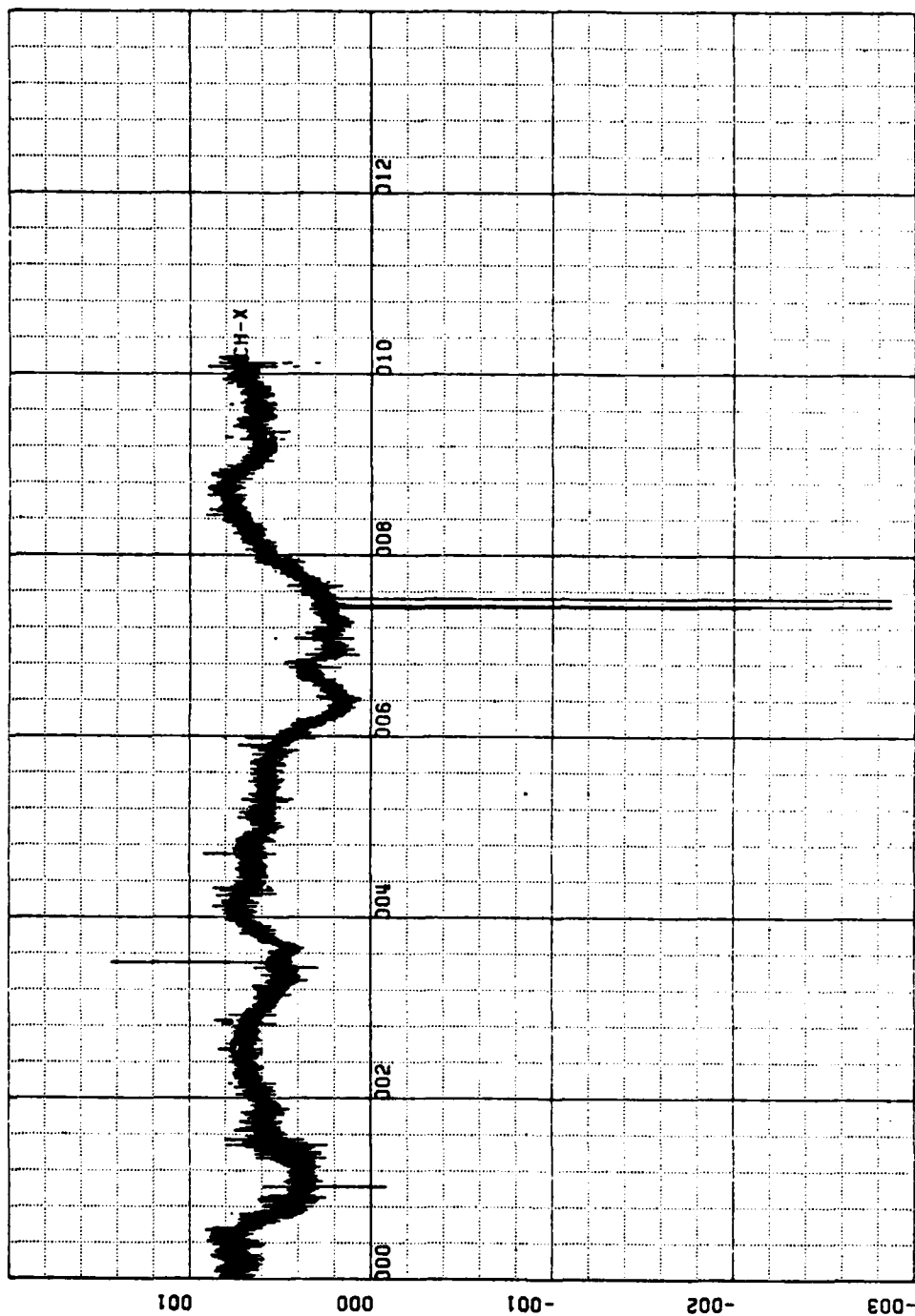


Figure 6.10 X Coil Voltage

Chew's Ridge, 1545 - 1602 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

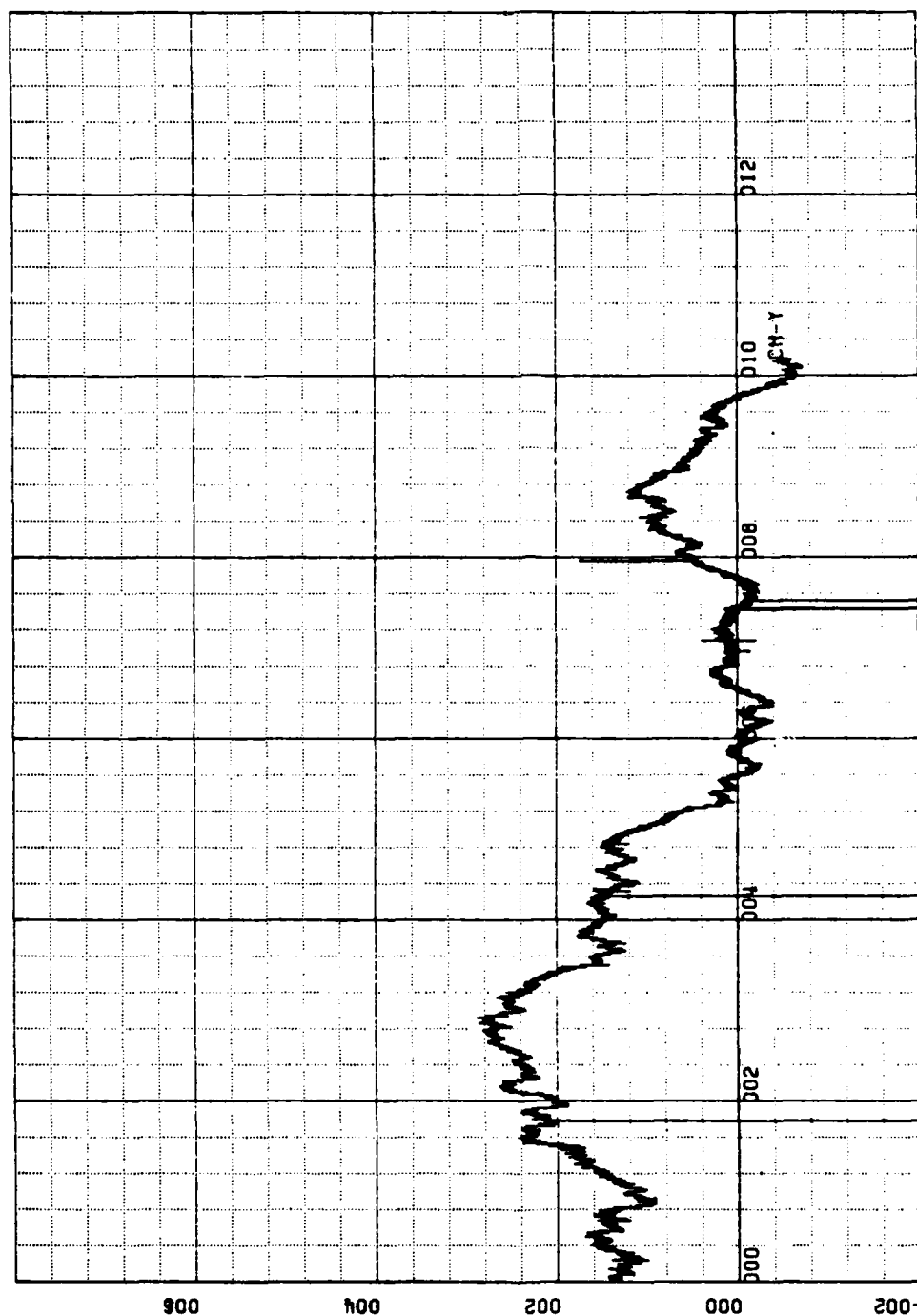


Figure 6.11 Y Coil Voltage

Chew's Ridge, 1545 - 1602 Local

Voltage (2 volts/inch) vs Time (200 seconds/inch).

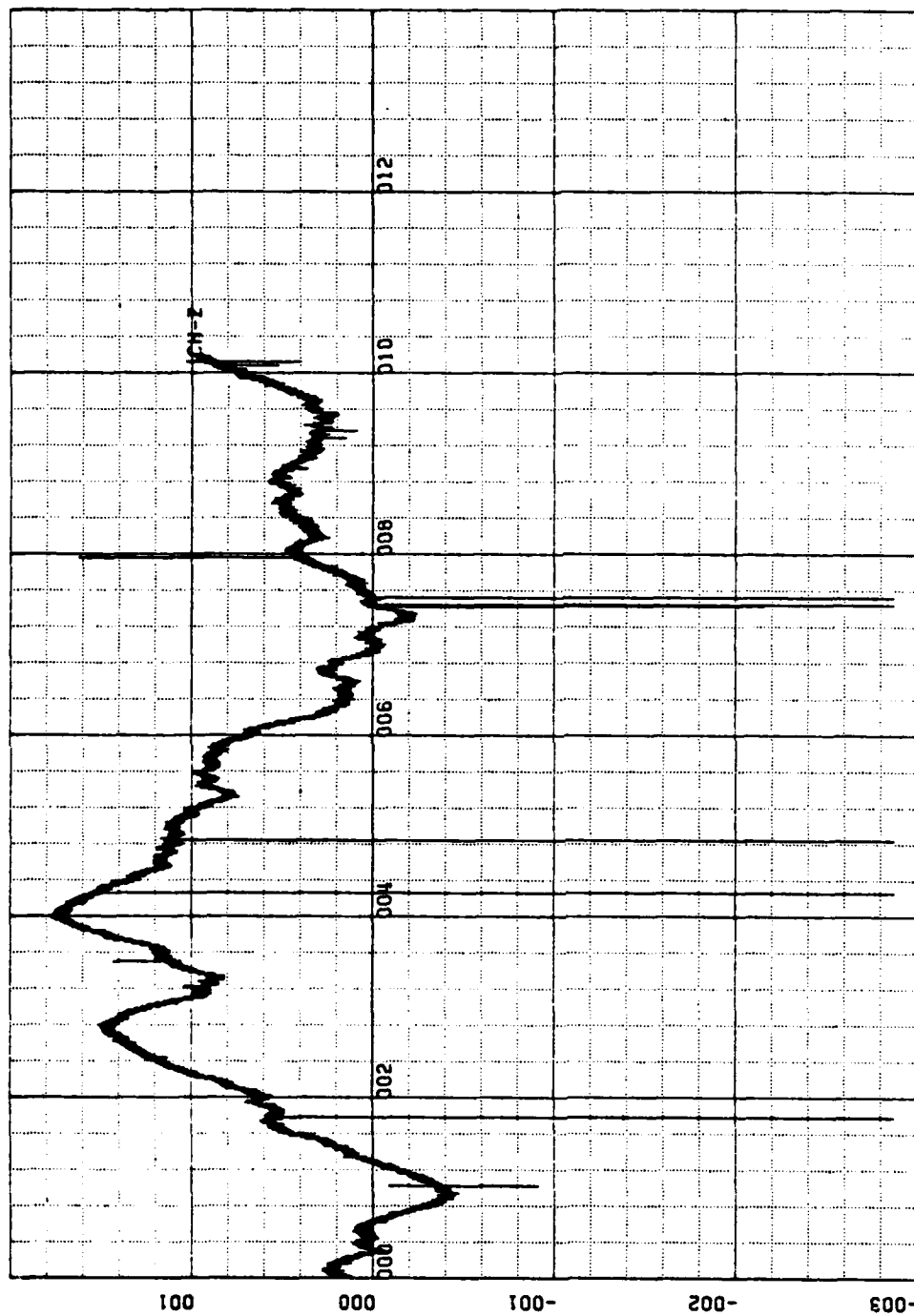


Figure 6.12 Z Coil Voltage

Chew's Ridge, 1545 - 1602 Local

Voltage (1 volt/inch) vs Time (200 seconds/inch).

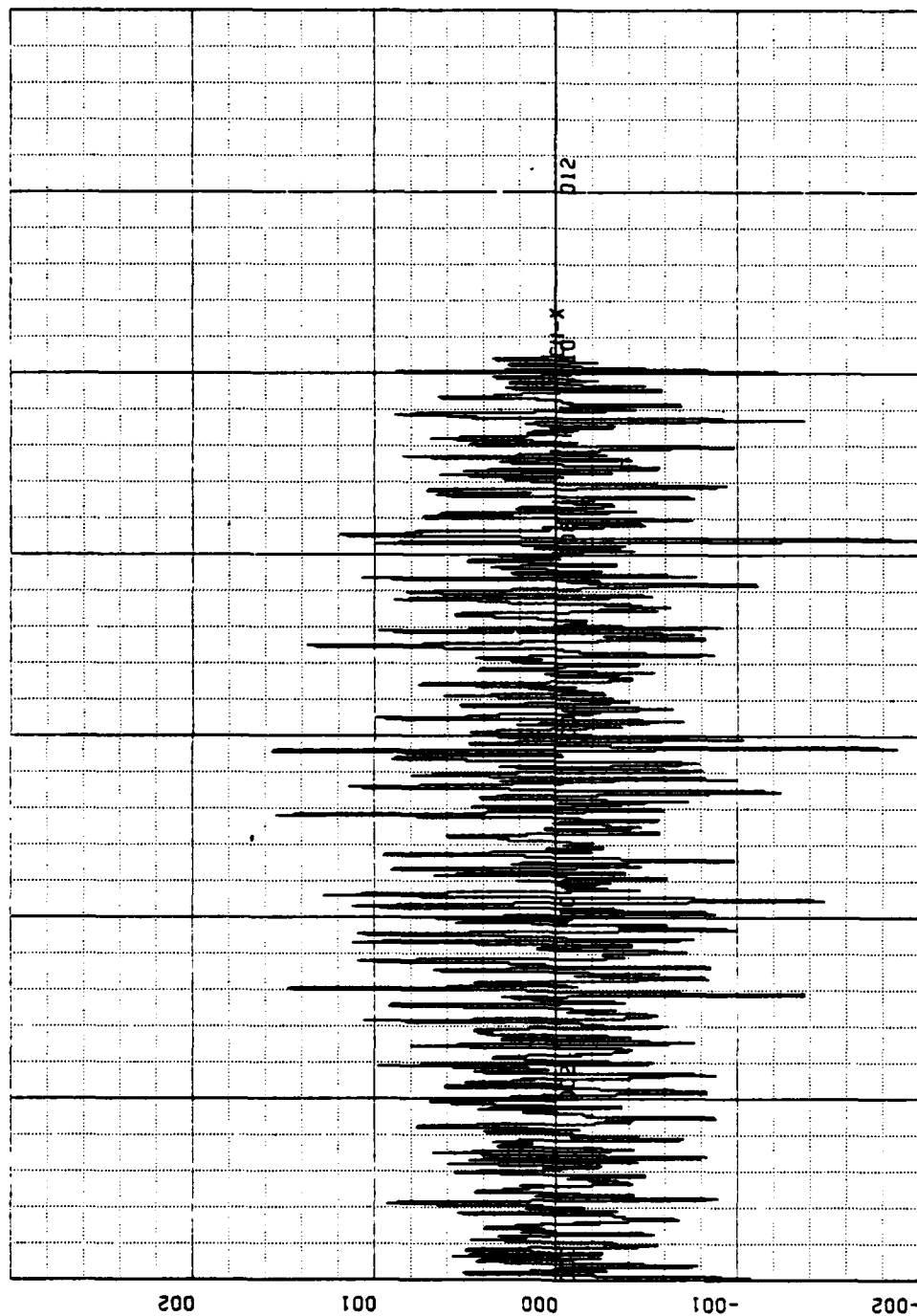


Figure 6.13 X Coil Voltage

La Mesa Village, 1610 - 1627 Local

Voltage (0.02 volts/inch) vs Time (200 seconds/inch).

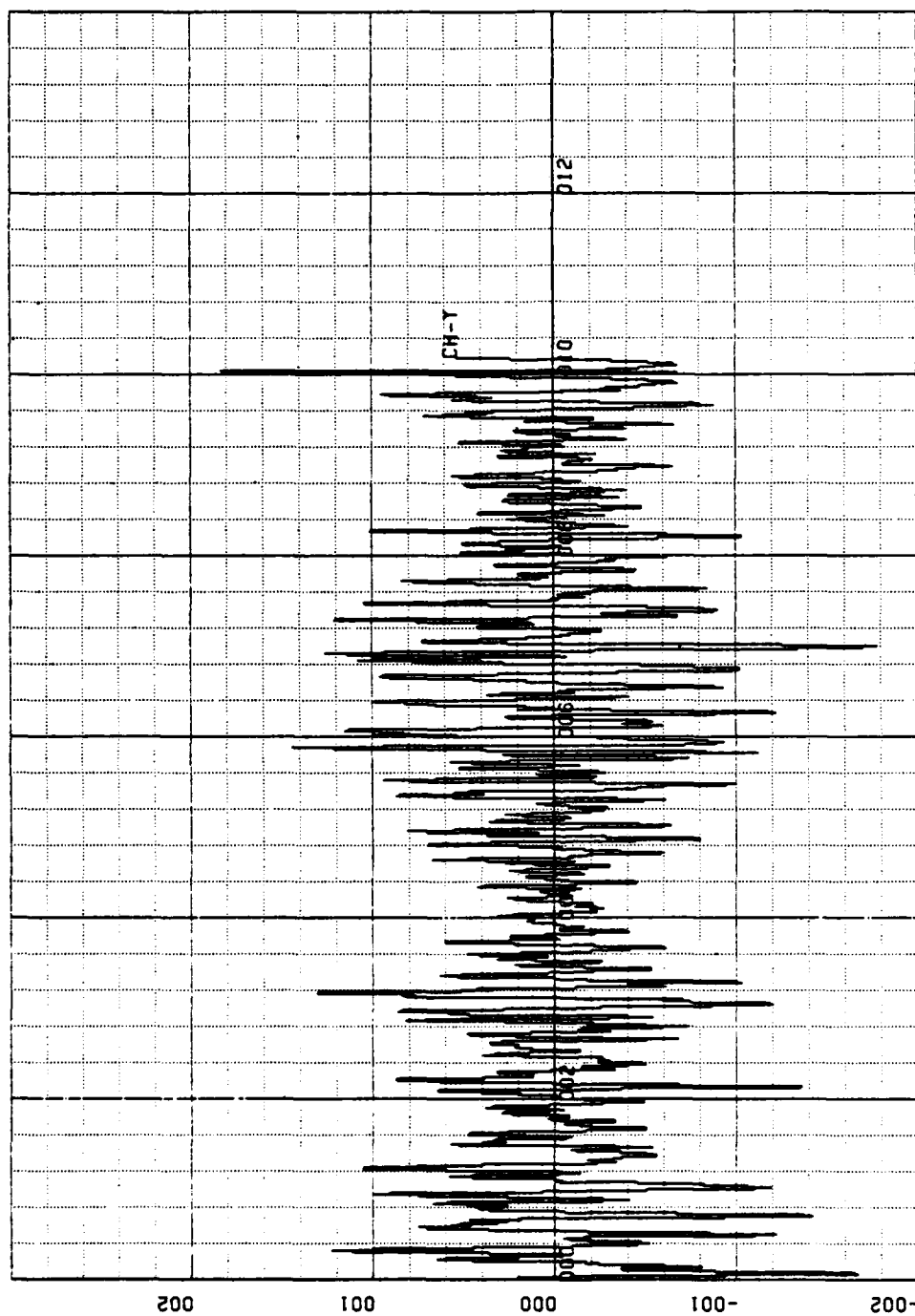


Figure 6.14 Y Coil Voltage

La Mesa Village, 1610 - 1627 Local

Voltage (0.01 volts/inch) vs Time (200 seconds/inch).

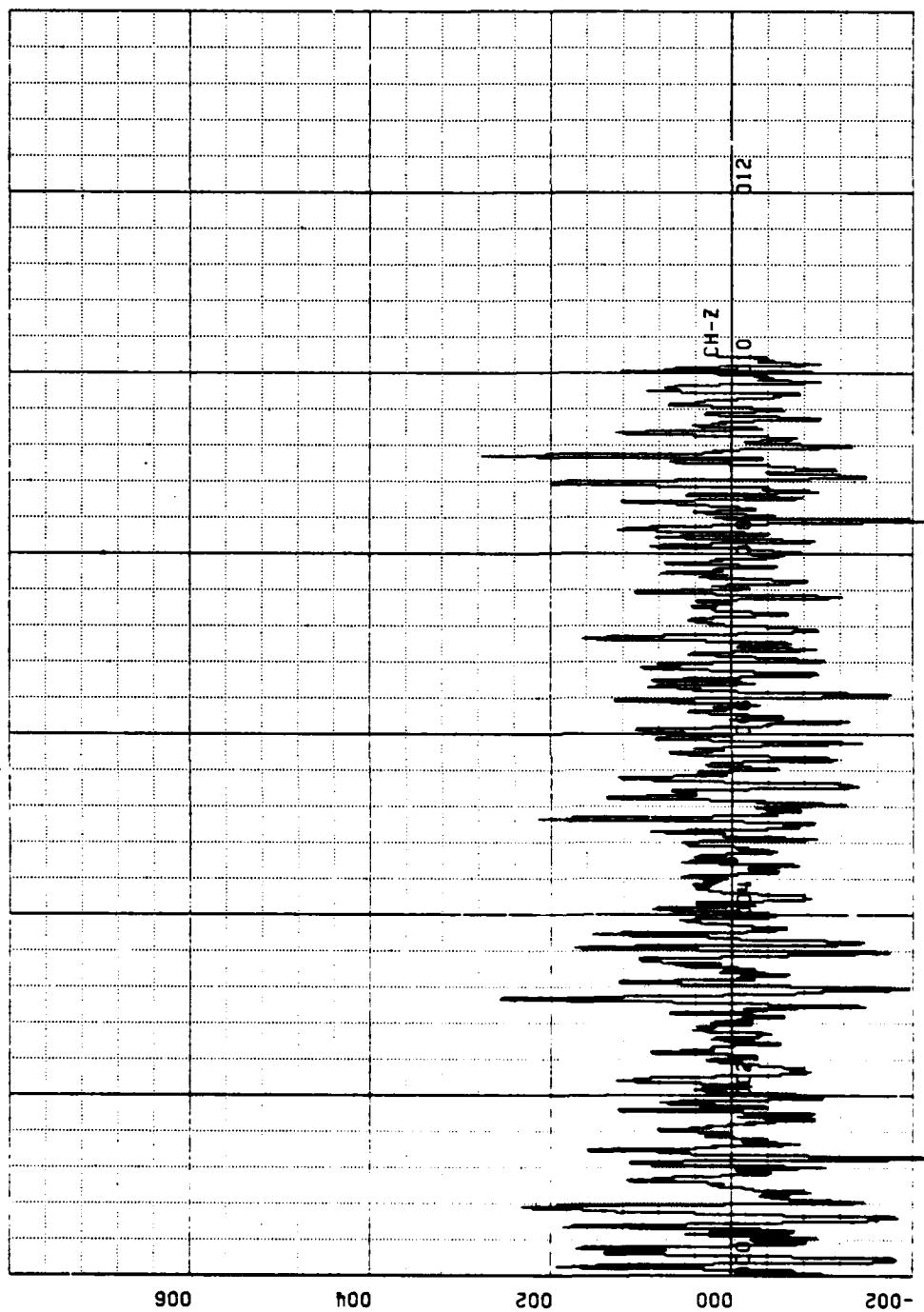


Figure 6.15 Z Coil Voltage

La Mesa Village, 1610 - 1627 Local

Voltage (0.02 volts/inch) vs Time (200 seconds/inch).

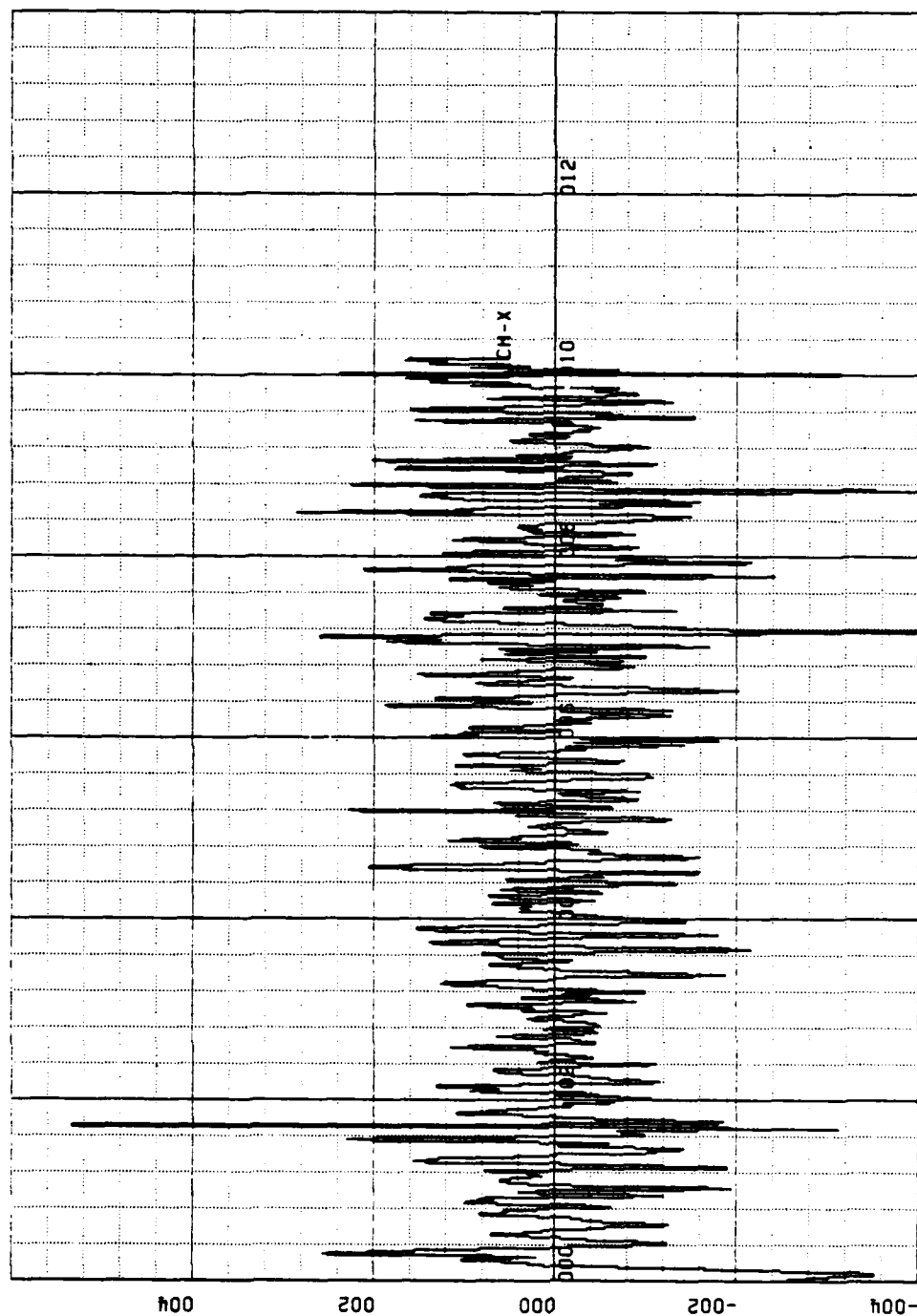


Figure 6.16 X Coil Voltage

Chew's Ridge, 1610 - 1627 Local

Voltage (0.02 volts/inch) vs Time (200 seconds/inch).

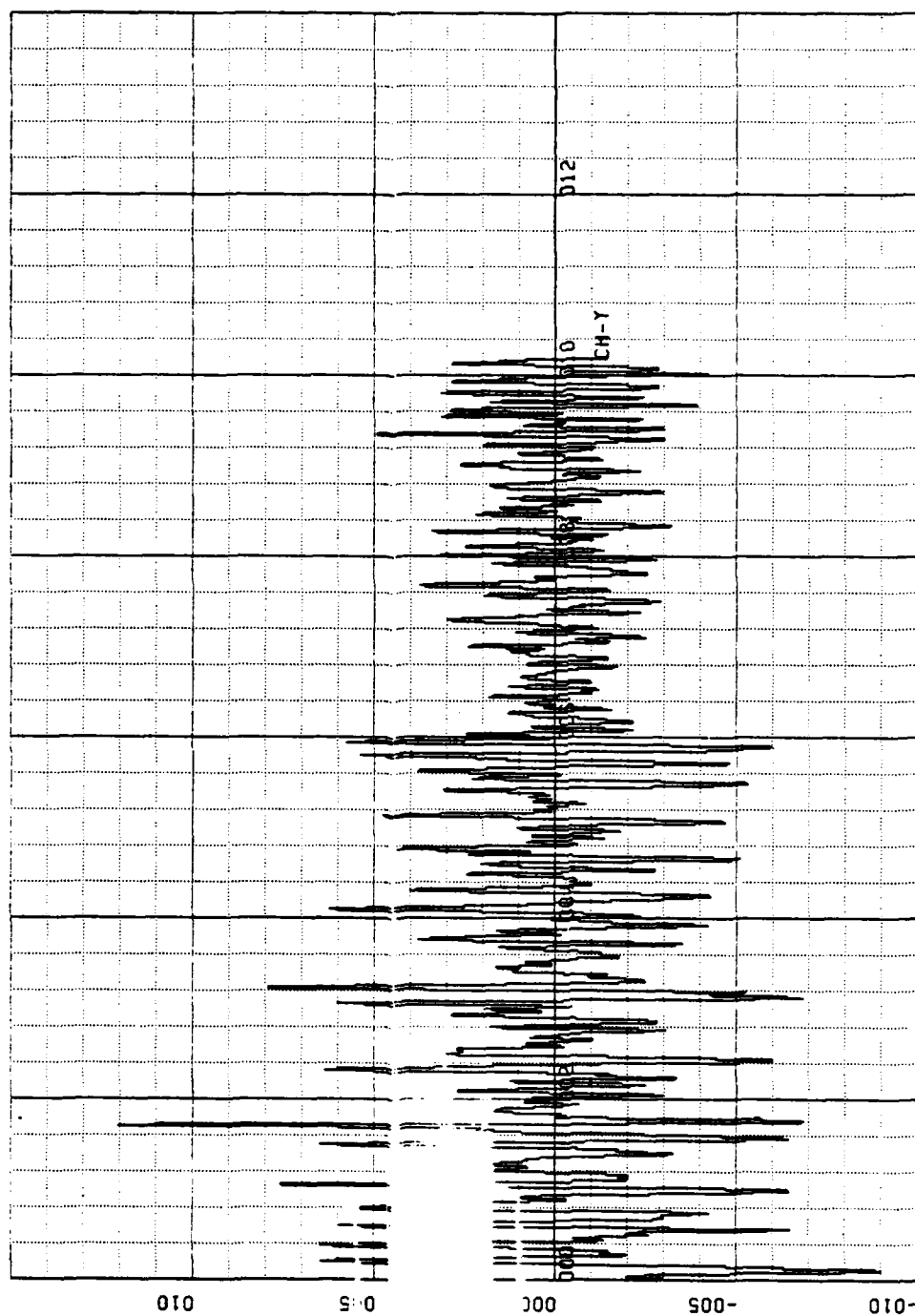


Figure 6.17 Y Coil Voltage

Chew's Ridge, 1610 - 1617 Local

Voltage (0.05 volts/inch) vs Time (200 seconds/inch).

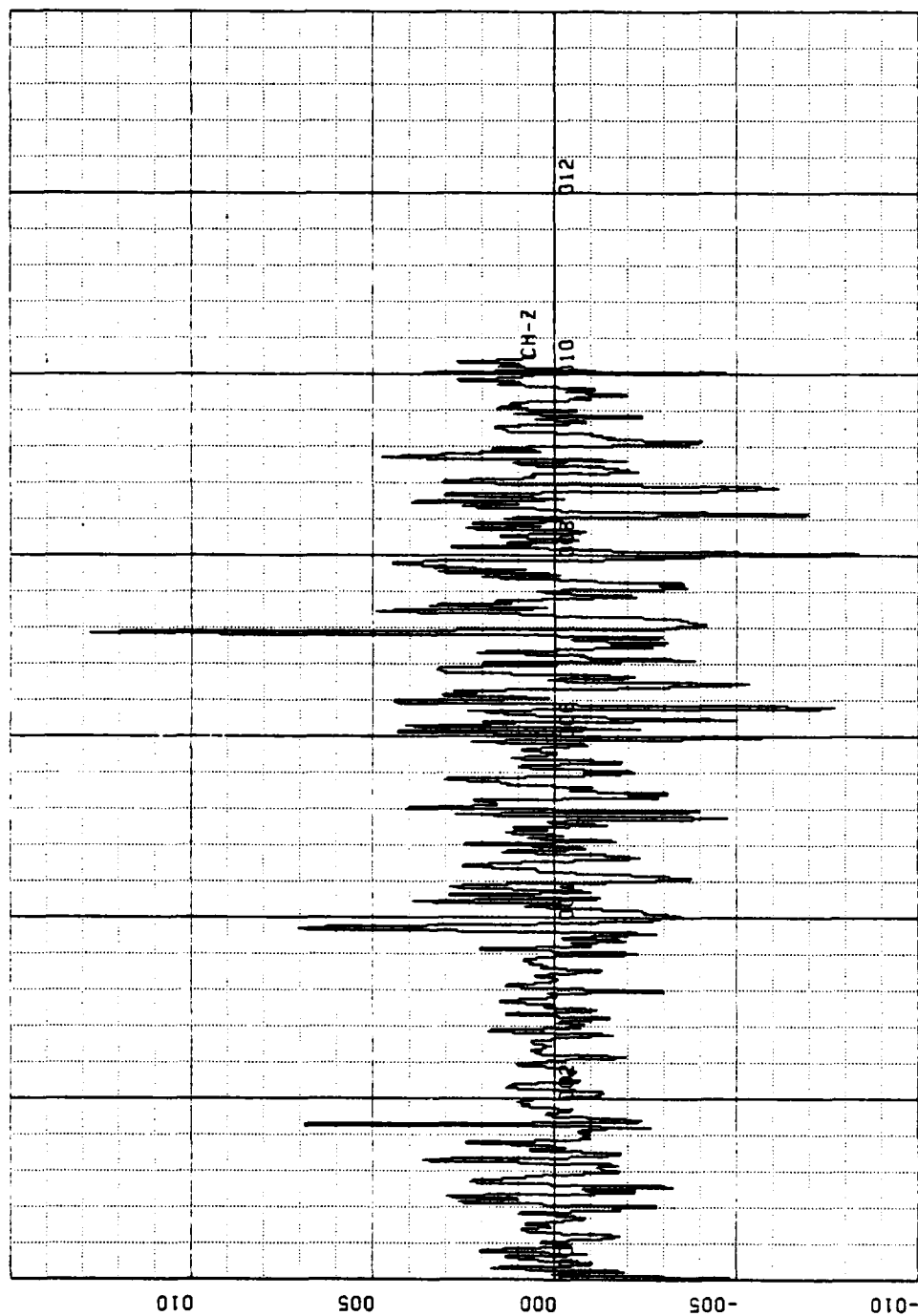


Figure 6.18 Z Coil Voltage

Chew's Ridge, 1610 - 1627 Local

Voltage (0.05 volts/inch) vs Time (200 seconds/inch).

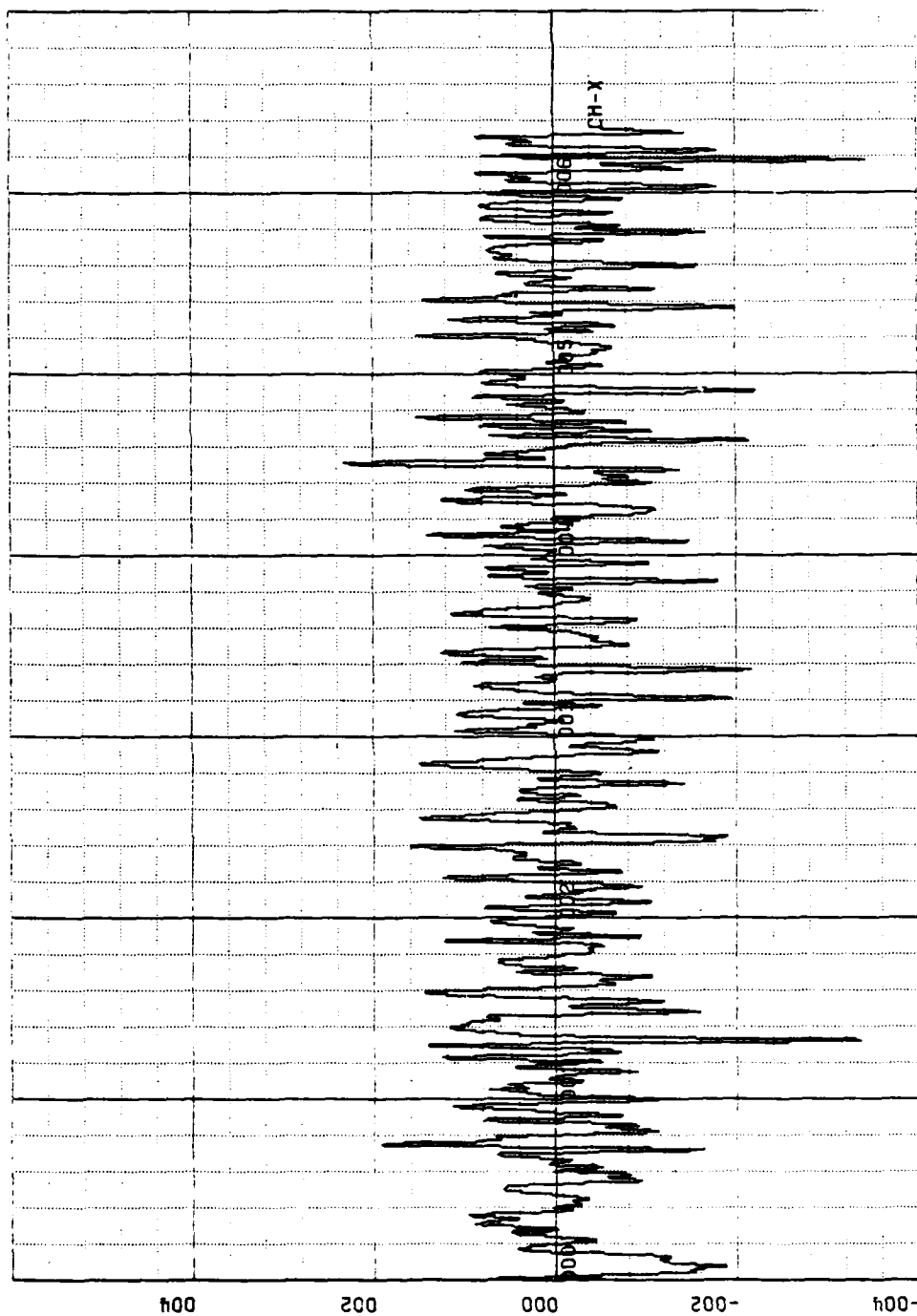


Figure 6.19 X Coil Voltage

La Mesa Village, 1802 - 1812 Local

Voltage (0.02 volts/inch) vs Time (100 seconds/inch).

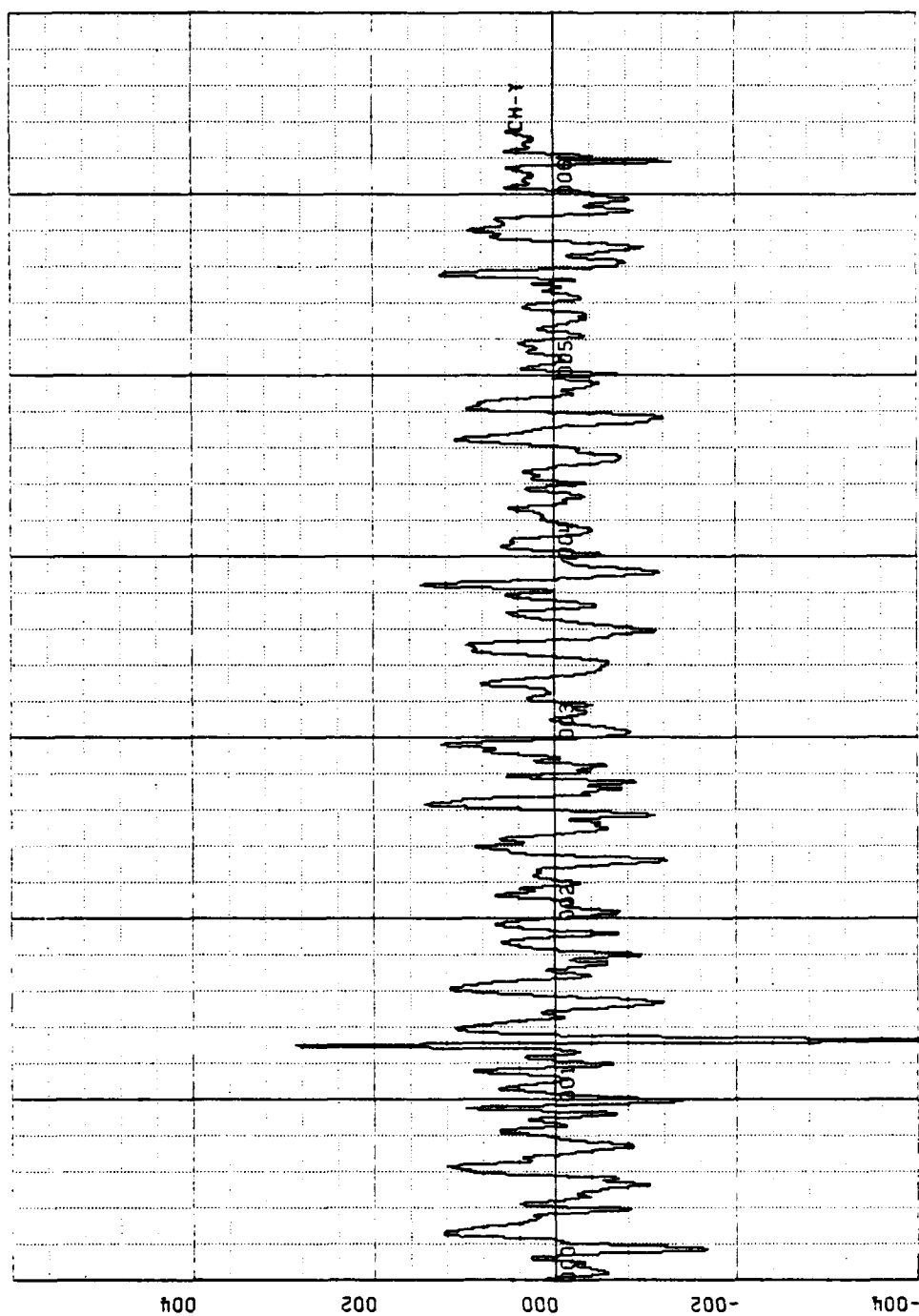


Figure 6.20 Y Coil Voltage

La Mesa Village, 1802 - 1812 Local

Voltage (0.02 volts/inch) vs Time (100 seconds/inch).

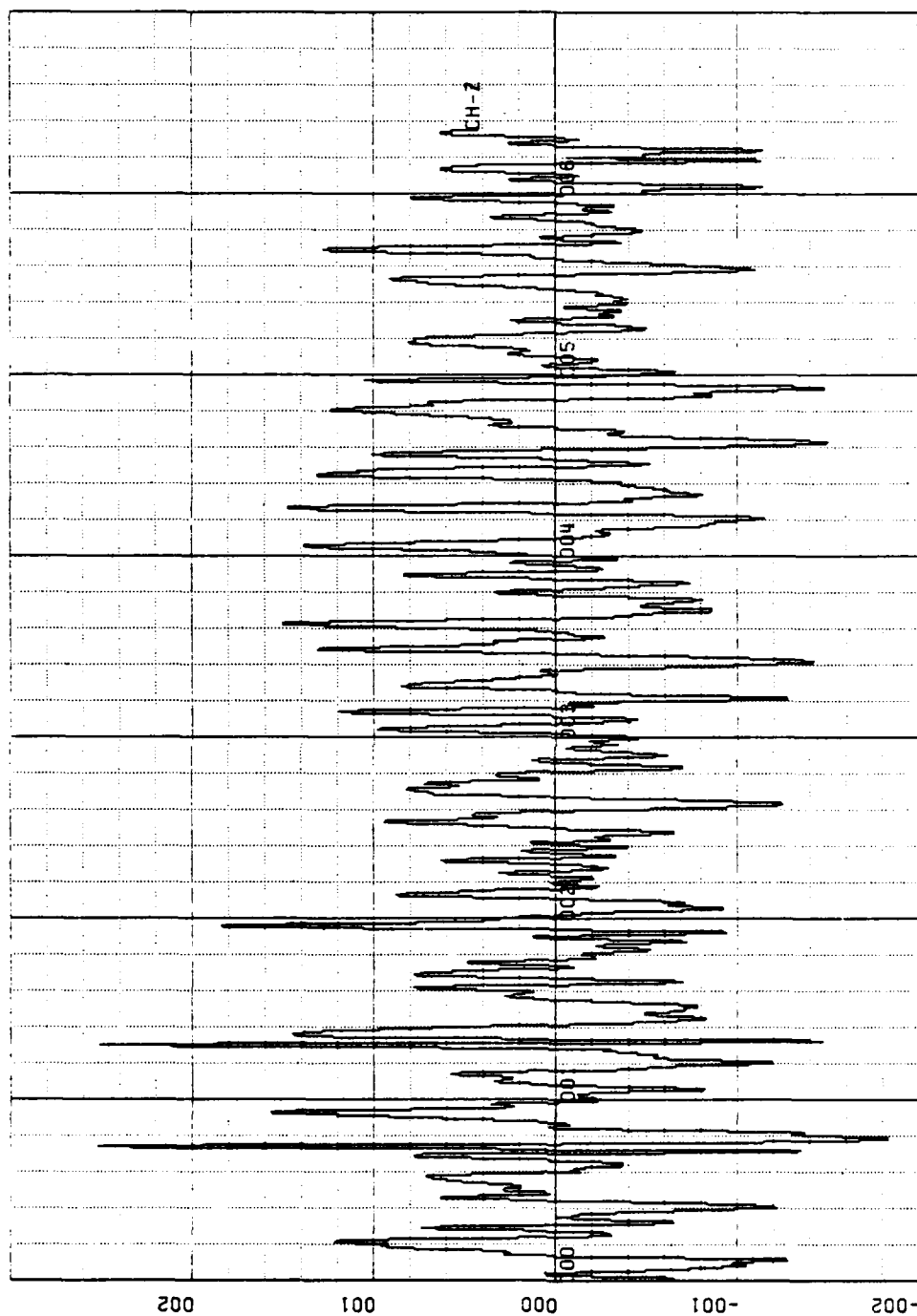


Figure 6 1 Z Coil Voltage

La Mesa Village, 1802 - 1812 Local

Voltage (0.01 volts/inch) vs Time (100 seconds/inch).

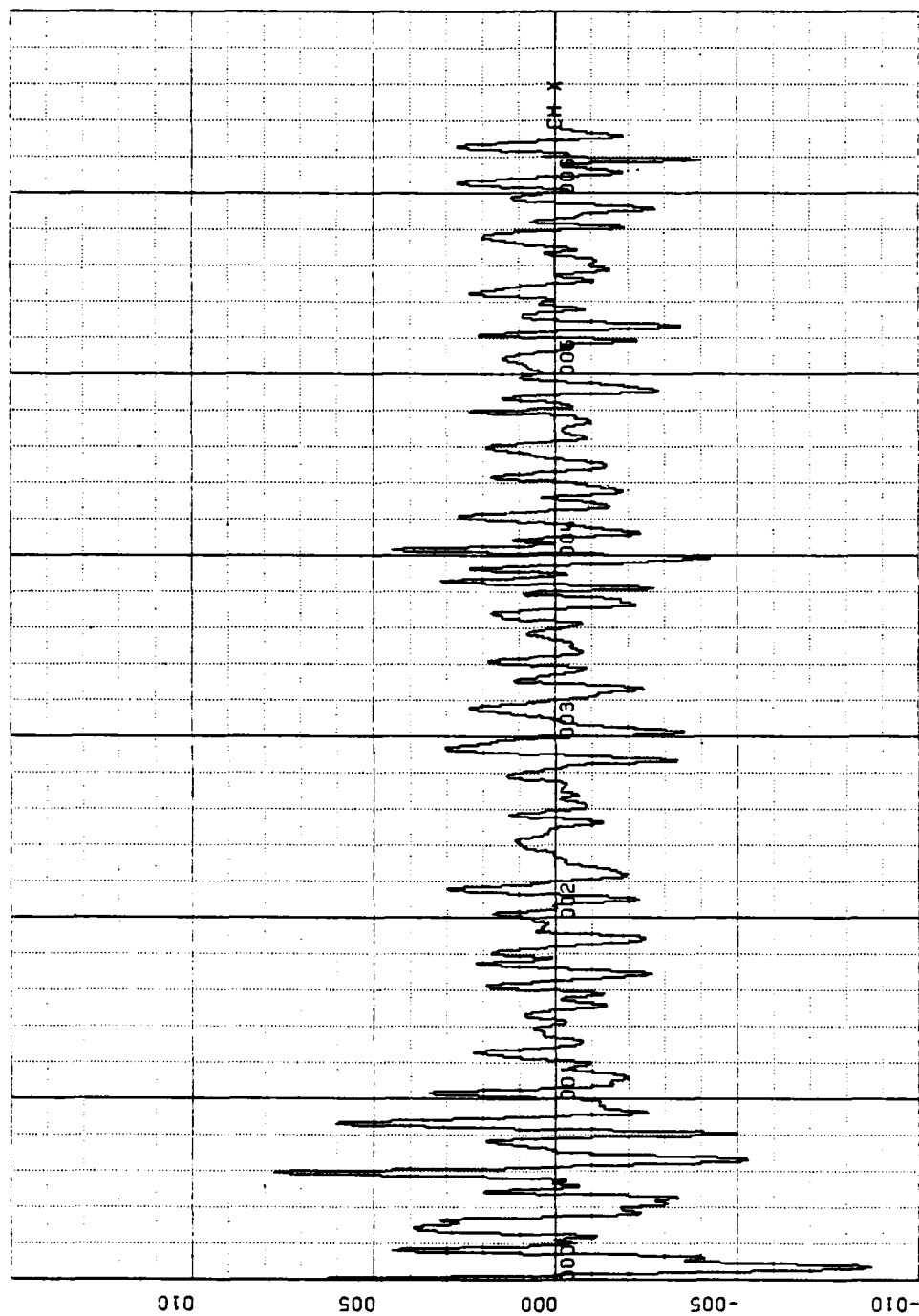


Figure 6.22 X Coil Voltage

Chew's Ridge, 1802 - 1812 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

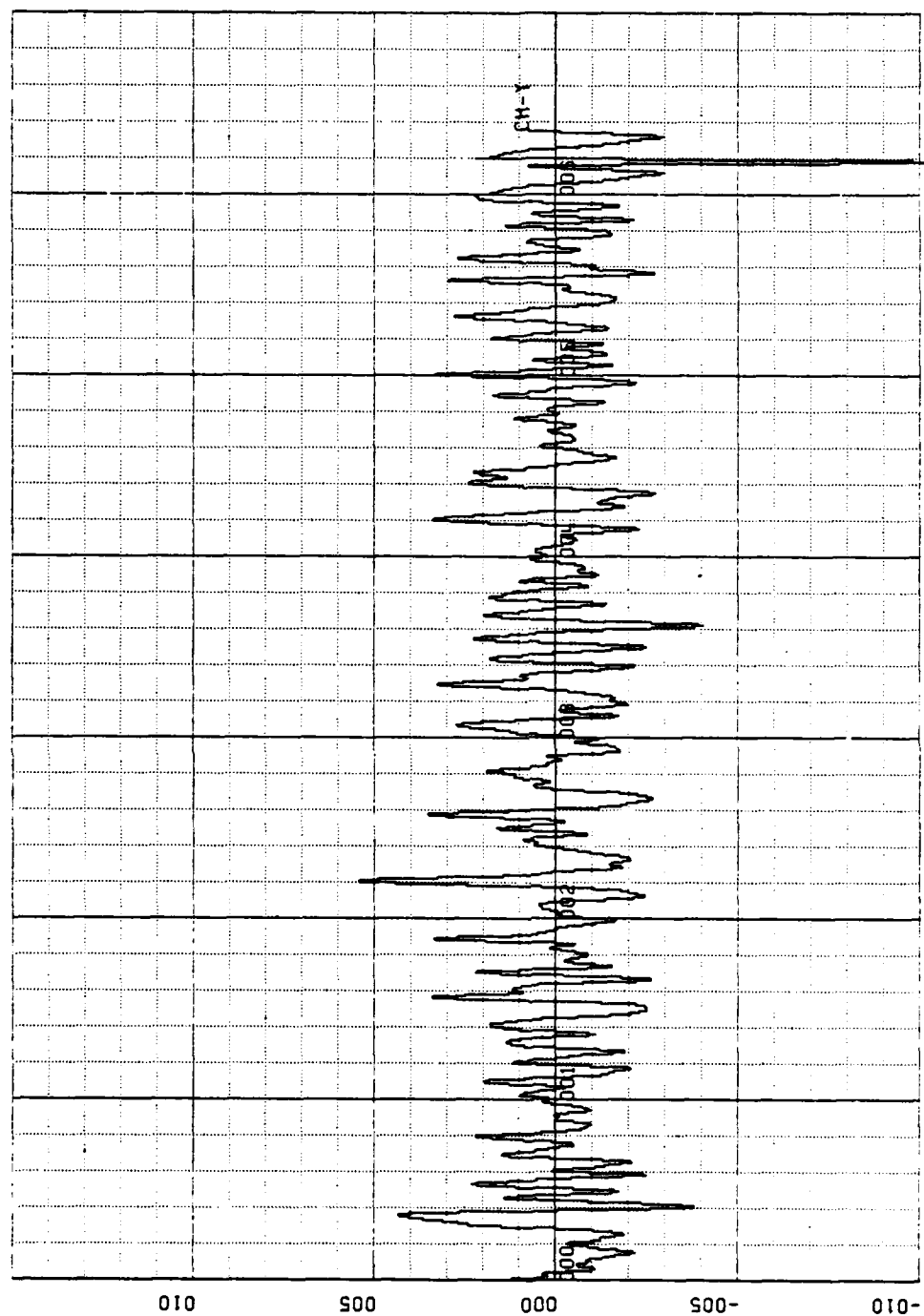


Figure 6.23 Y Coil Voltage

Chew's Ridge, 1802 - 1812 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

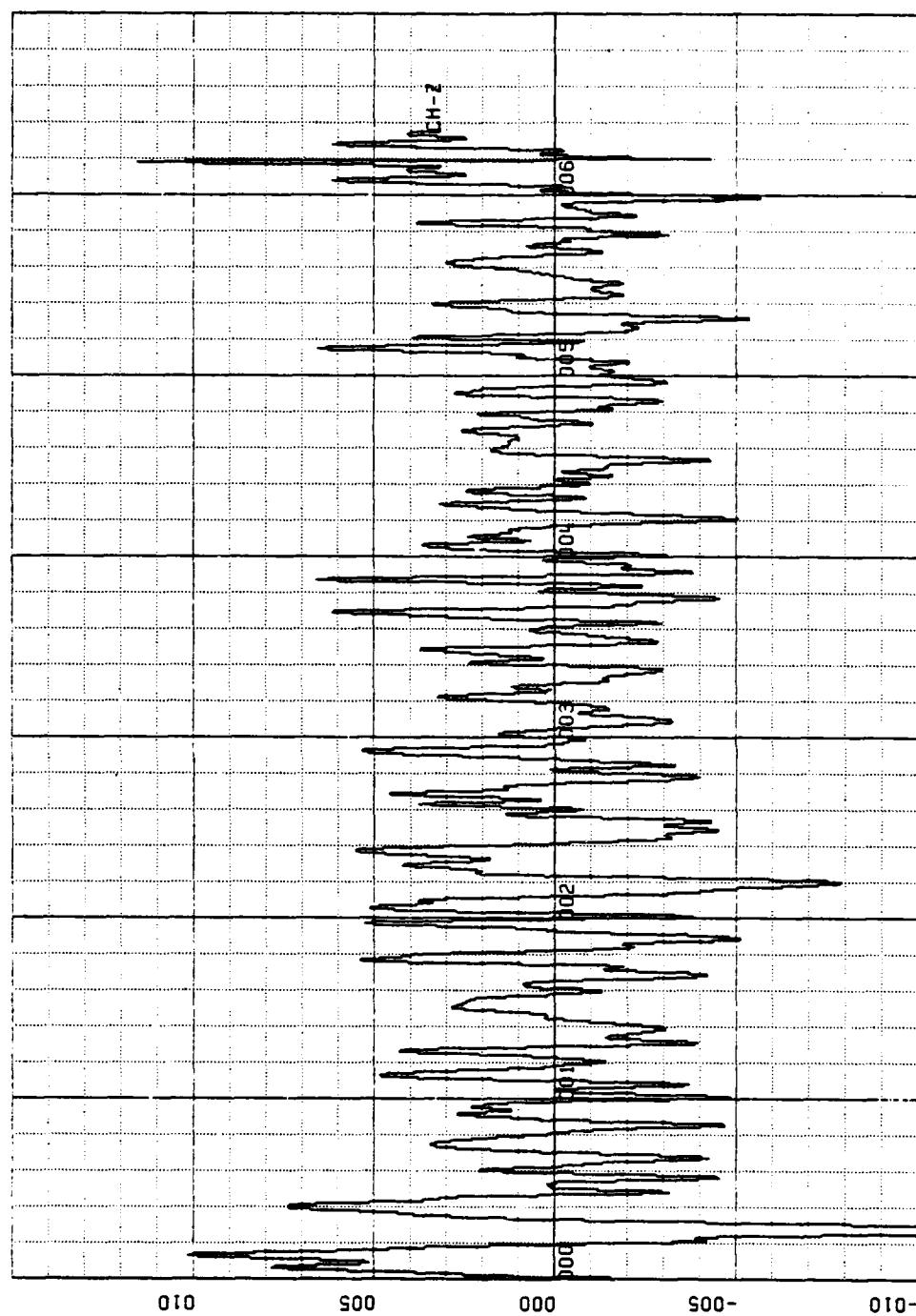


Figure 6.24 Z Coil Voltage

Chew's Ridge, 1802 - 1812 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

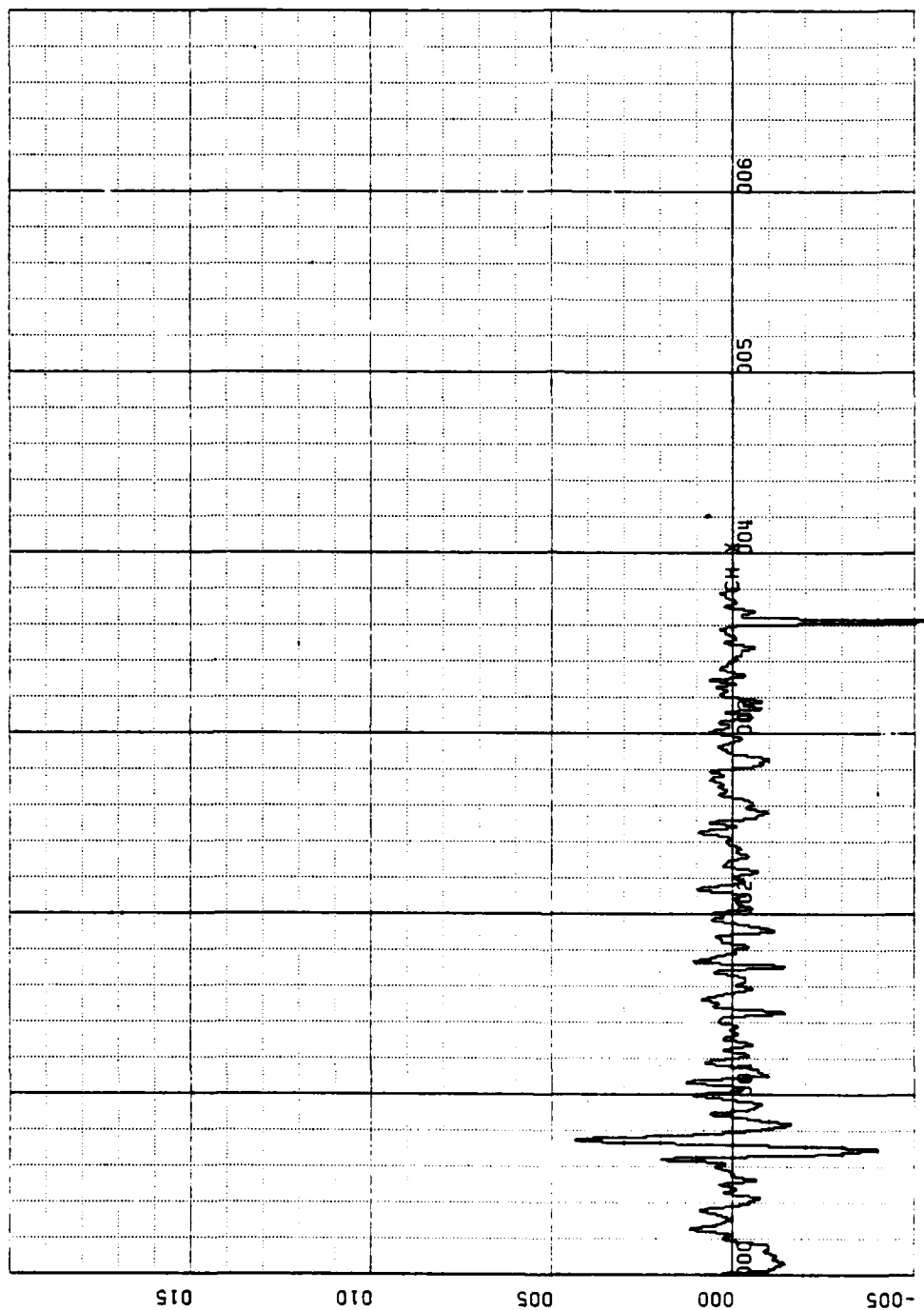


Figure 6.25 X Coil Voltage

La Mesa Village, 1834 - 1840 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

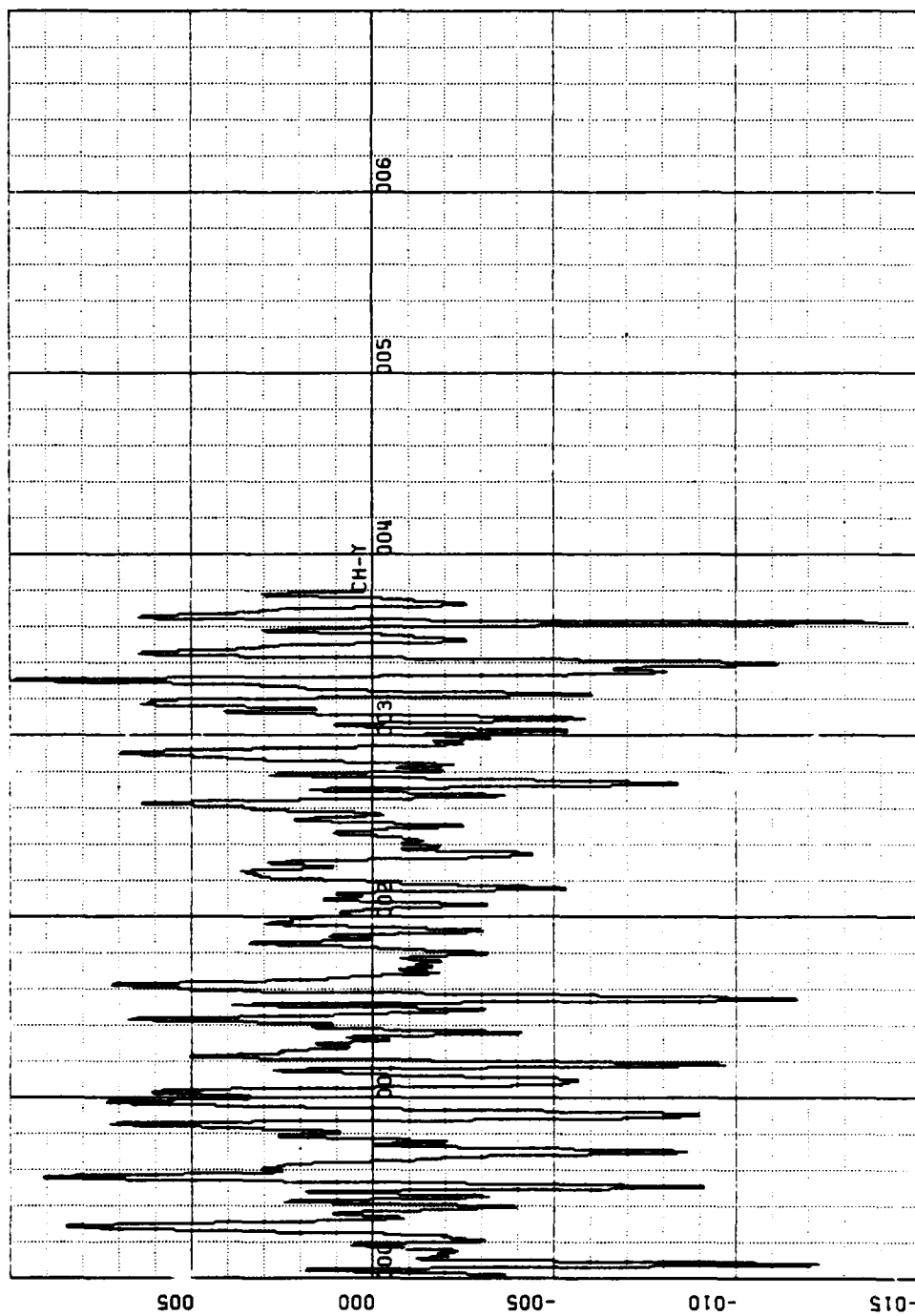


Figure 6.26 Y Coil Voltage

La Mesa Village, 1834 - 1840 Local

Voltage (0.005 volts/inch) vs Time (100 seconds/inch).

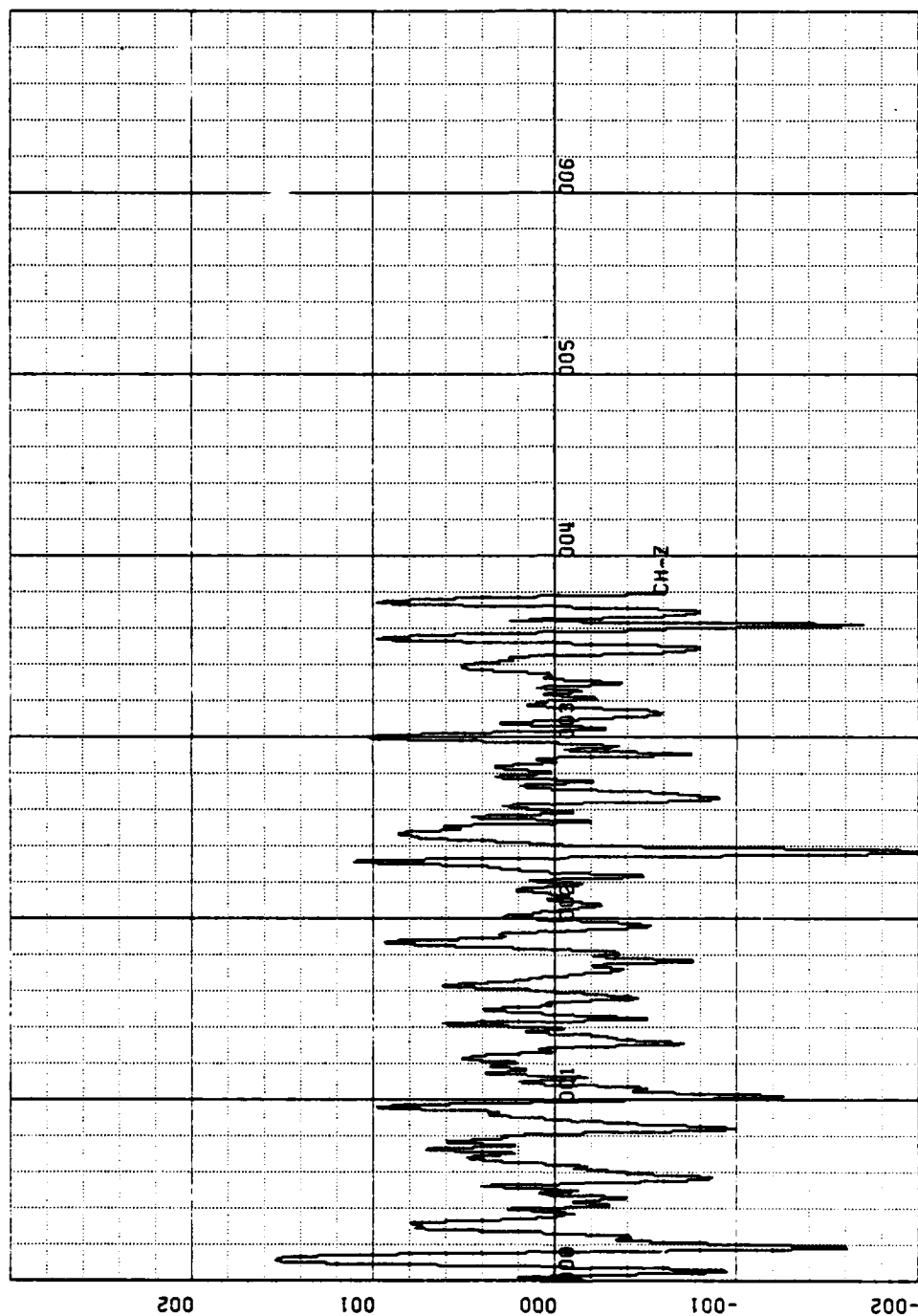


Figure 6.27 Z Coil Voltage

La Mesa Village, 1834 - 1840 Local

Voltage (0.01 volts/inch) vs Time (100 seconds/inch).

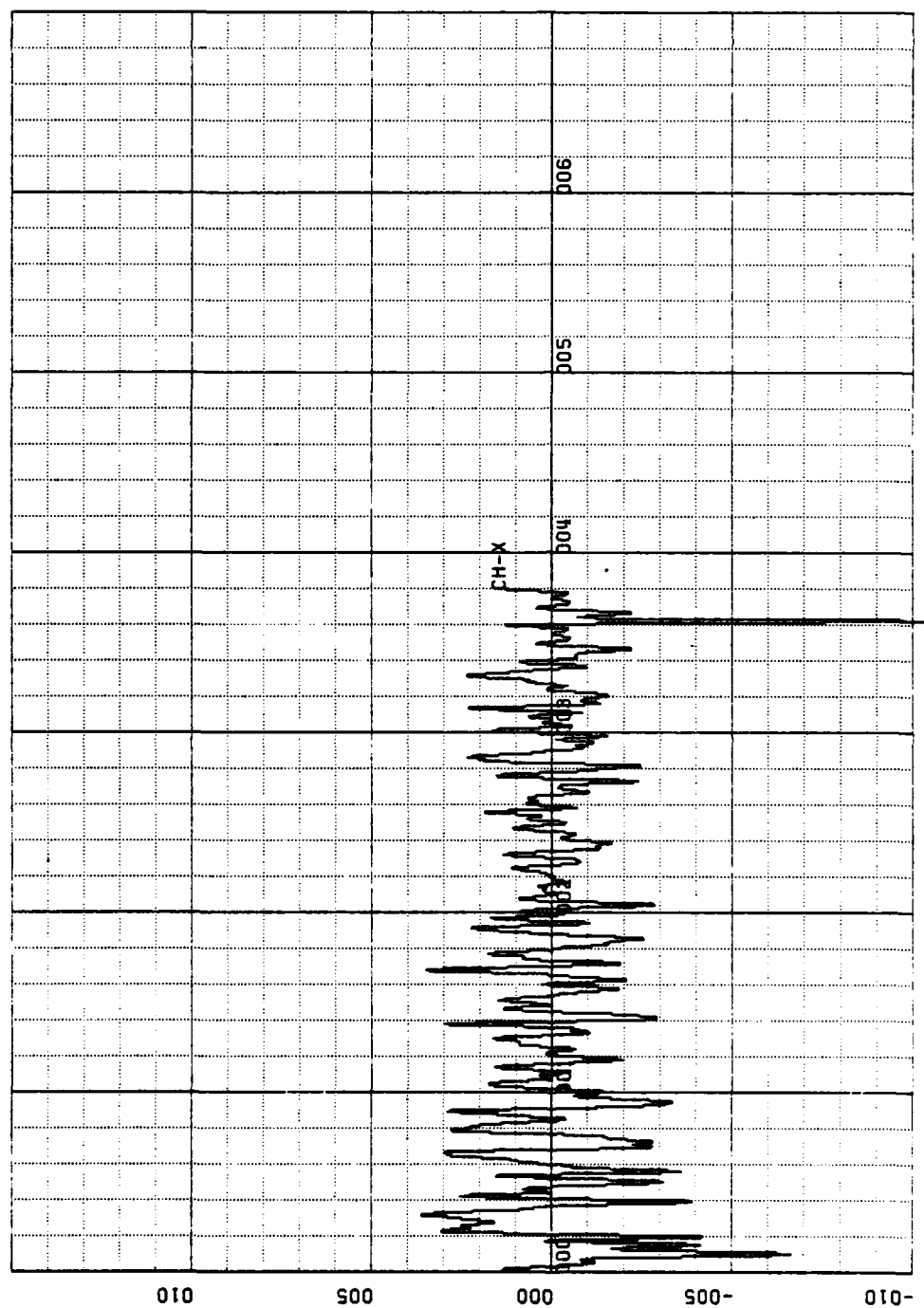


Figure 6.28 X Coil Voltage

Chew's Ridge, 1834 - 1840 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

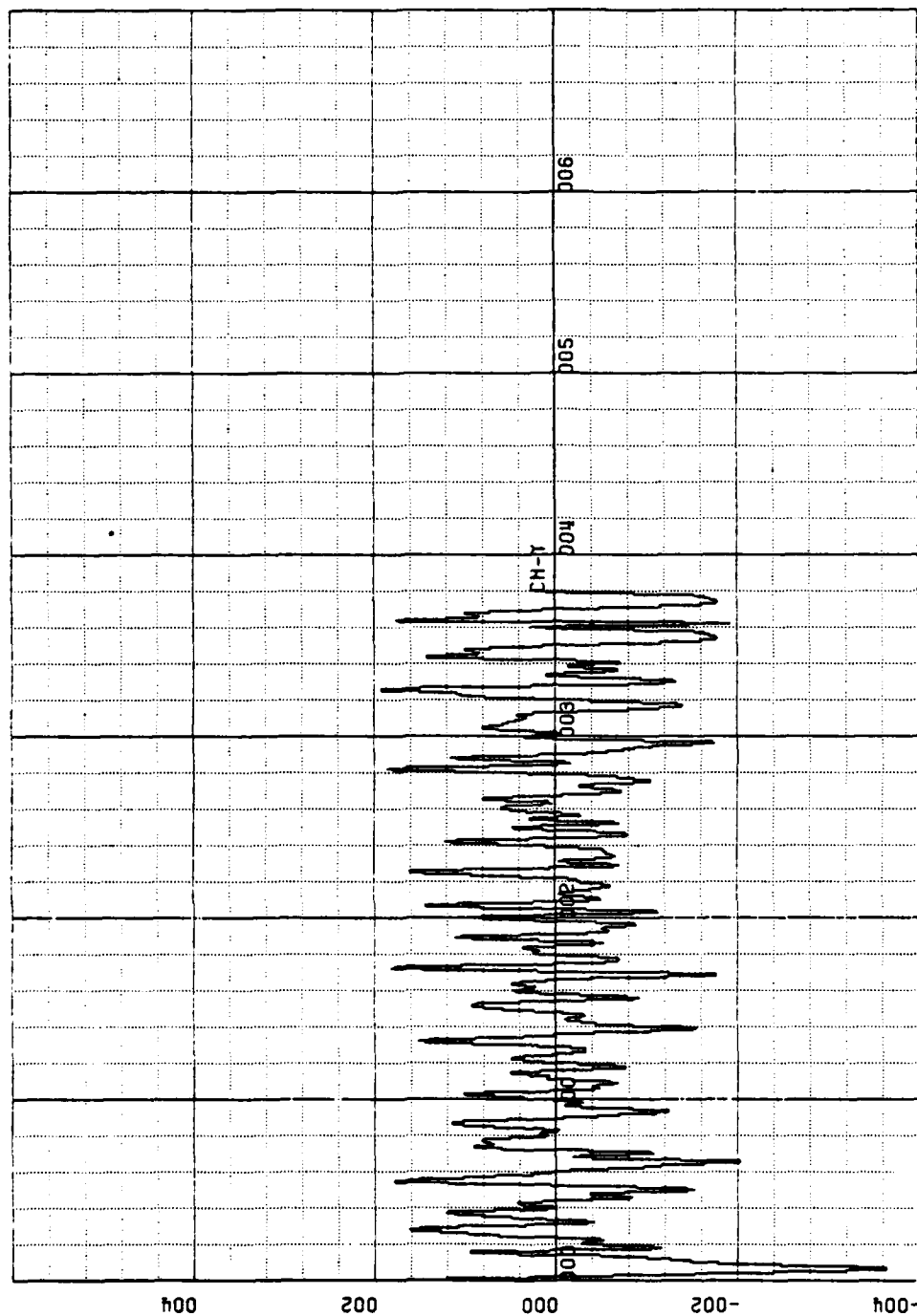


Figure 6.29 Y Coil Voltage

Chew's Ridge, 1834 - 1840 Local

Voltage (0.02 volts/inch) vs Time (100 seconds/inch).

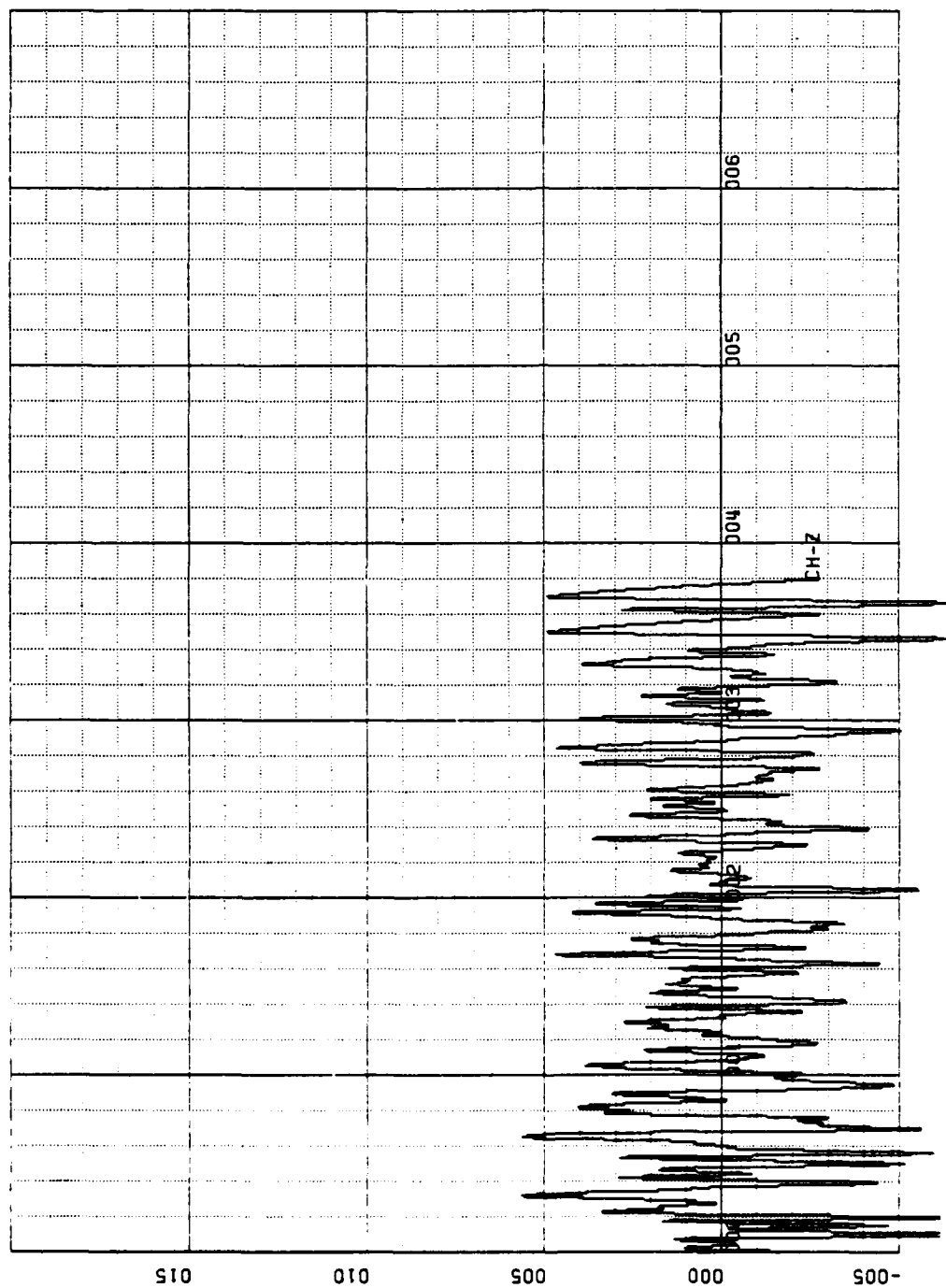


Figure 6.30 Z Coil Voltage

Chew's Ridge, 1834 - 1840 Local

Voltage (0.05 volts/inch) vs Time (100 seconds/inch).

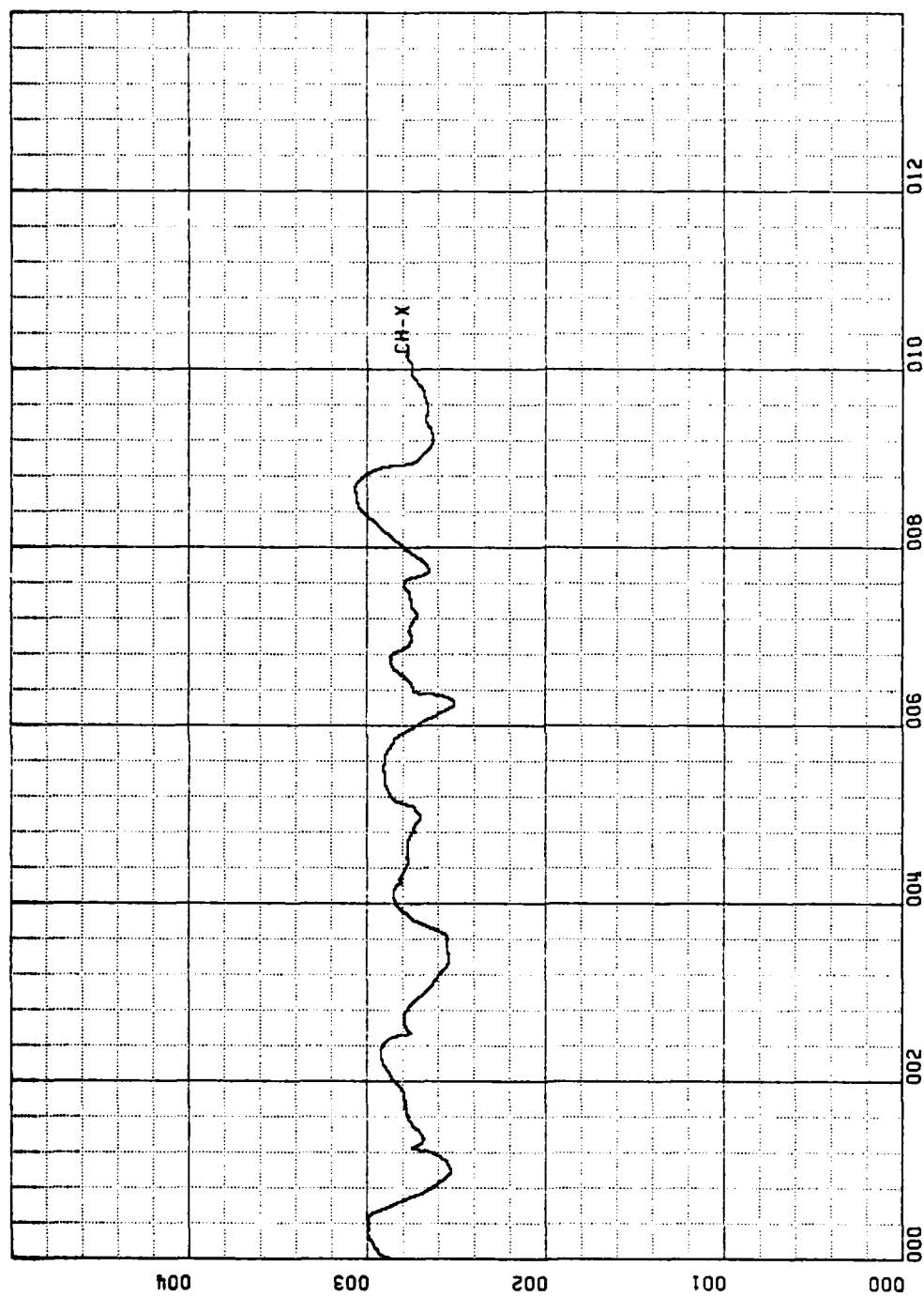


Figure 6.31 X Coil Magnetic Field

Chew's Ridge, 1545 - 1602 Local

Field (10 nanoteslas/inch) vs Time (200 seconds/inch).

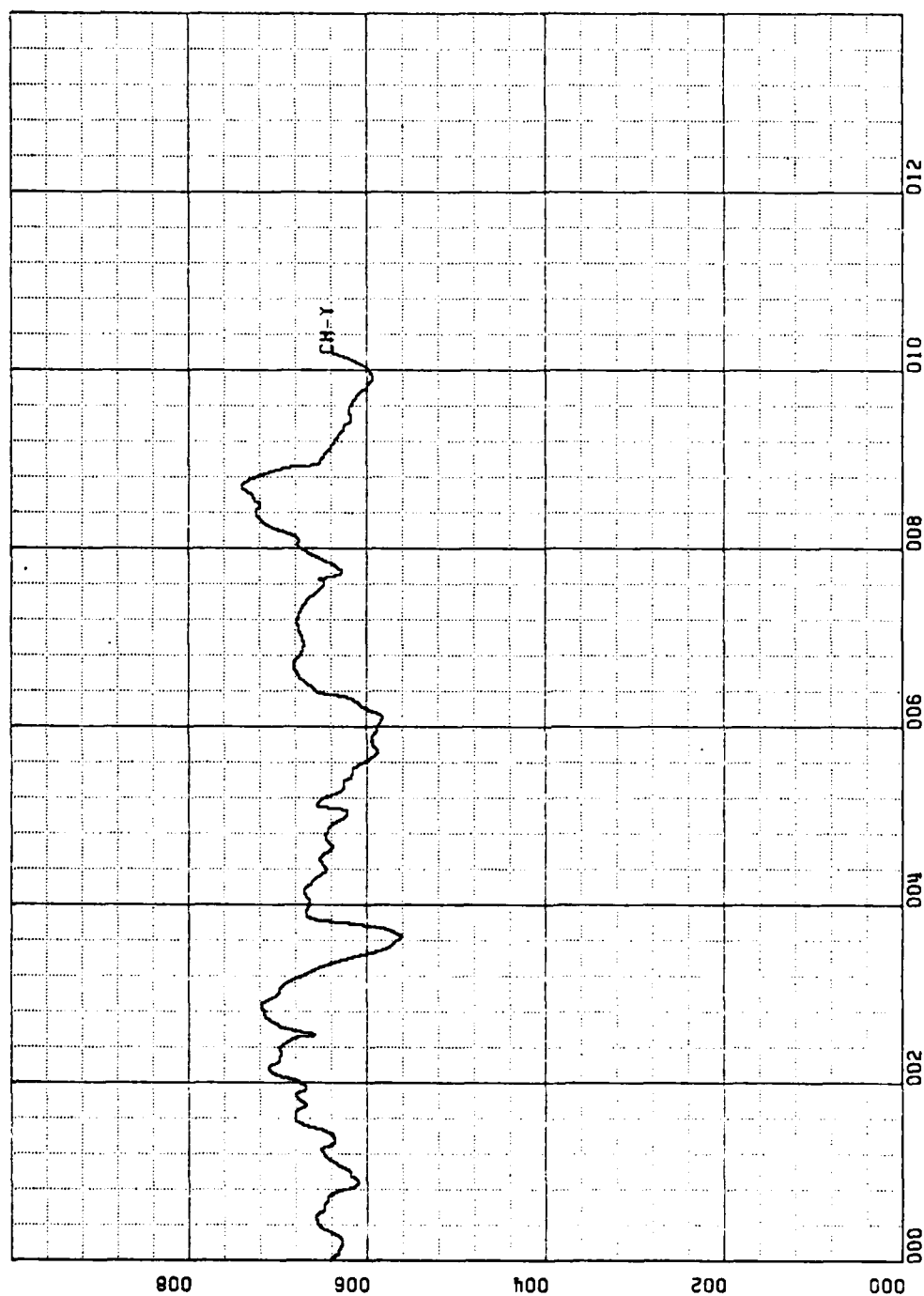


Figure 6.32 Y Coil Magnetic Field

Chew's Ridge, 1545 - 1602 Local

Field (20 nanoteslas/inch) vs Time (200 seconds/inch).

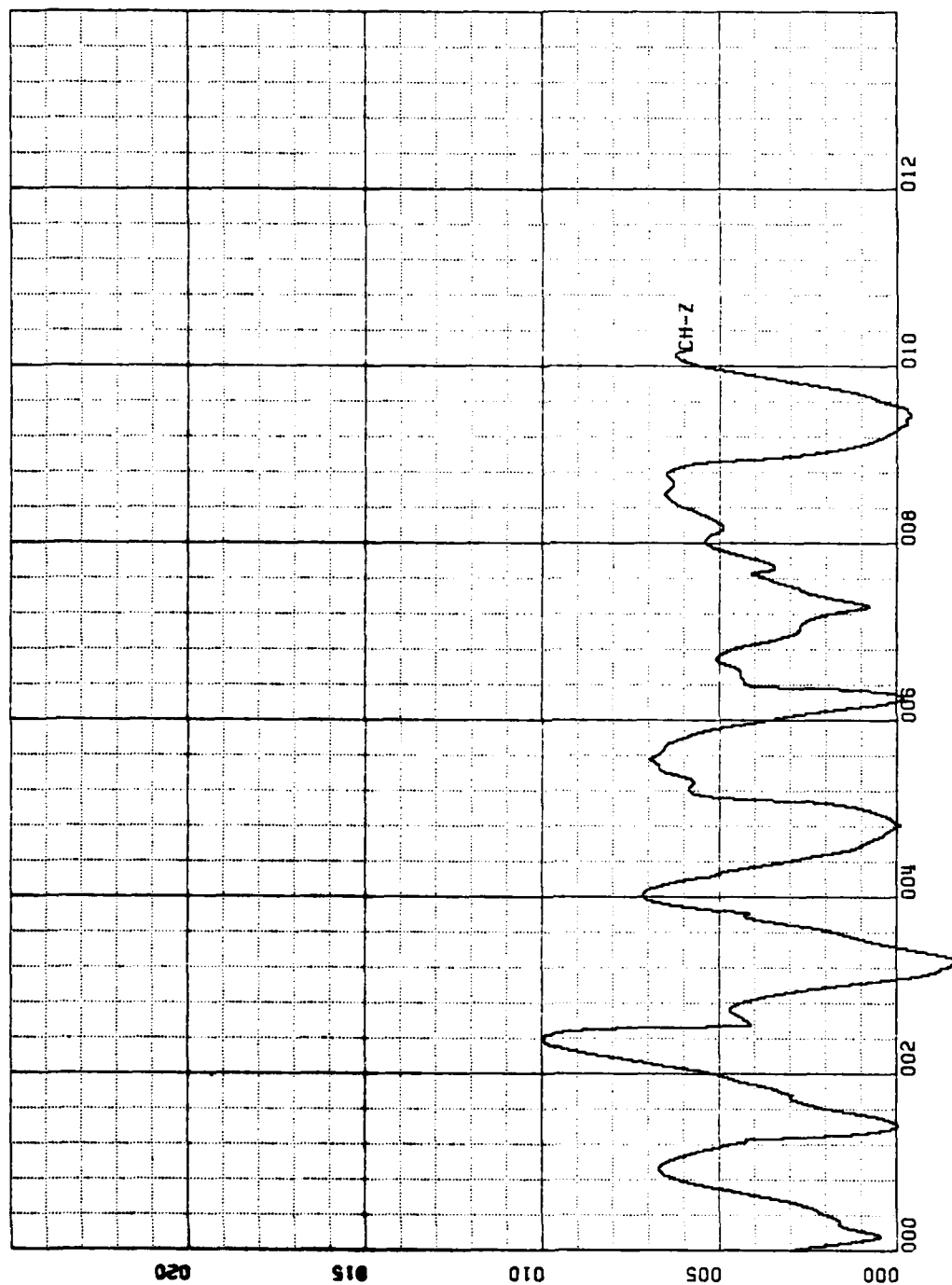


Figure 6.33 X Coil Magnetic Field

Chew's Ridge, 1545 - 1602 Local

Field (5 nanoteslas/inch) vs Time (200 seconds/inch).

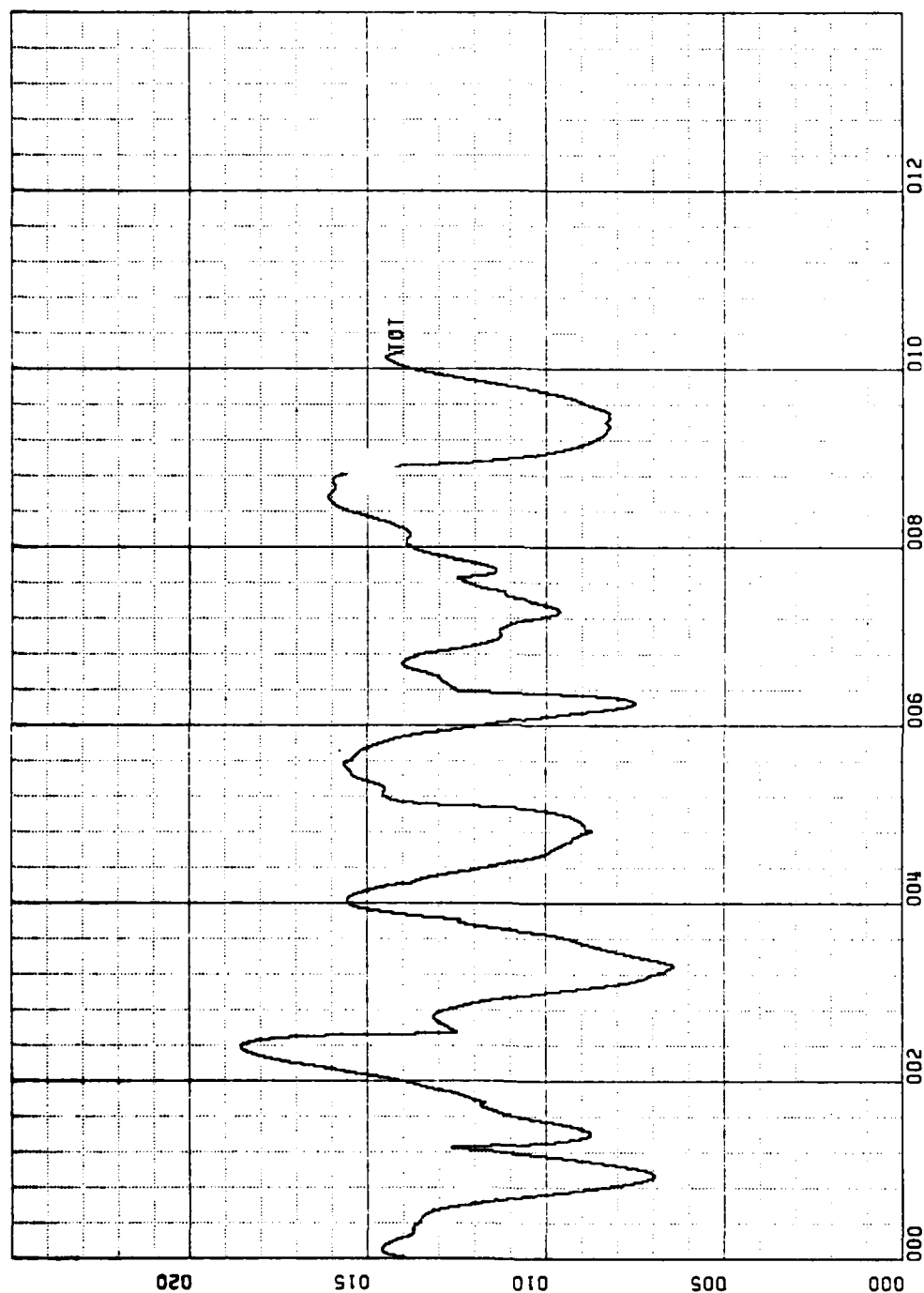


Figure 6.34 Total Magnetic Field

Chew's Ridge, 1545 - 1602 Local

Field (5 nanoteslas/inch) vs Time (200 seconds/inch).

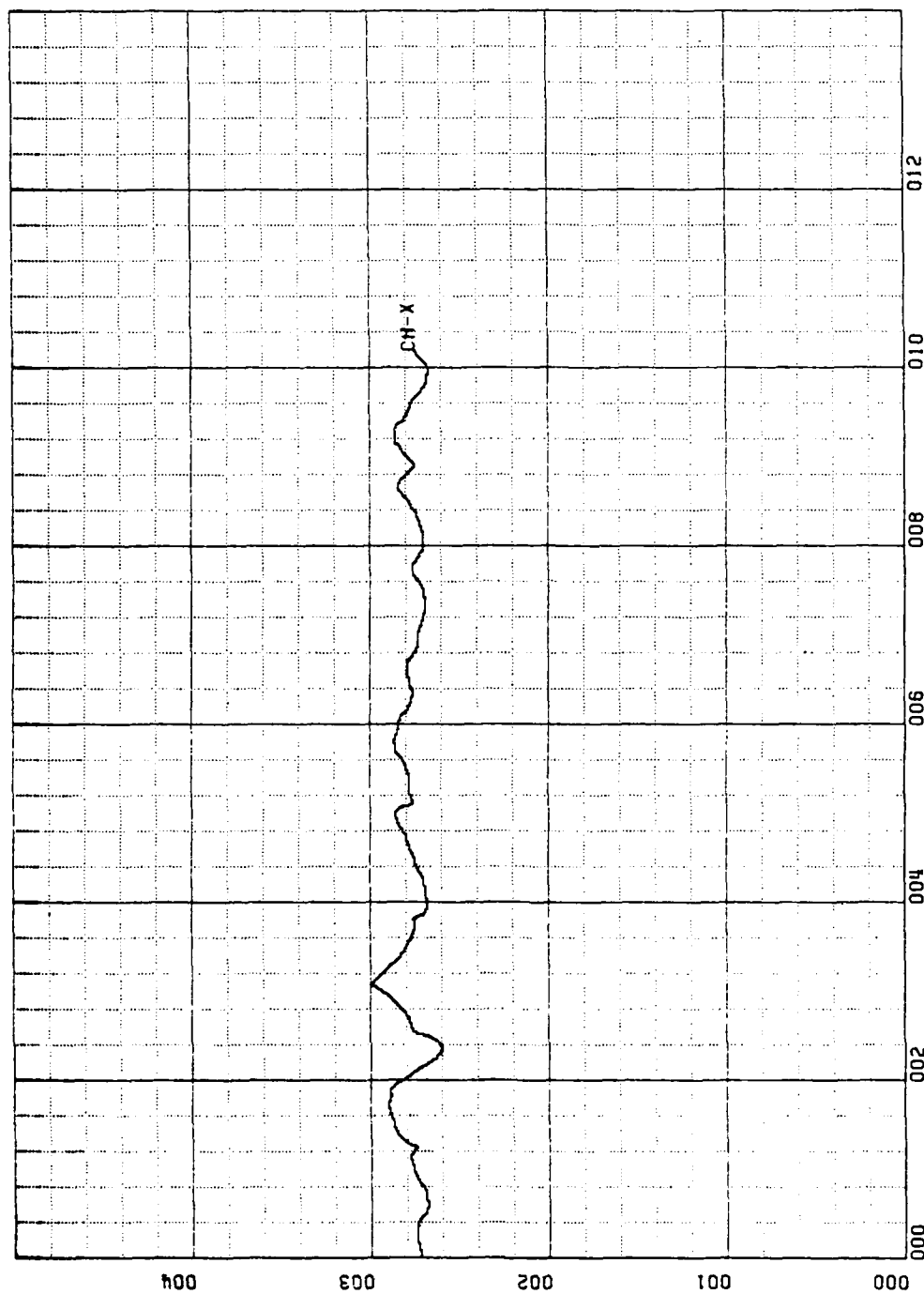


Figure 6.35 X Coil Magnetic Field

Chew's Ridge, 1310 - 1317 Local

Field (10 nanoteslas/inch) vs Time (200 seconds/inch).

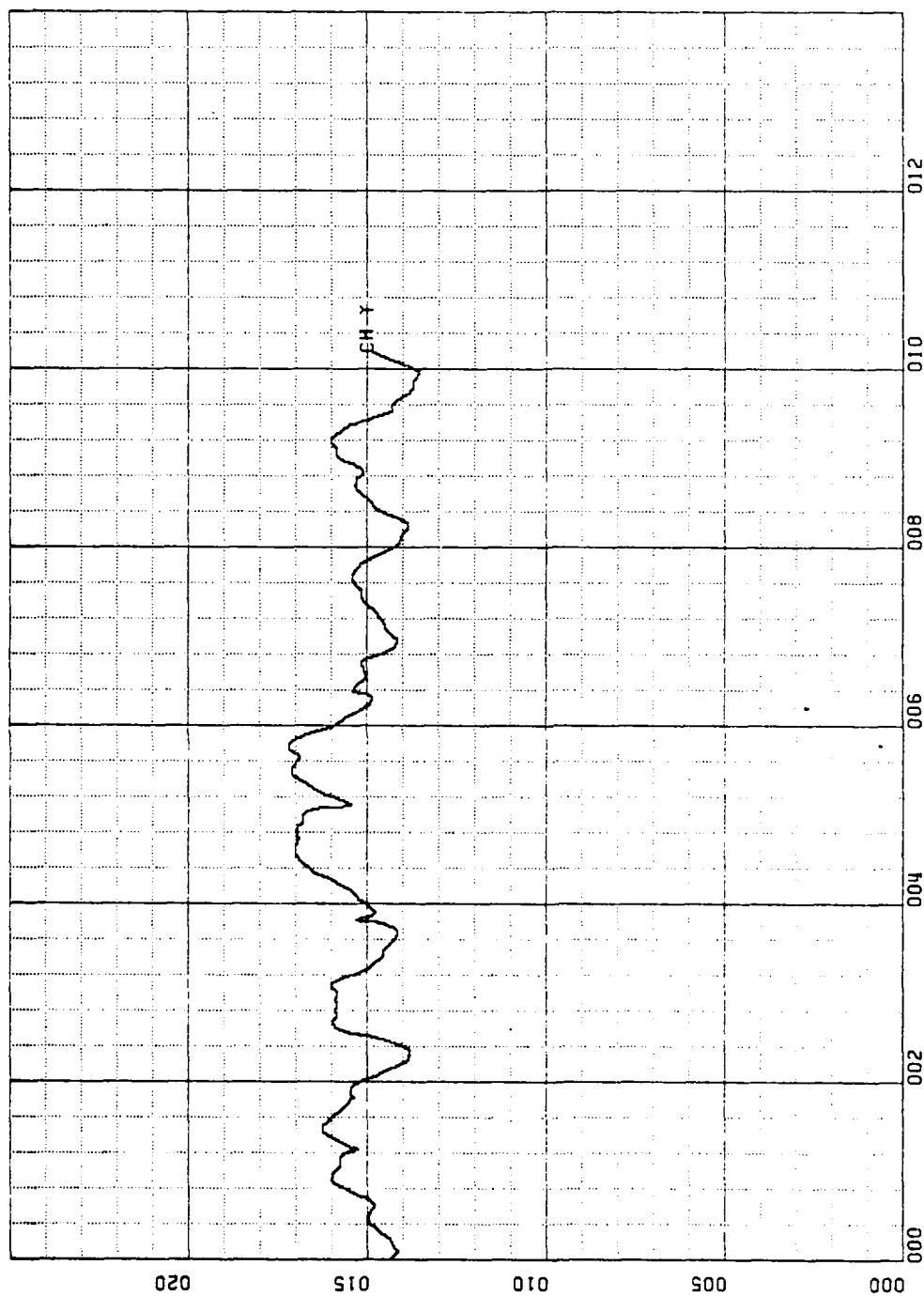


Figure 6.36 Y Coil Magnetic Field

Chew's Ridge, 1310 - 1317 Local

Field (5 nanoteslas/inch) vs Time (200 seconds/inch).

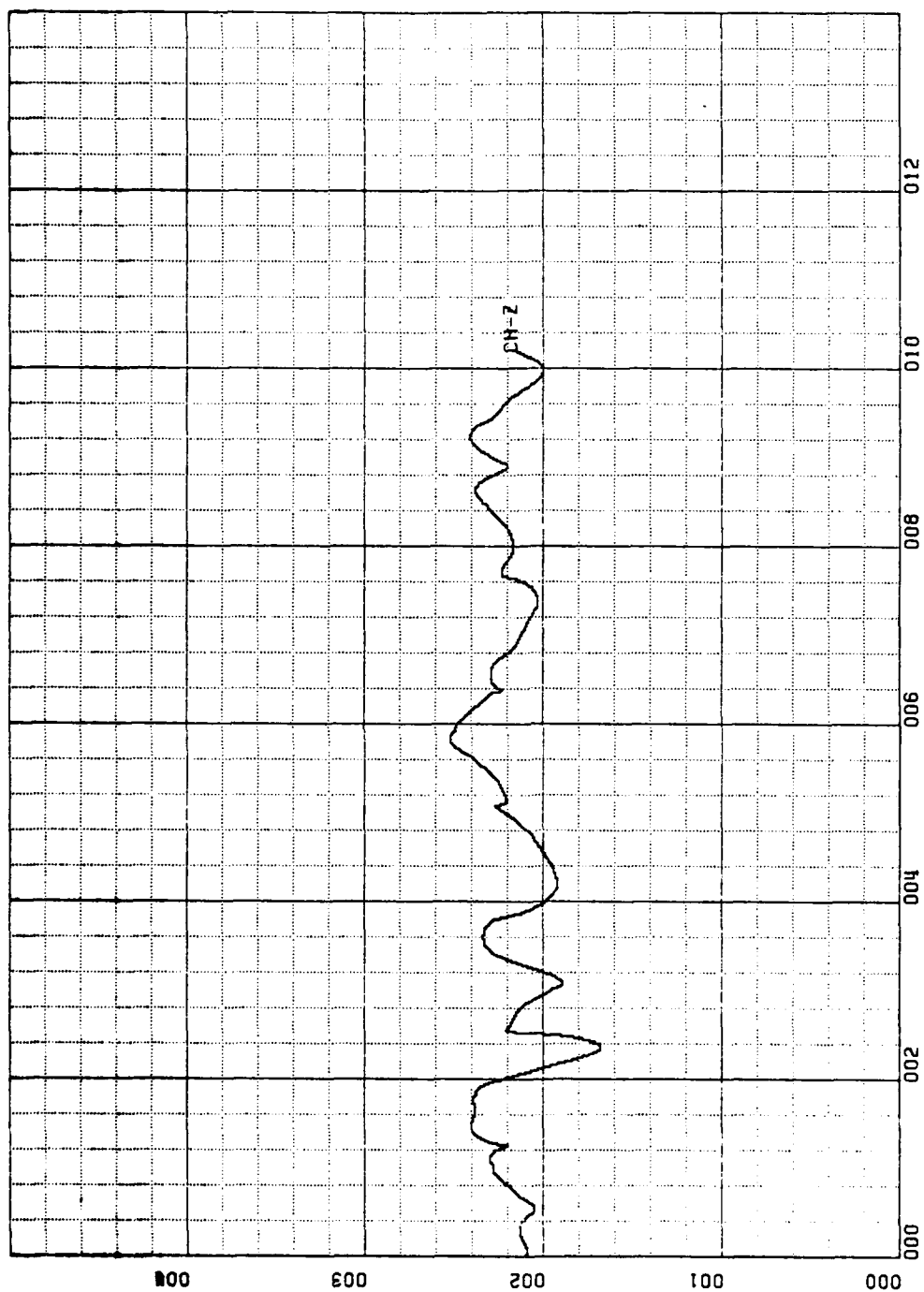


Figure 6.37 Z Coil Magnetic Field

Chew's Ridge, 1310 - 1317 Local

Field (10 nanoteslas/inch) vs Time (200 seconds/inch).

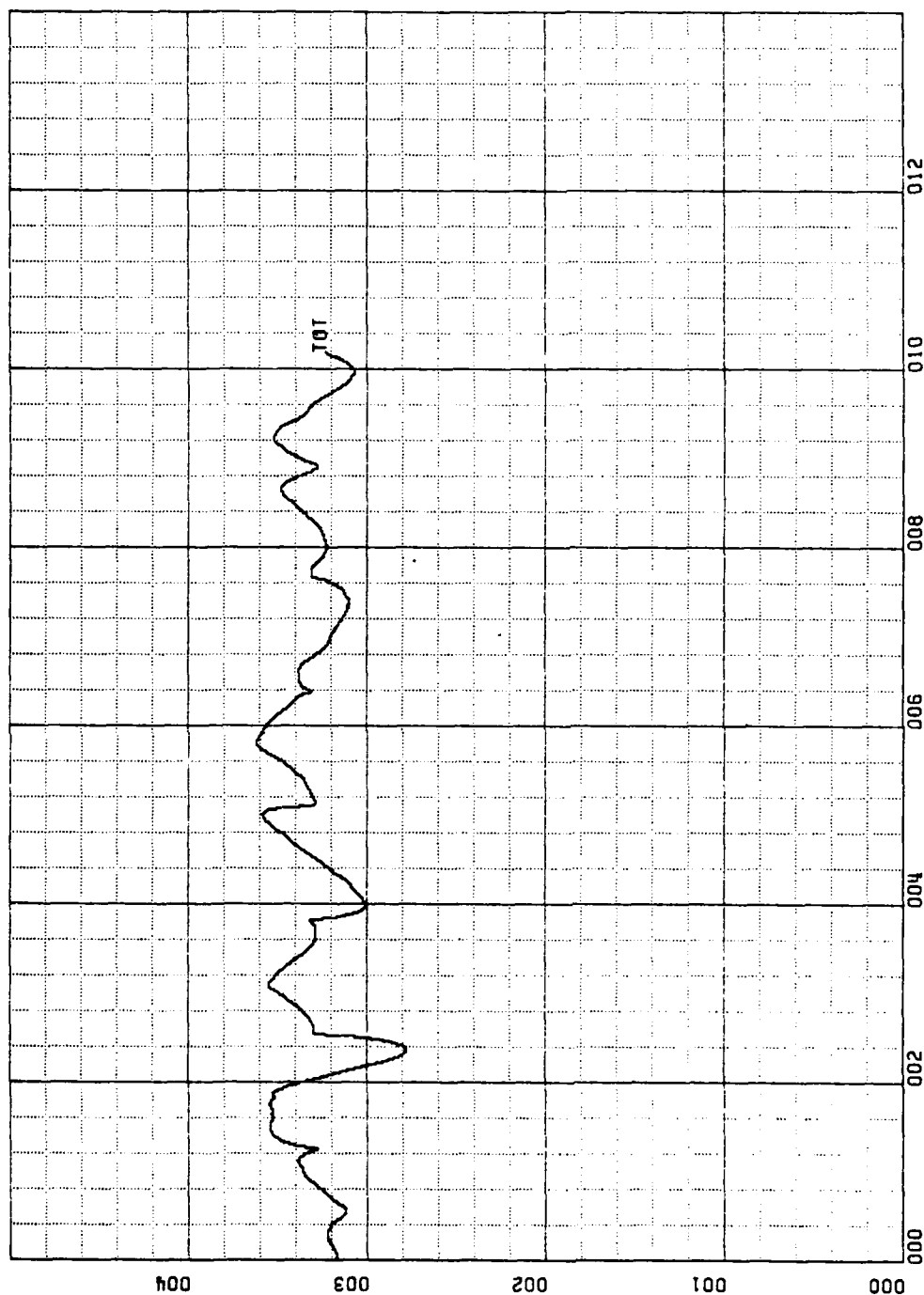


Figure 6.38 Total Magnetic Field

Chew's Ridge, 1310 - 1317 Local

Field (10 nanoteslas/inch) vs Time (200 seconds/inch).

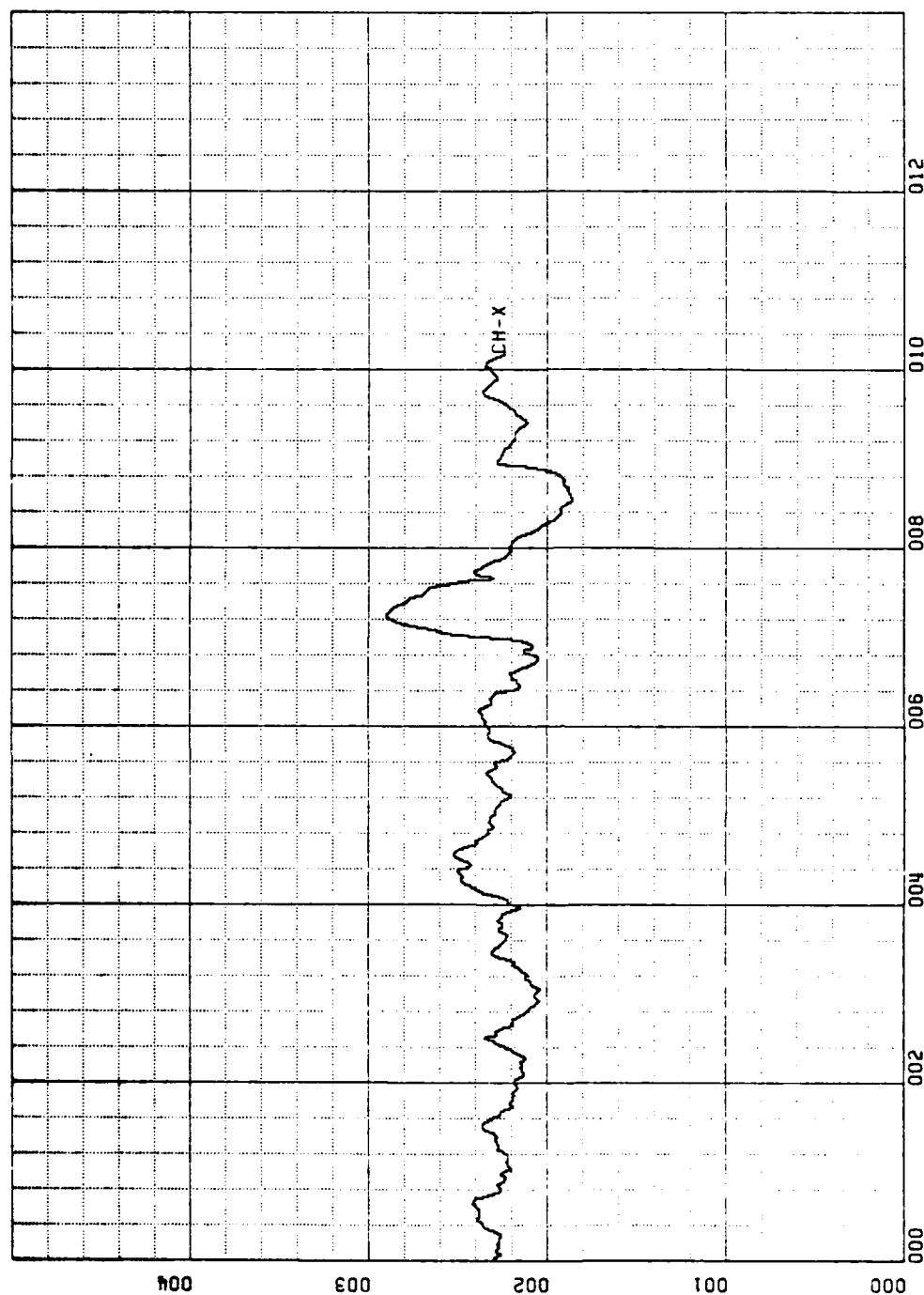


Figure 6.39 X Coil Magnetic Field

La Mesa Village, 1515 - 1532 Local

Field (1 nanotesla/inch) vs Time (200 seconds/inch).

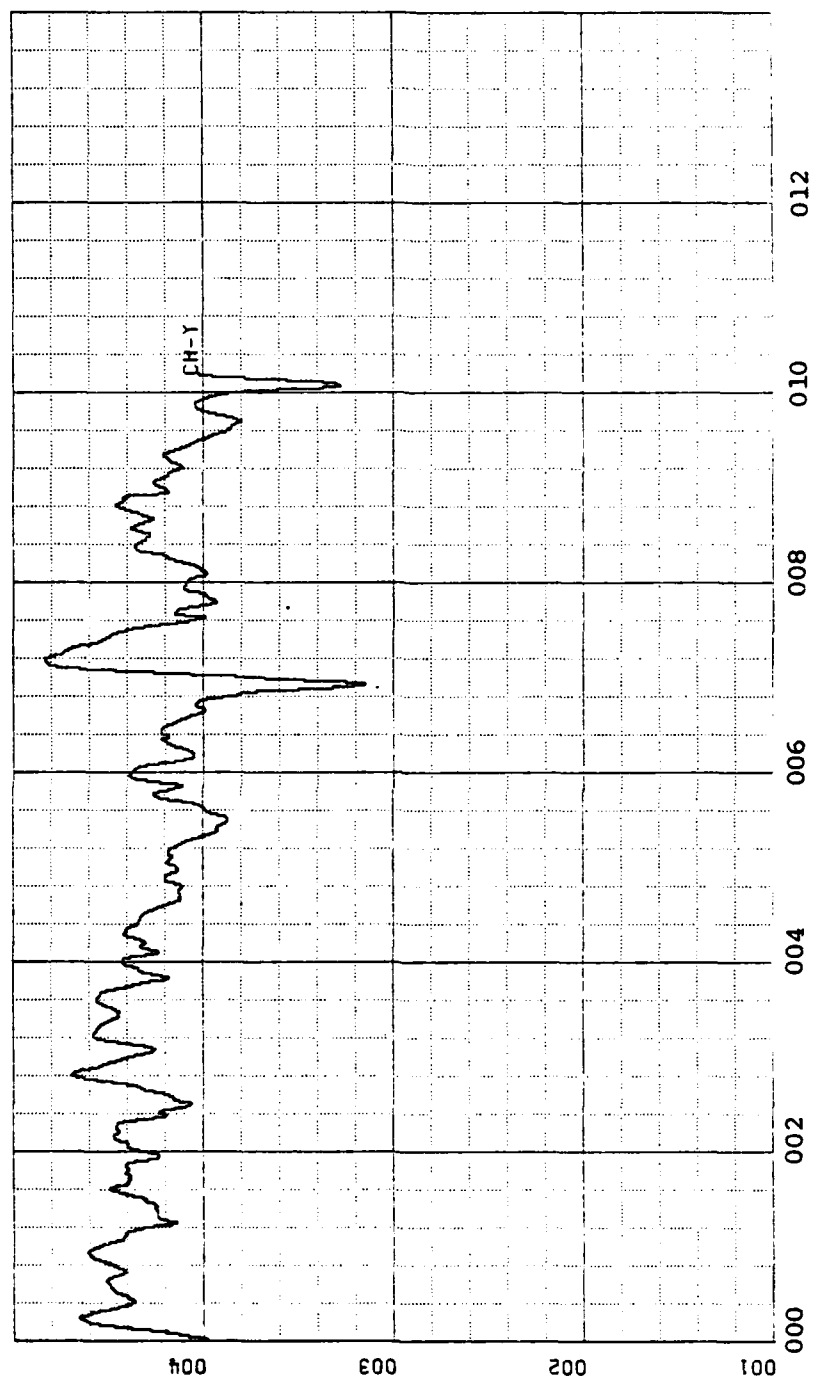


Figure 6.40 Y Coil Magnetic Field

La Mesa Village, 1515 - 1532 Local

Field (1 nanotesla/inch) vs Time (200 seconds/inch).

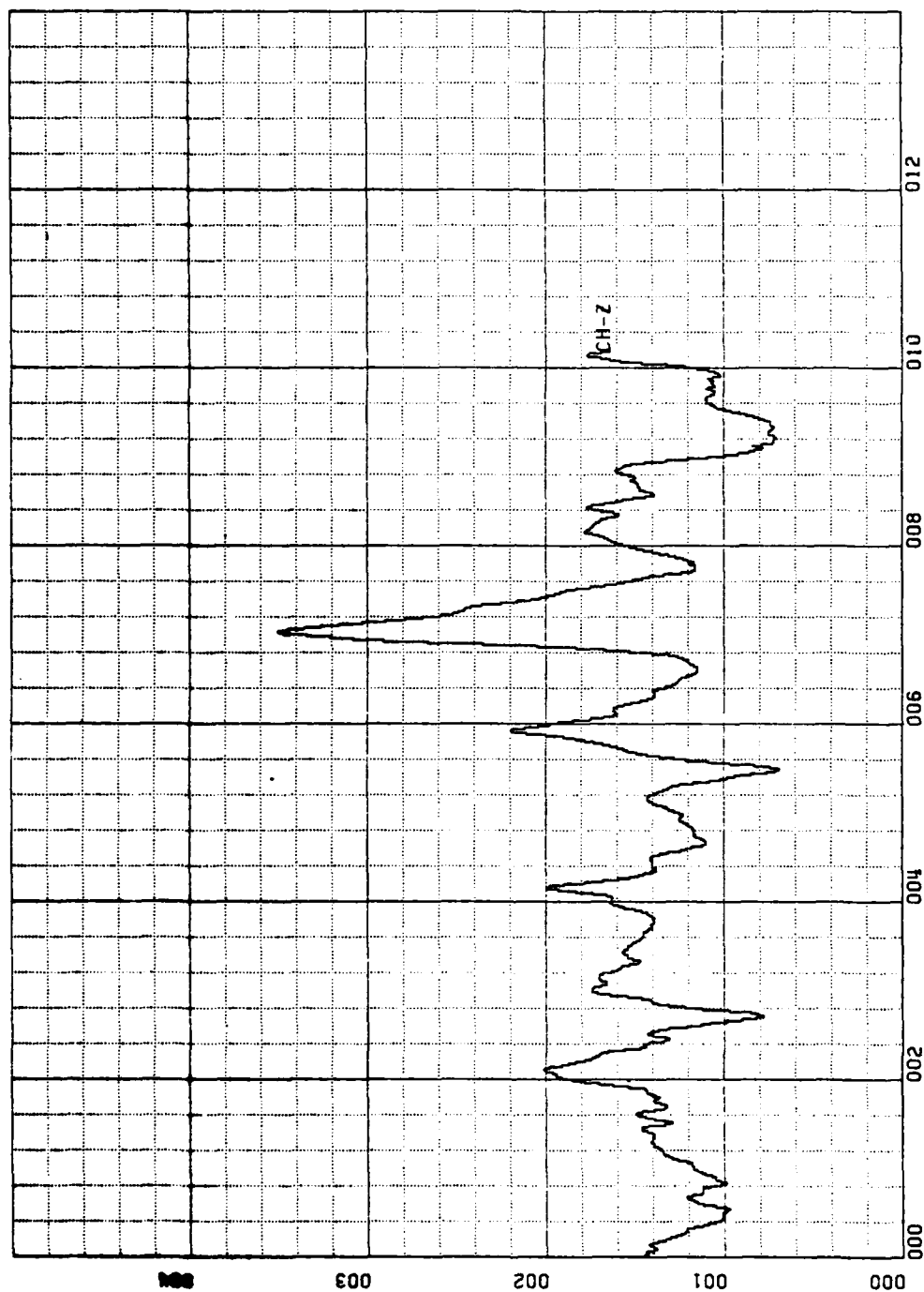


Figure 6.41 Z Coil Magnetic Field

La Mesa Village, 1515 - 1532 Local

Field (1 nanotesla/inch) vs Time (200 seconds/inch).

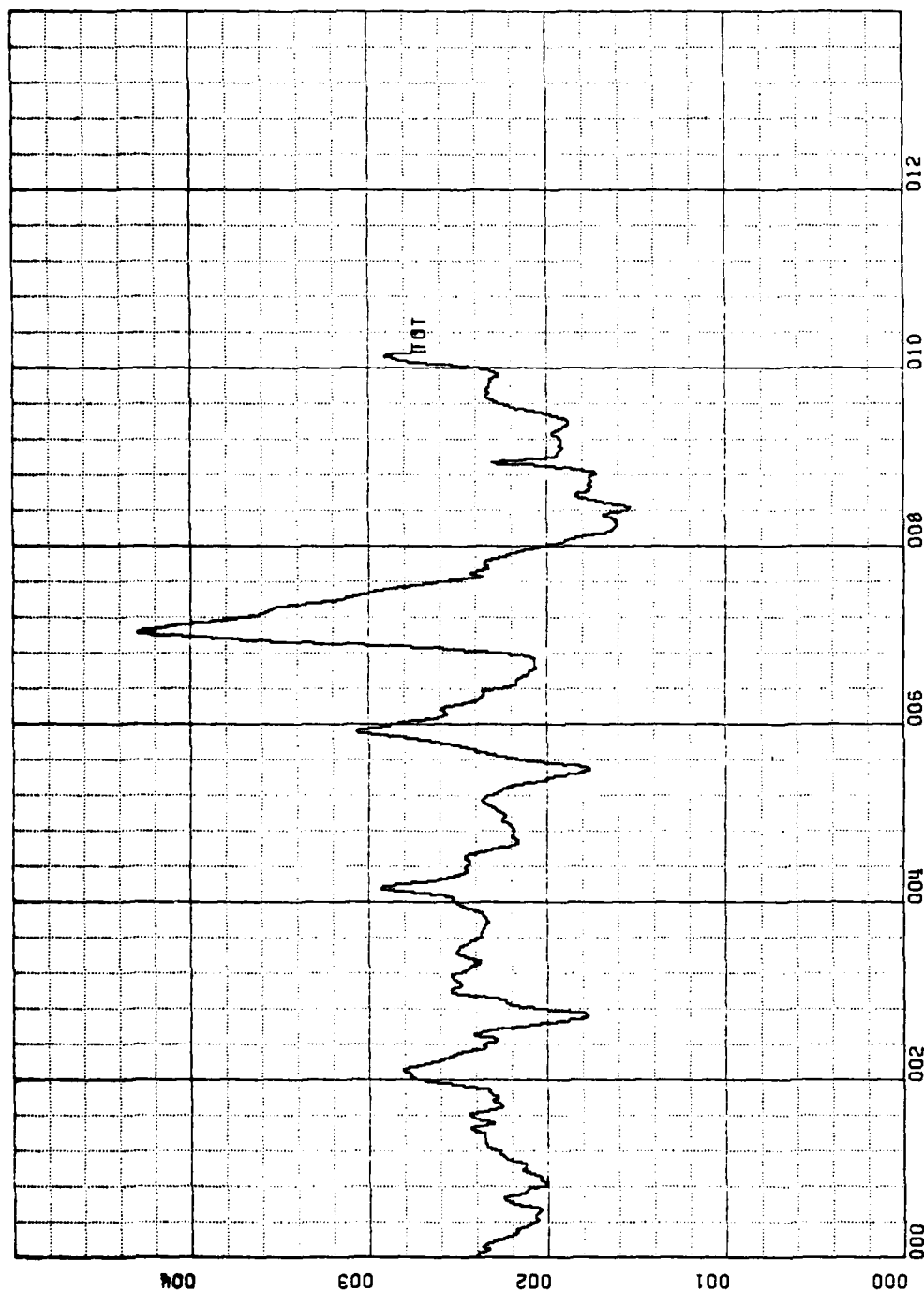


Figure 6.42 Total Magnetic Field

La Mesa Village, 1515 - 1532 Local

Field (1 nanotesla/inch) vs Time (200 seconds/inch).

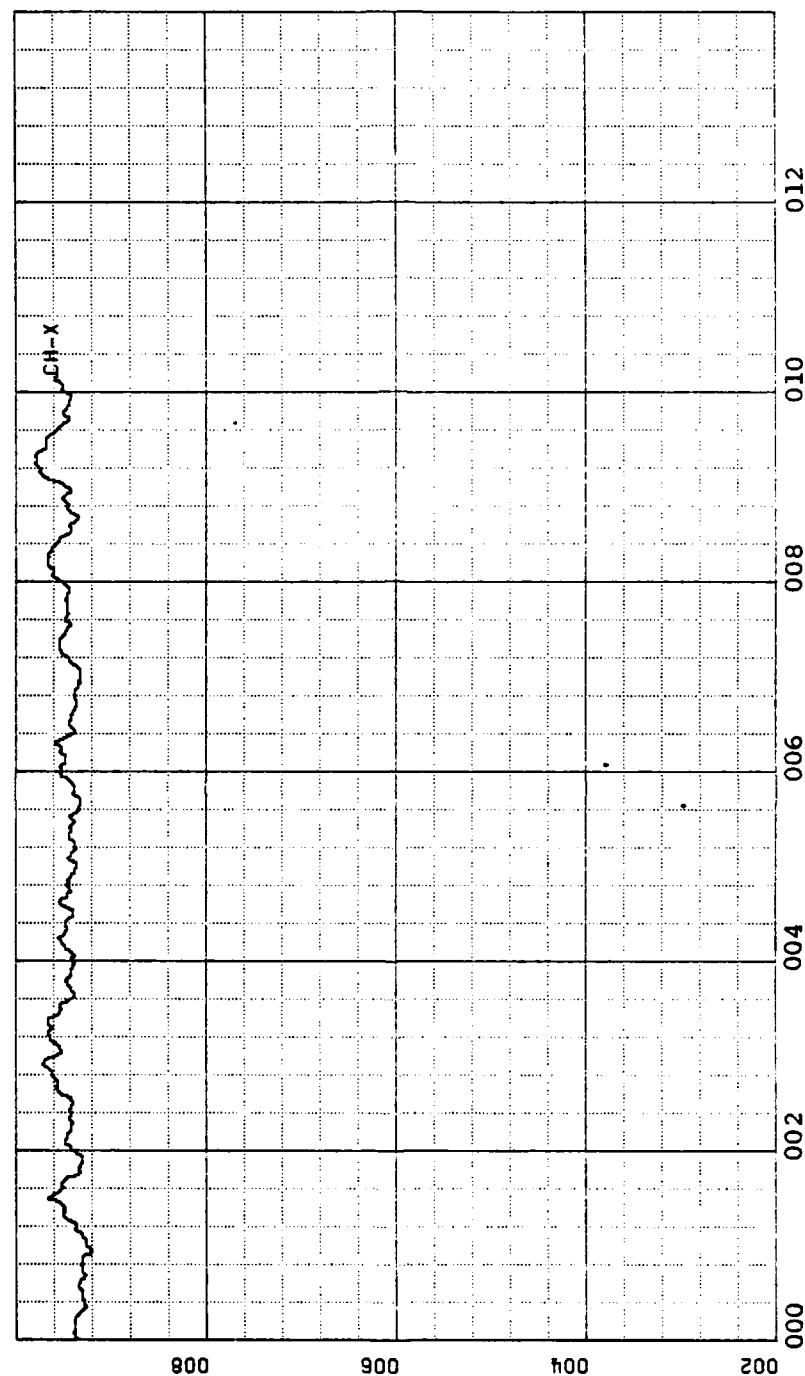


Figure 6.43 X Coil Magnetic Field

La Mesa Village, 1802 - 1819 Local

Field (2 nanotesla/inch) vs Time (200 seconds/inch).

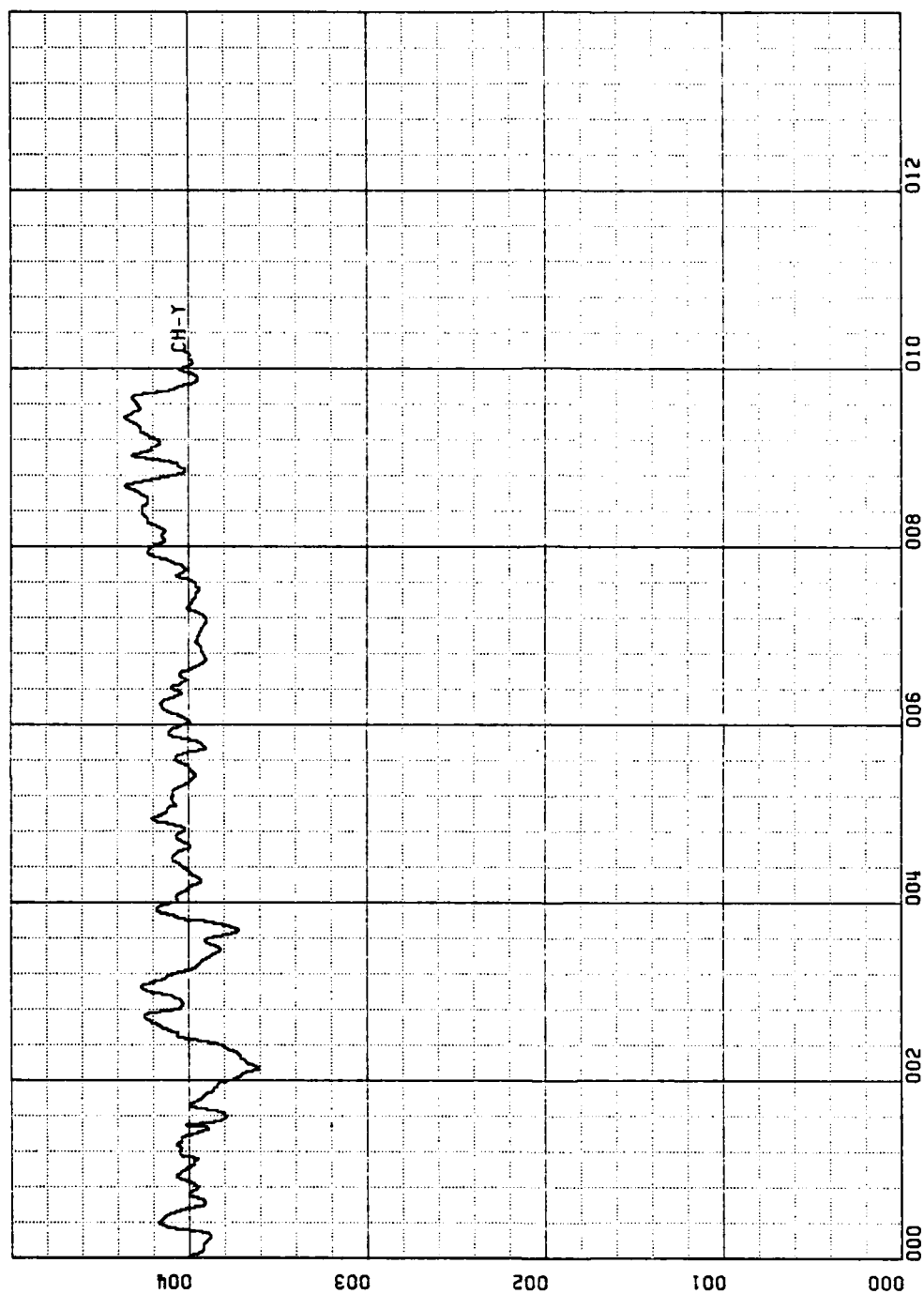


Figure 6.44 Y Coil Magnetic Field

La Mesa Village, 1802 - 1819 Local

Field (1 nanotesla/inch) vs Time (200 seconds/inch).

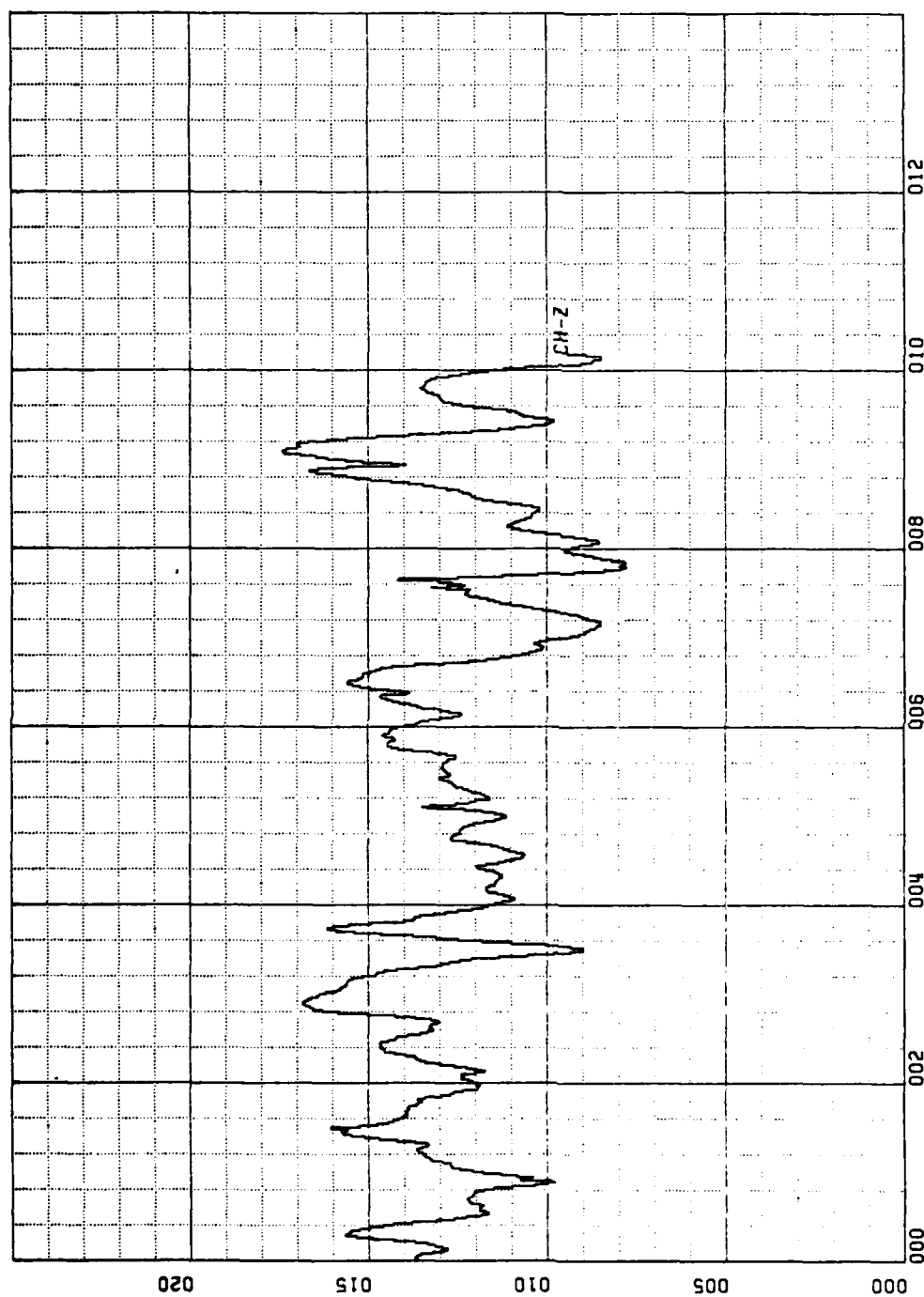


Figure 6.45 Z Coil Magnetic Field

La Mesa Village, 1802 - 1819 Local

Field (0.5 nanotesla/inch) vs Time (200 seconds/inch).

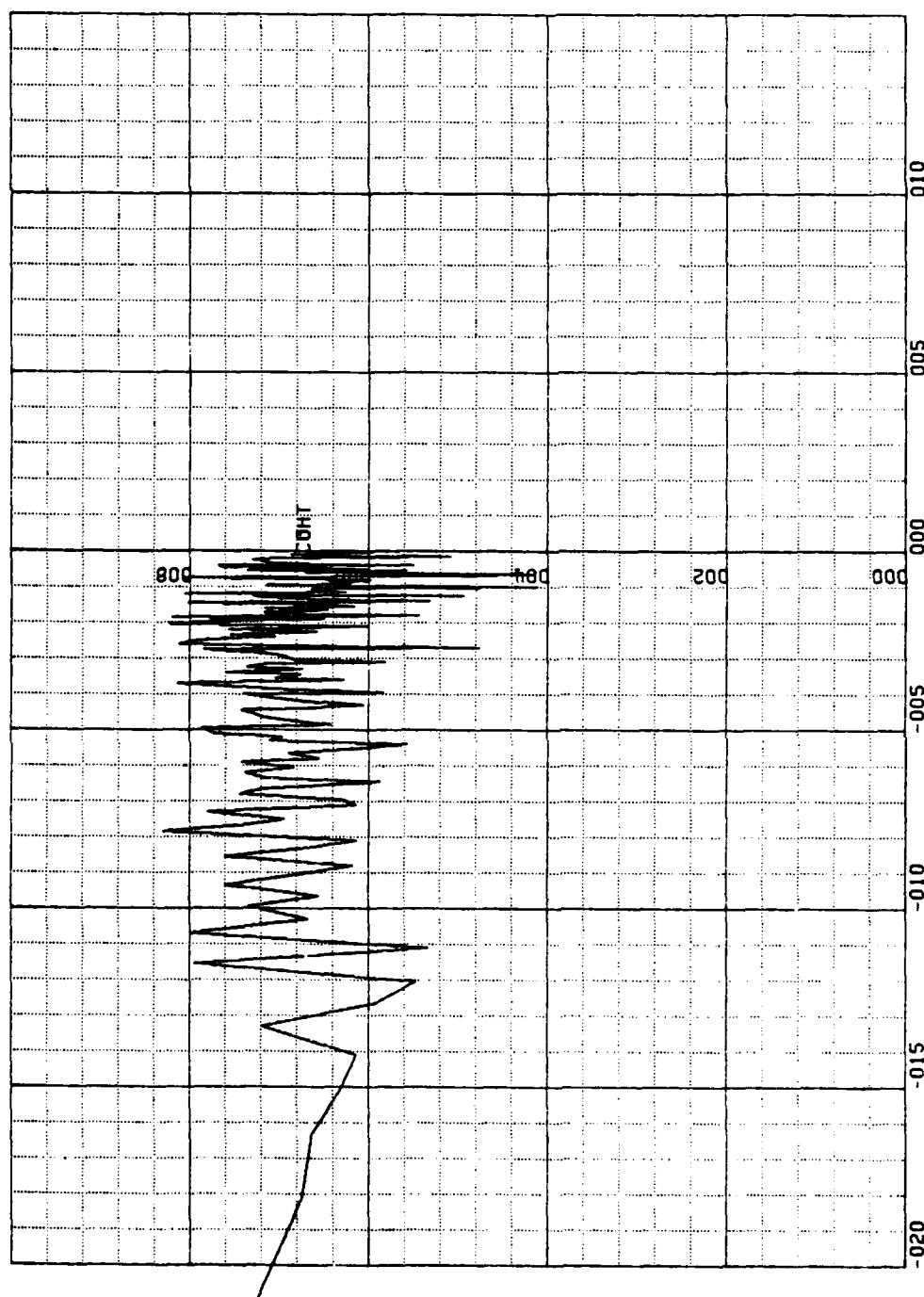


Figure 6.46 Total Field Coherence

1310 - 1350 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/inch).

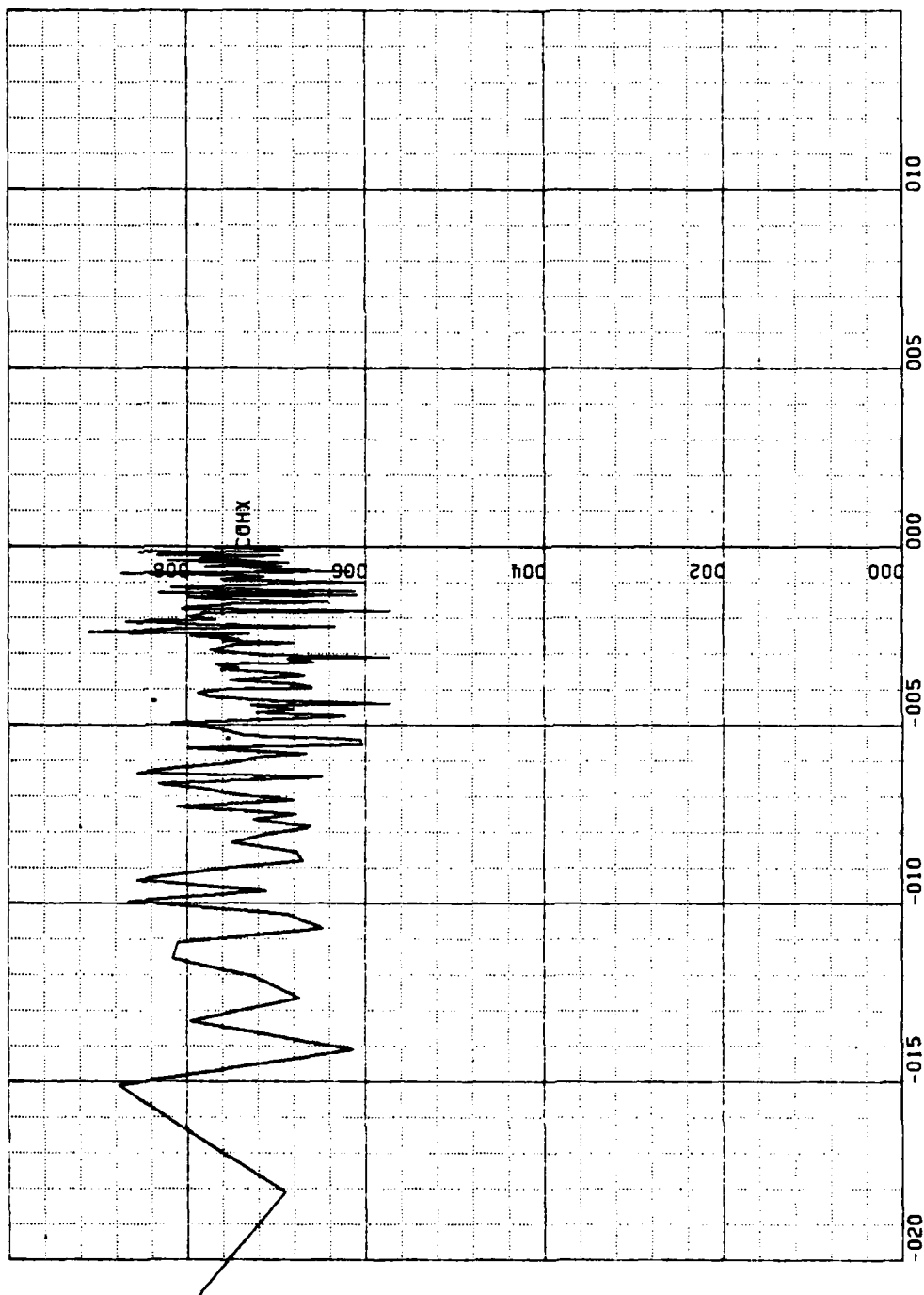


Figure 6.47 X Coil Coherence

1310 - 1350 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

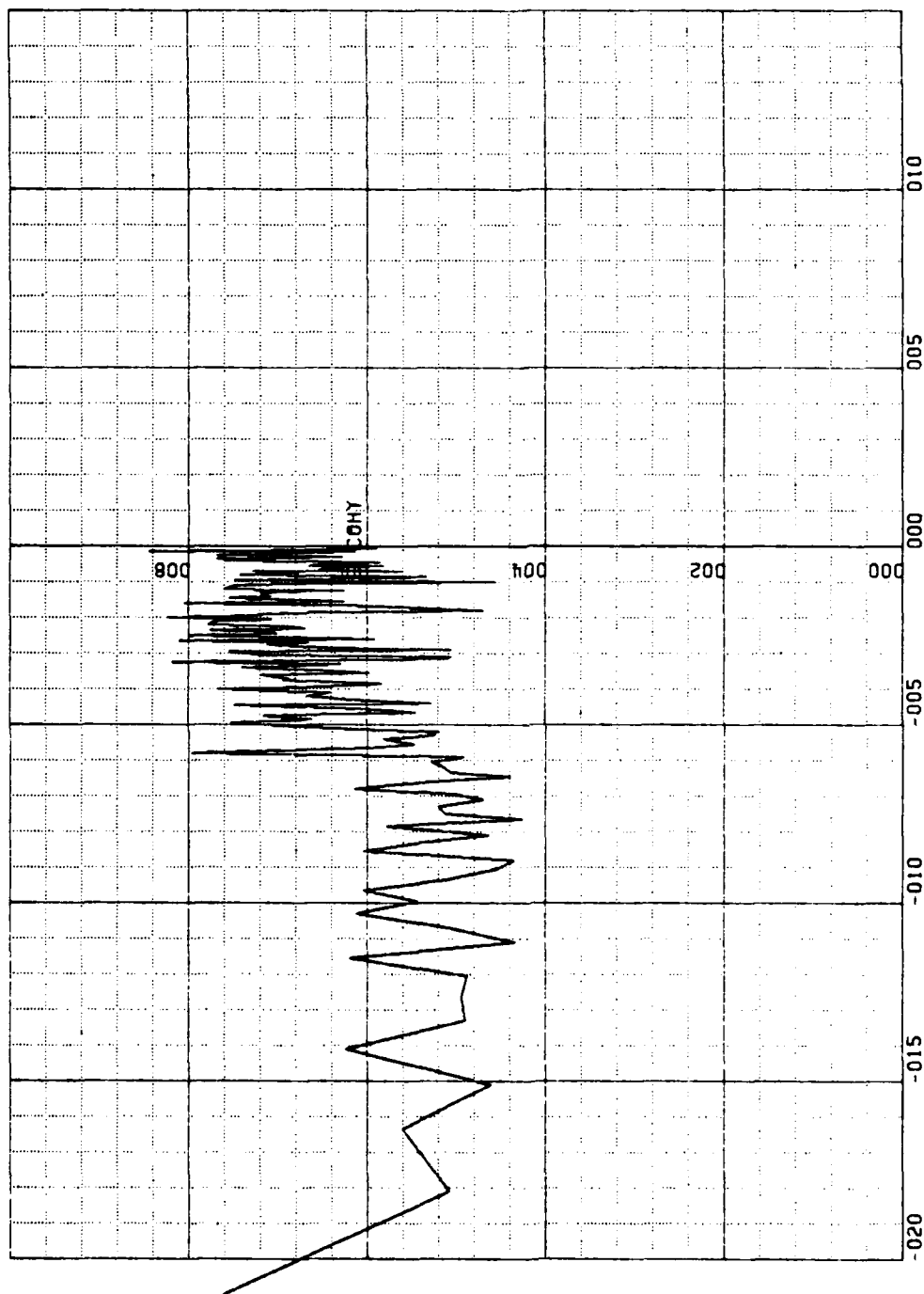


Figure 6.48 Y Coil Coherence

1310 - 1350 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

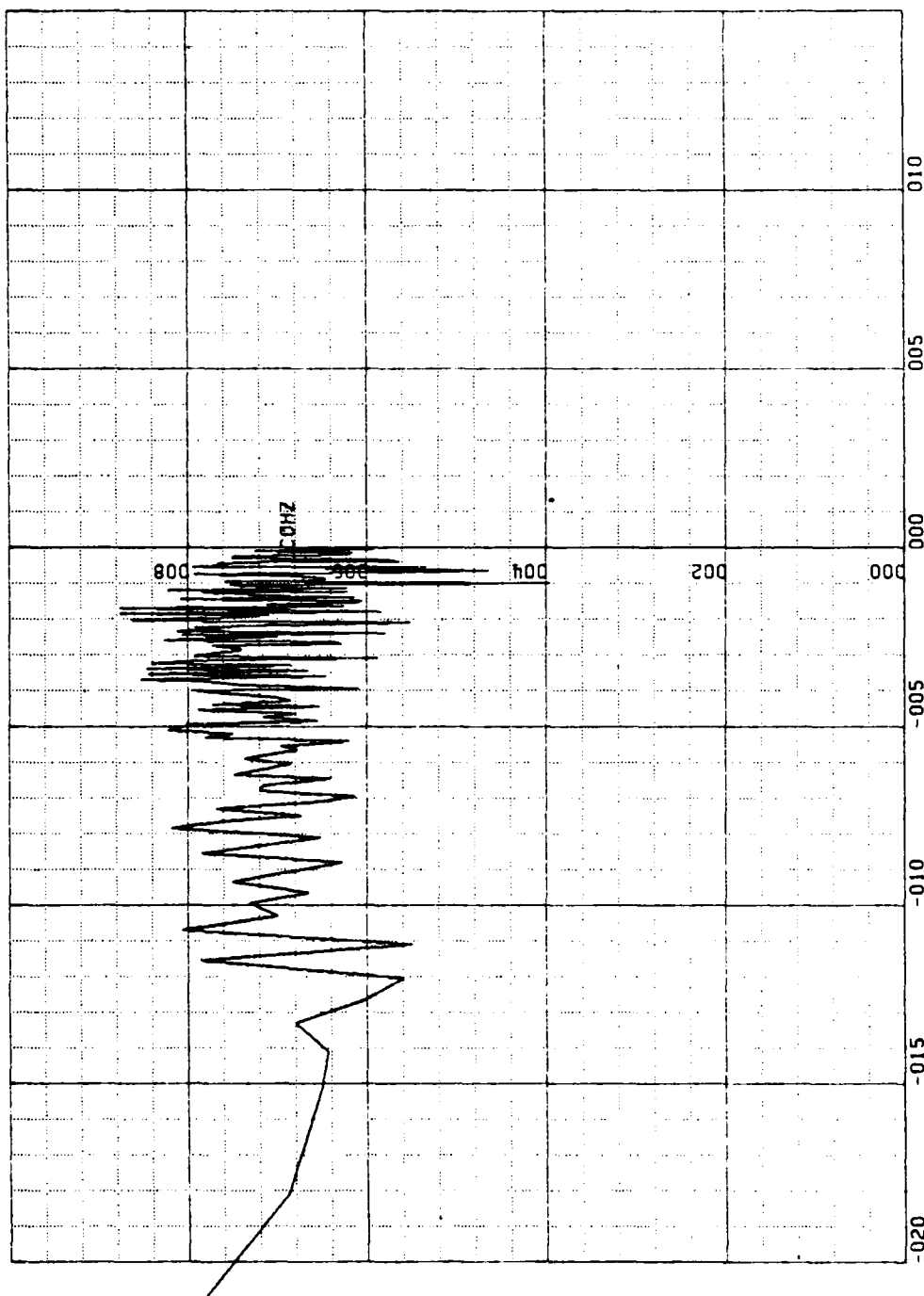


Figure 6.49 Z Coil Coherence

1310 - 1350 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

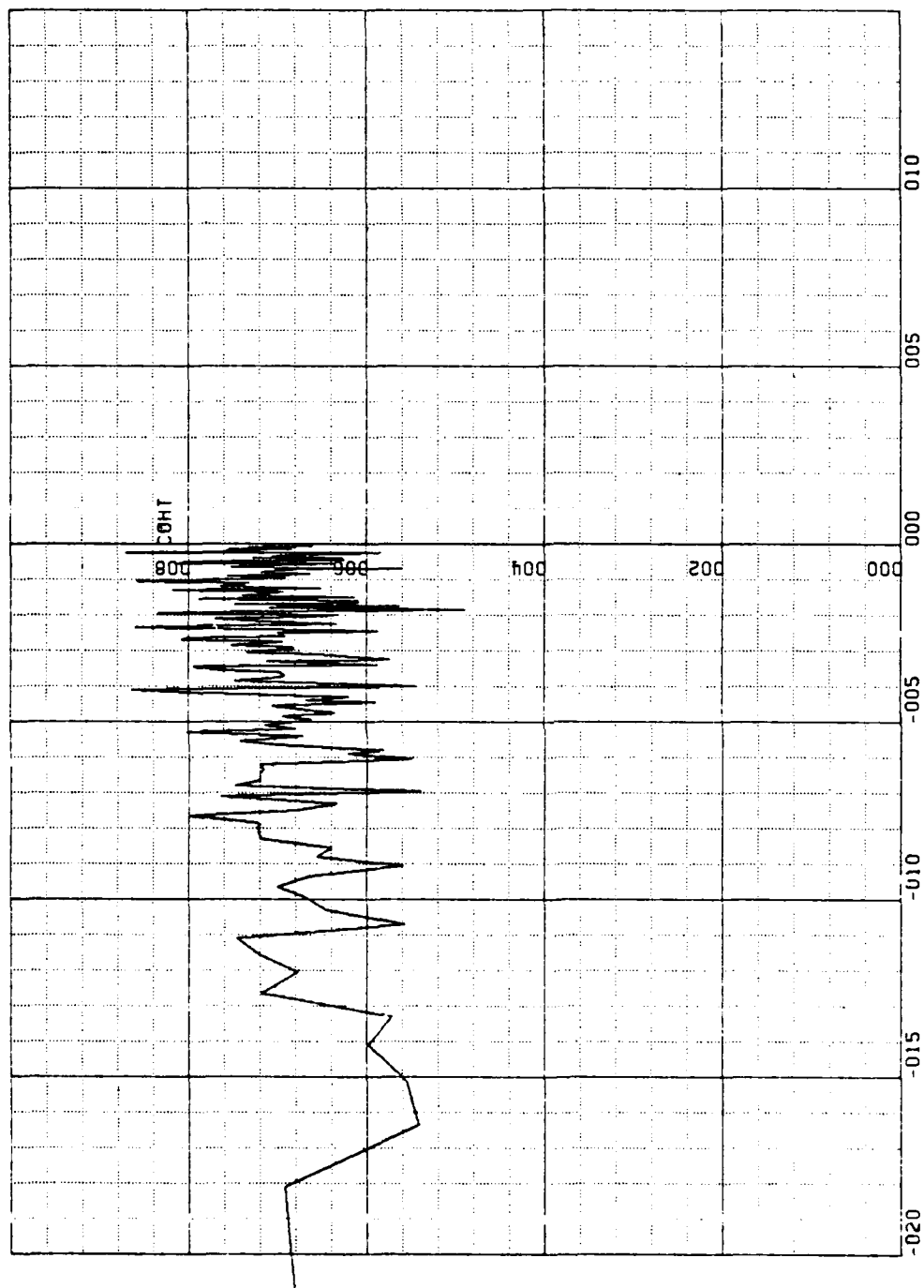


Figure 6.50 Total Field Coherence

1500 - 1540 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

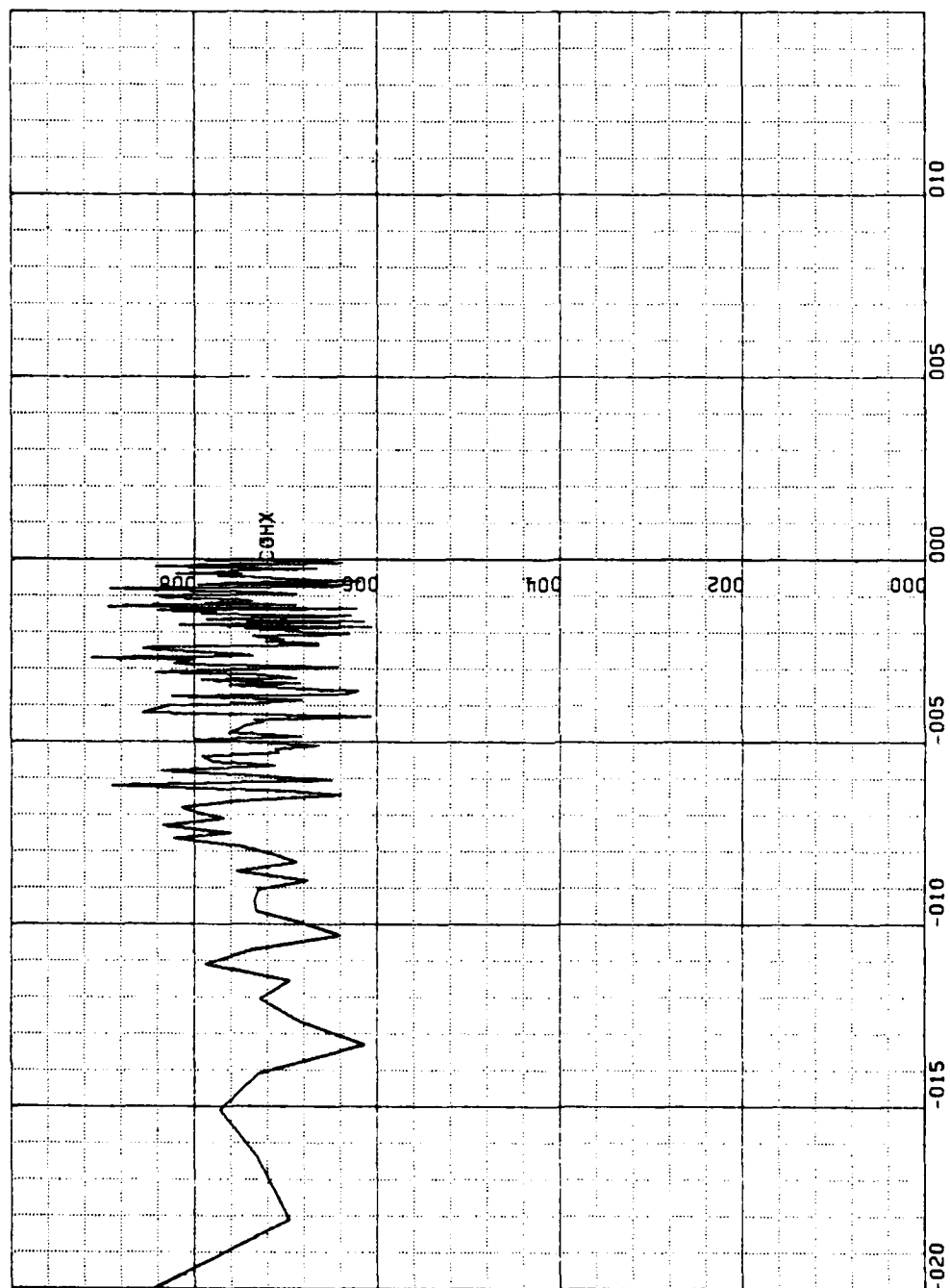


Figure 6.51 X Coil Coherence

1500 - 1540 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

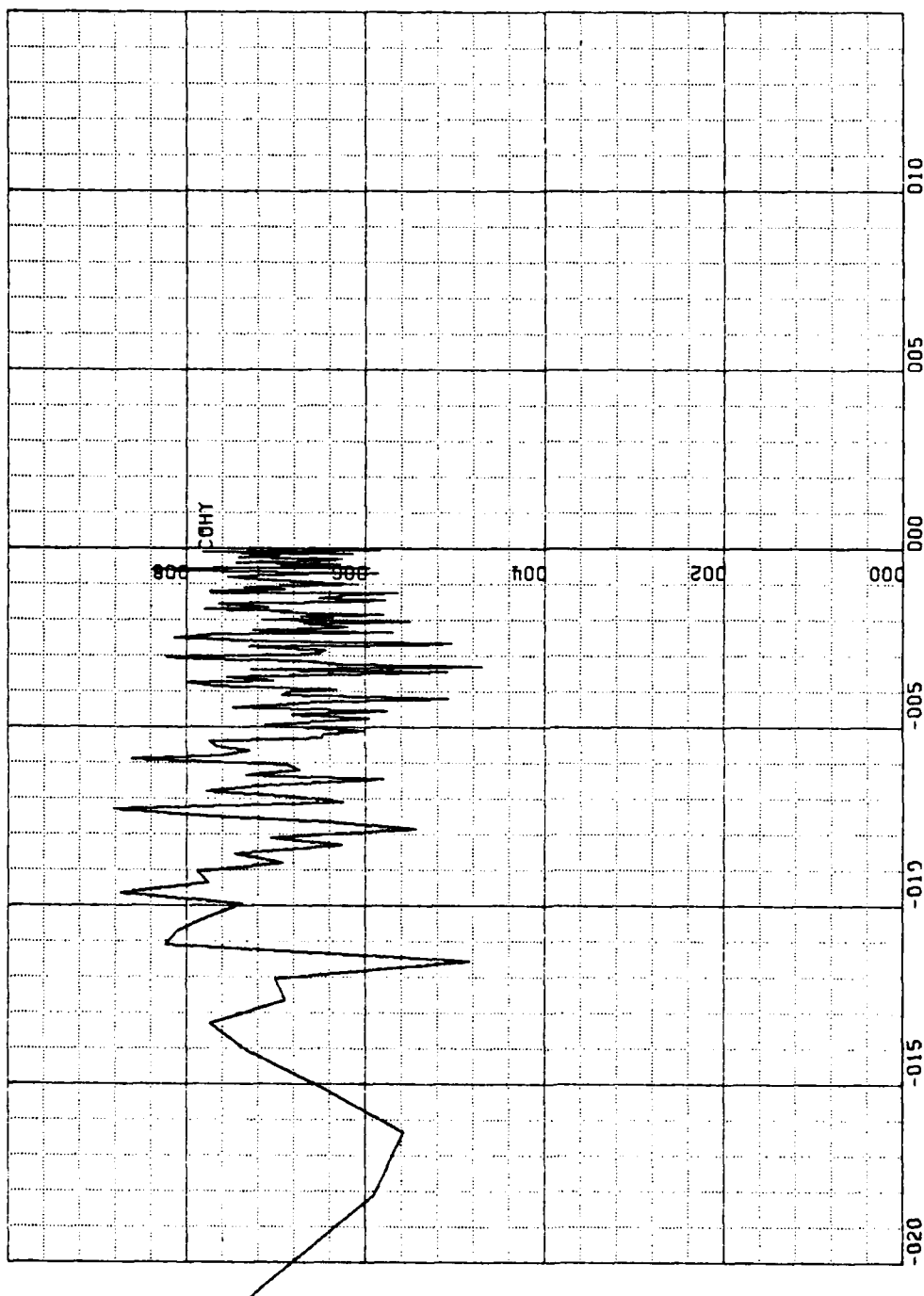


Figure 6.52 Y Coil Coherence

1500 - 1540 Local

Coherency (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

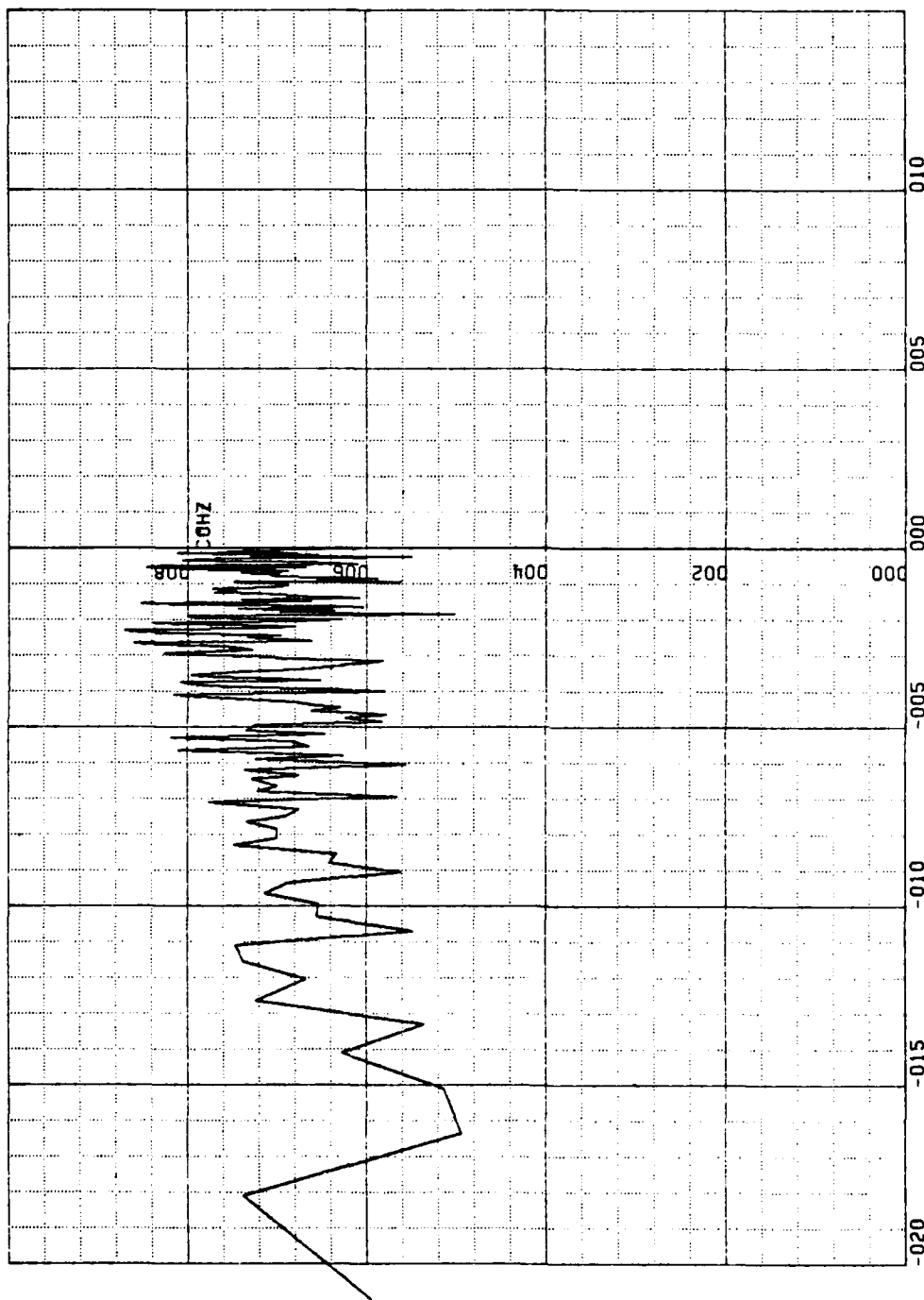


Figure 6.53 Z Coil Coherence

1500 - 1540 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

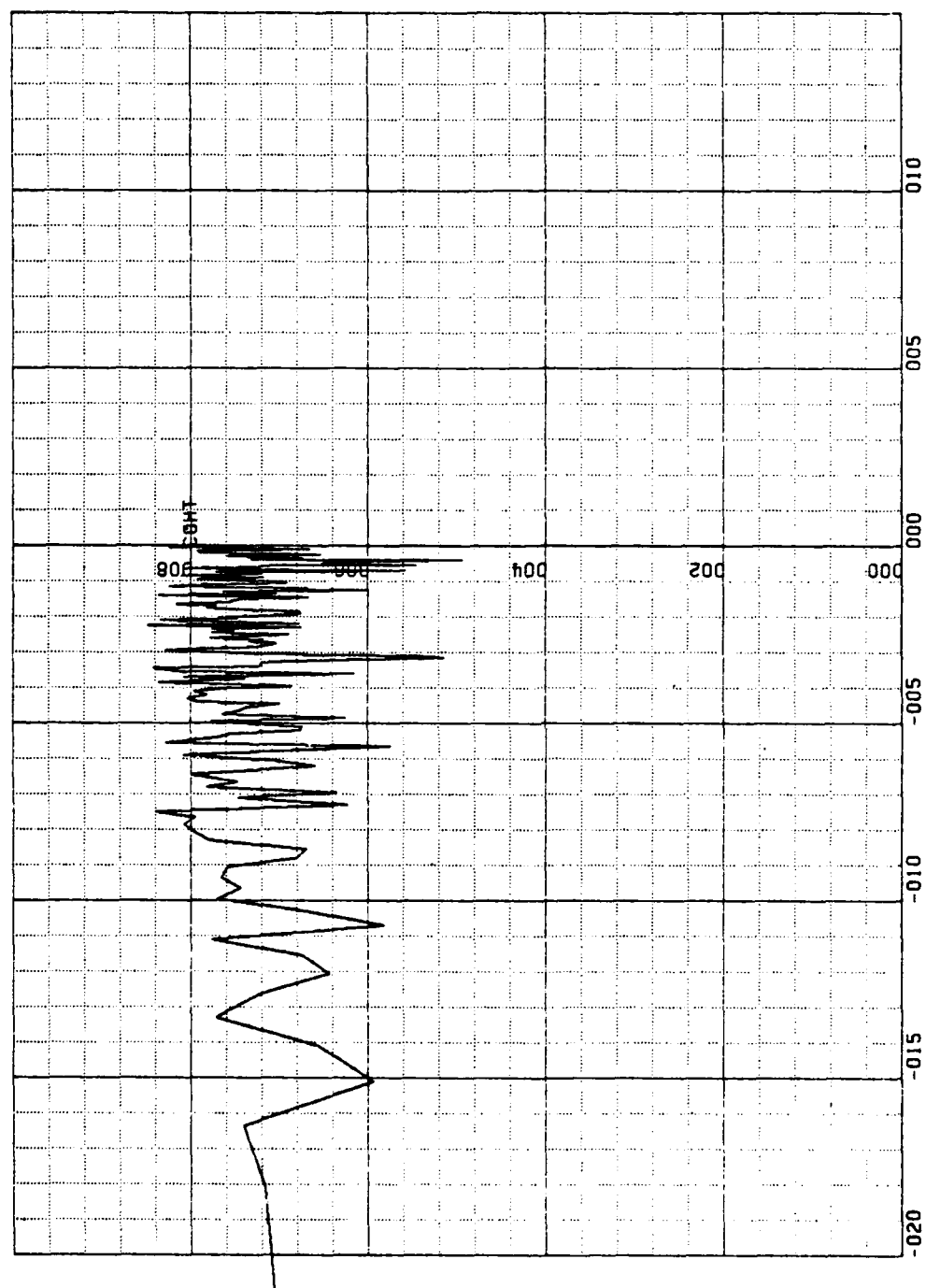


Figure 6.54 Total Field Coherence

1700 - 1740 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/

inch).

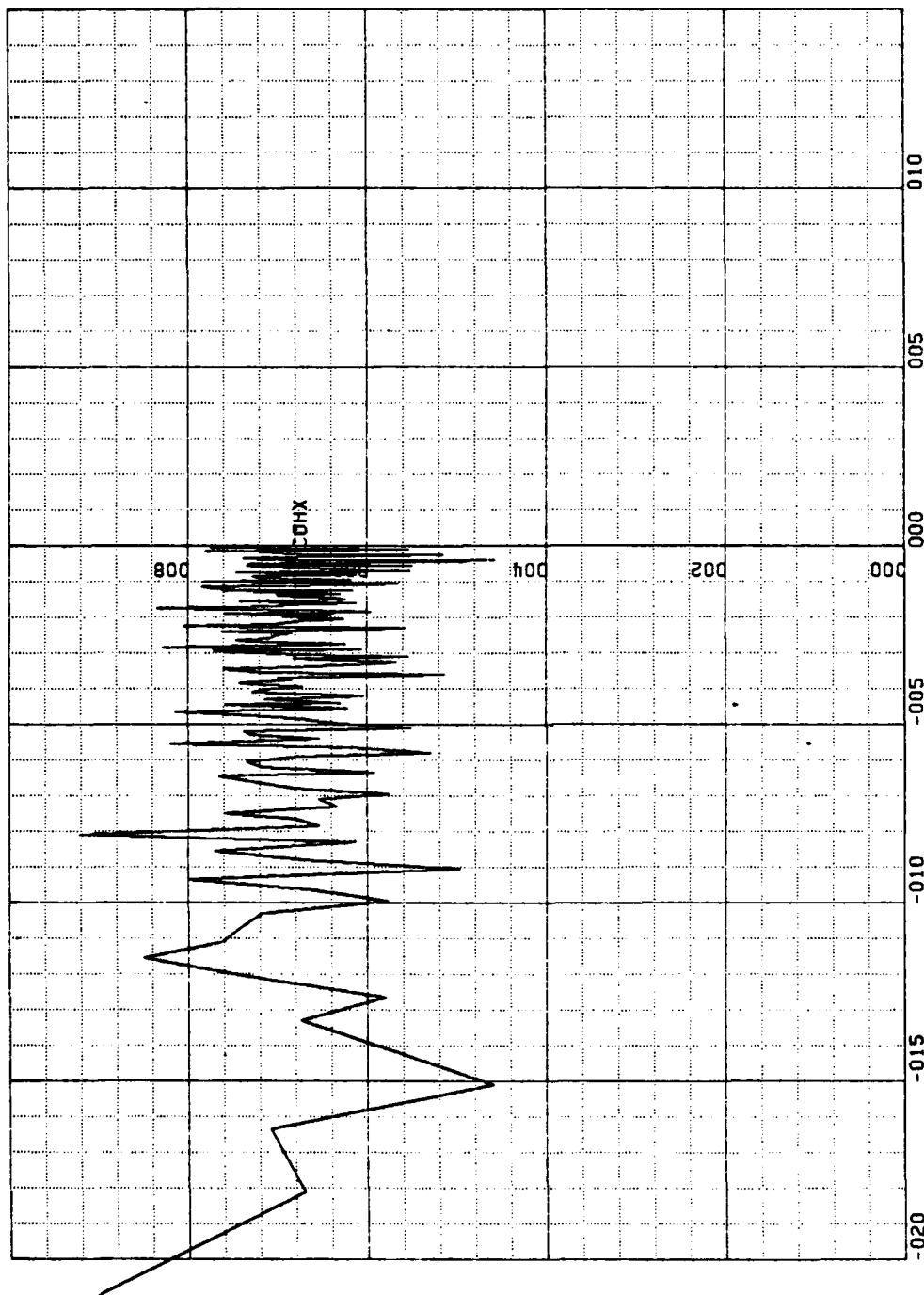


Figure 6.55 X Coil Coherence

1700 - 1740 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

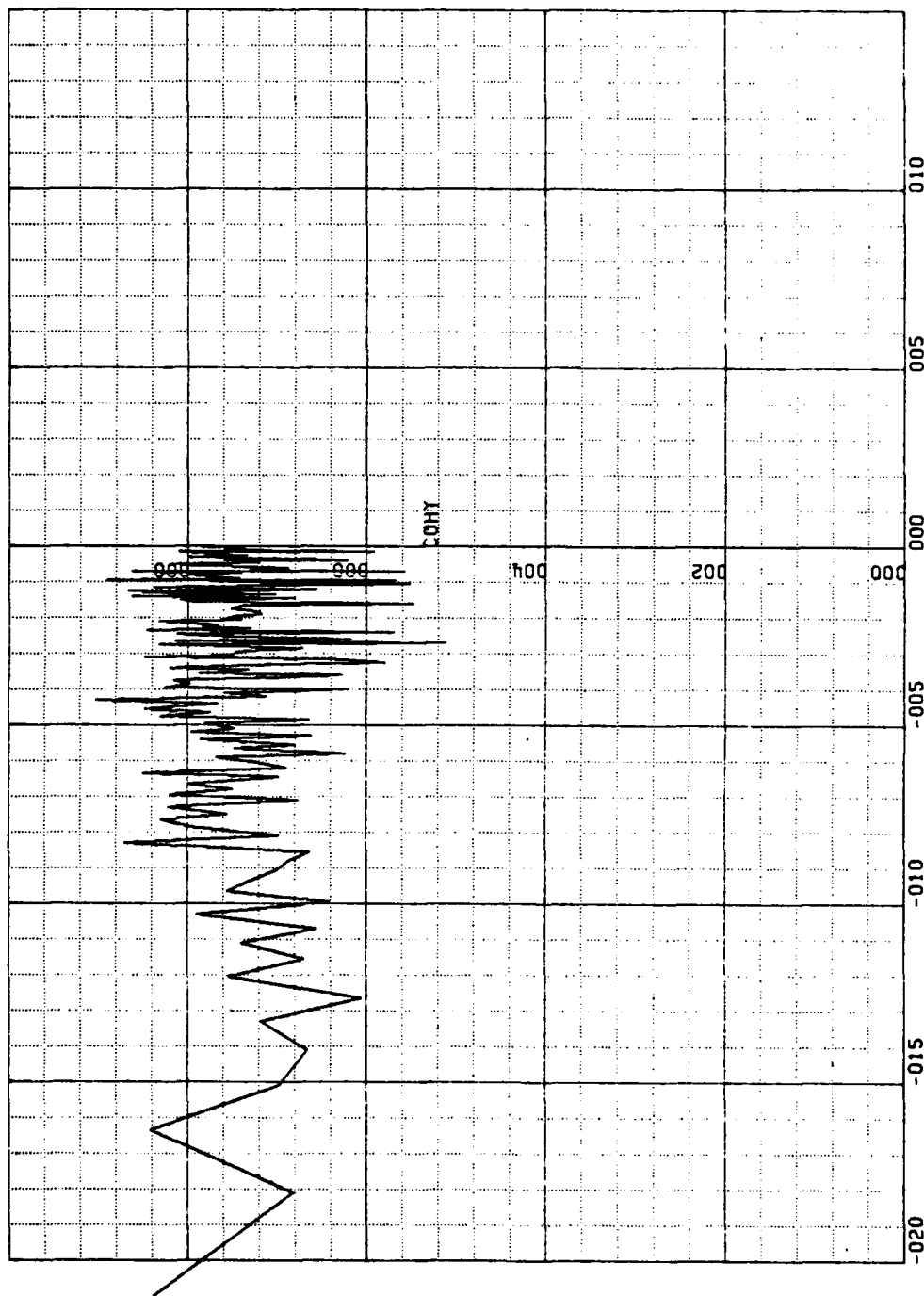


Figure 6.56 Y Coil Coherence

1700 - 1740 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

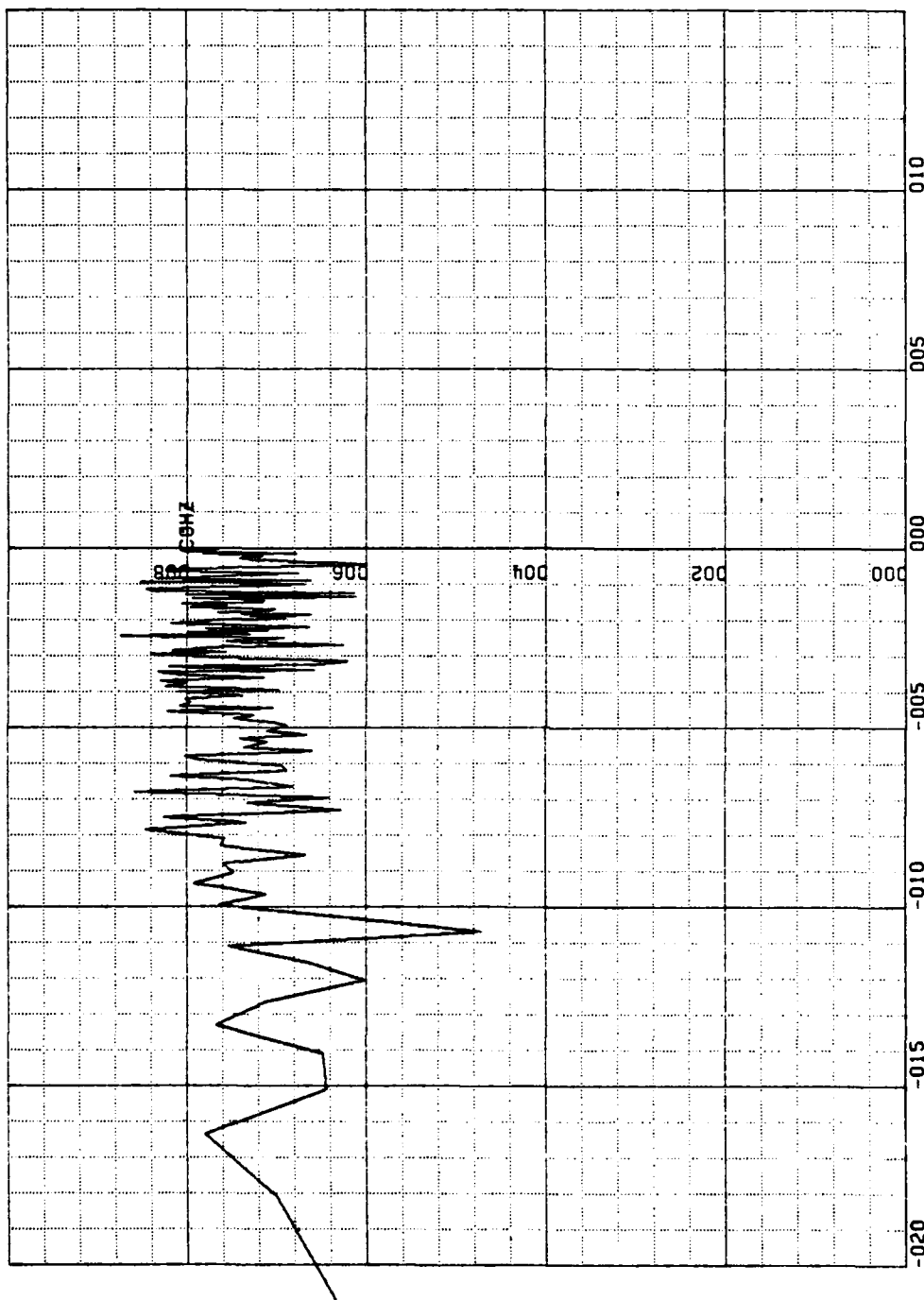


Figure 6.57 Z Coil Coherence

1700 - 1740 Local

Coherence (0.2 units/inch) vs Log Frequency (0.5 Log Hz/
inch).

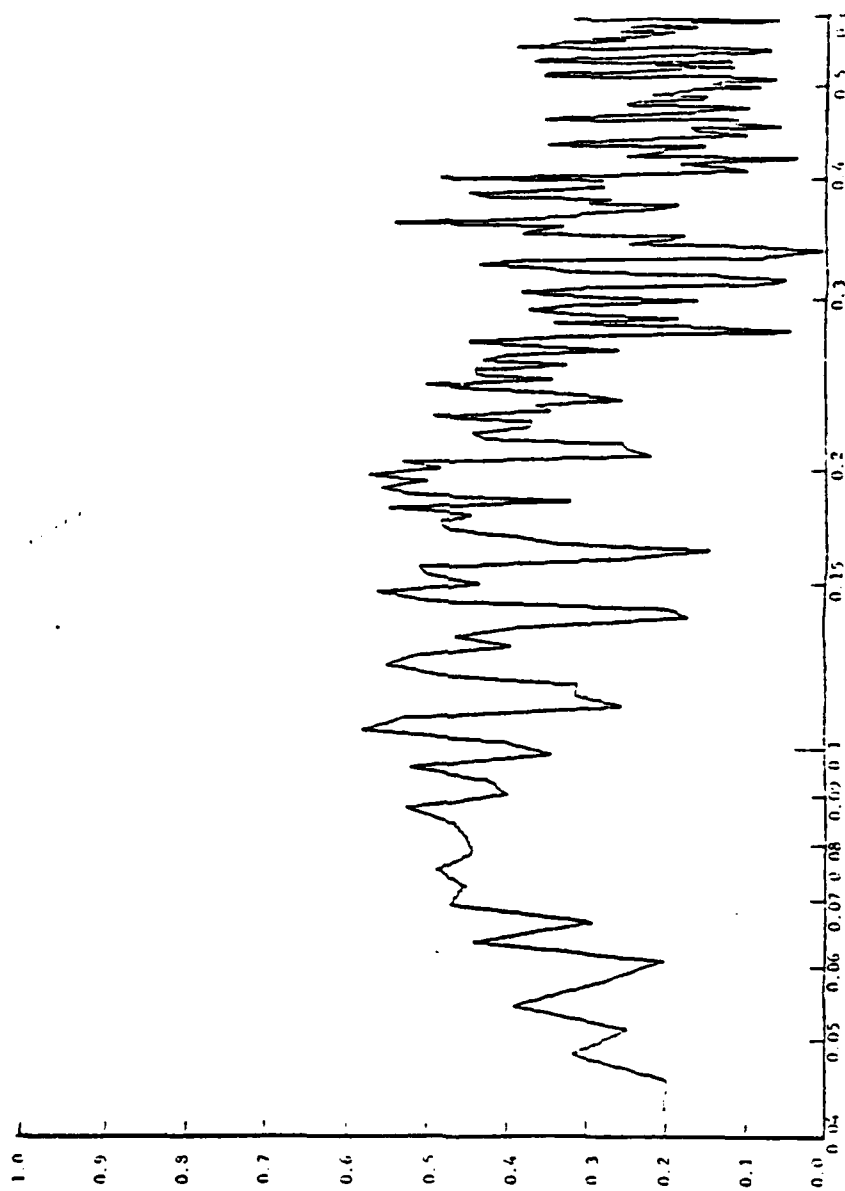


Figure 6.58 Total Field Coherence, NADC

11 July 1979, 1430 - 1630 Local

Coherence vs Frequency

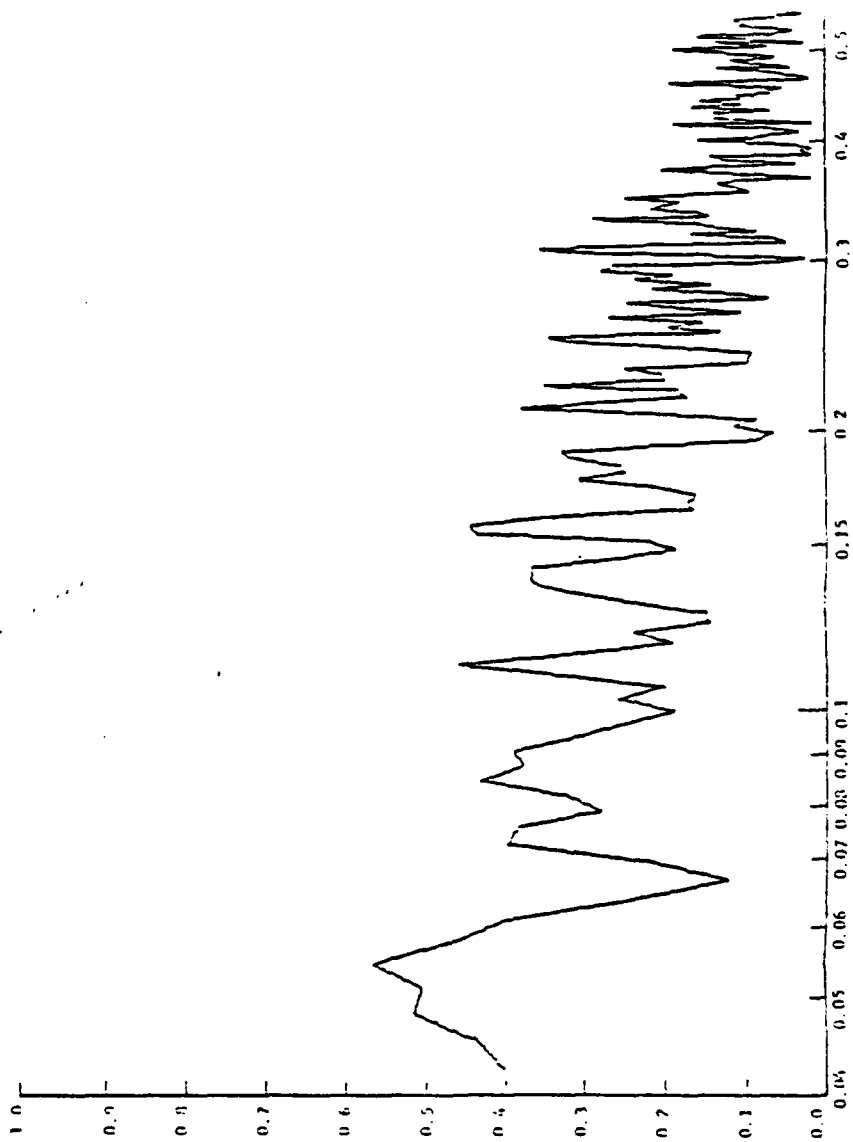


Figure 6.59 Total Field Coherence, NADC
 11 July 1979, 1700 - 1900 Local
 Coherence vs Frequency

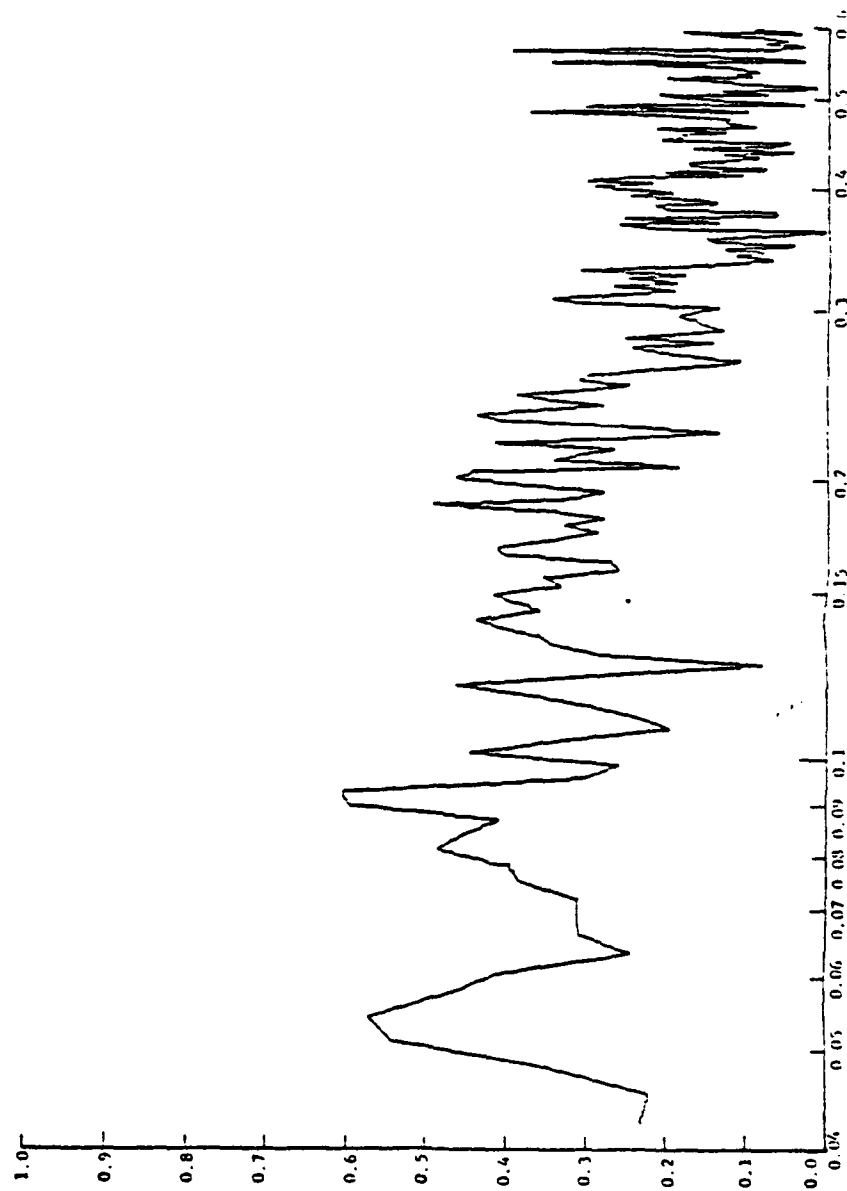


Figure 6.60 Total Field Coherence, NADC

11 July 1979, 1915 - 2115 Local

Coherence vs Frequency

VII. CONCLUSIONS AND RECOMMENDATIONS

A coherence of 0.6 - 0.8 in the background component of the geomagnetic field between 0.04 and 0.6 Hz was established. A coherence in this range should be considered only moderate. A lack of high coherence (0.9 - 1) indicates that the variations in the background field observed at the earth's surface at the two sites are not produced directly by the same source. However, the variations are clearly not random in nature. The moderate coherences found suggest that the source mechanisms for the background component in the geomagnetic field are complex and involve mechanisms in addition to or intermediate to simple fluctuations in the interplanetary magnetic field.

A discernable micropulsation was not recorded during the five hours of data taken. It is recommended that additional data be taken at the two sites in the hope of performing a coherence study on the micropulsation component of the geomagnetic field. It is also recommended that data be taken at additional sites of greater separation (100 km or more) in order to investigate the degree of coherence with distance.

APPENDIX A
SITE DESCRIPTION

The Chew's Ridge fire lookout is located 40 km south-east of the Naval Postgraduate School and at an altitude of approximately 3900 feet above sea level. It was chosen for its remoteness from the local power grid. Since the site is within the Los Padres National Forest, permission to collect data there had to be obtained from the National Forest Service. A dirt road provides easy access to the site for the transporting of equipment. The Monterey Institute for Research in Astronomy is currently constructing an observatory approximately one half mile from the lookout. What affect its presence will have on the suitability of the fire lookout for future data collection is not currently known.

Initial attempts to transmit the PCM data via a 170 MHz carrier wave from this site to the school proved impossible due to the relatively low transmission power used (3 watts), less than ideal line of sight, less than ideal antenna.

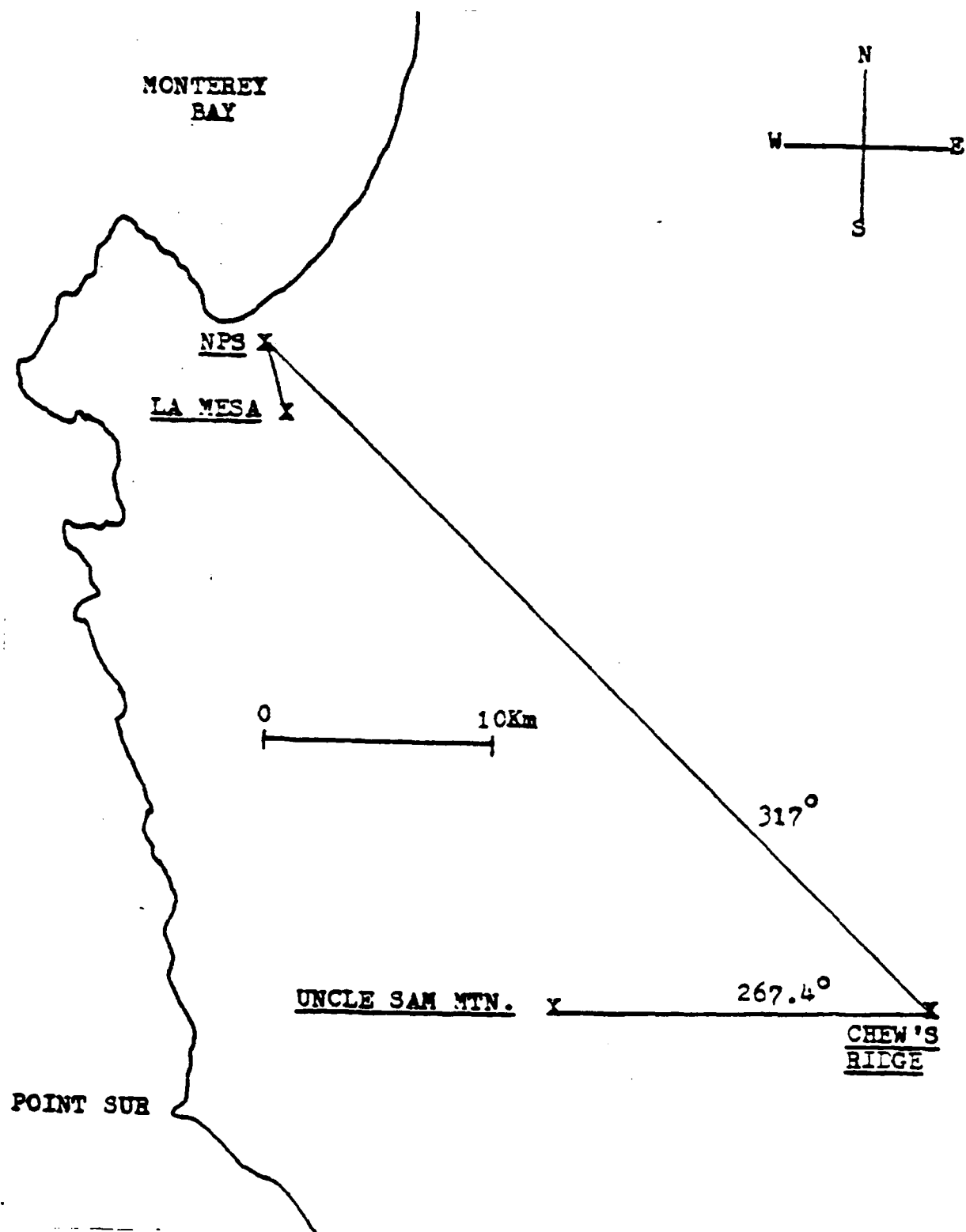


Figure A.1 Geographical Area of Data Collection.

APPENDIX B

PCM DECODING PROCEDURE

Several electronic components are utilized to decode the PCM data to digital form which is ultimately stored on nine track, 800 bits per inch digital tape. This data processing system is shown in Figure B.1. Central control of this process is accomplished with a Hewlett Packard 9845A computer utilizing an operator interactive program, "PCMPROG". After execution of the program, the computer requests entry of specific function control parameters into the computer and other equipment. These inputs are used to control synchronization of equipment start, digital tape drive speed, decode rate, decode time and synchronization code word entry into the decoder. The PCM encoded data is fed into the system from the HP 3964A/3968A tape recorder previously used to record the data. The decoding of the PCM data is accomplished with a Marine Profiles, Incorporated Model 319 PCM decoder. A Monsanto AM-6419/USM-368 oscilloscopes are used to display the PCM data. A Kennedy Model 9800 digital recorder and computer interface are employed to store the digital data on the nine track digital tape.

2/2

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DEC 83

F/G 8/14

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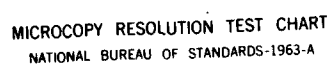
2003

Figure 1

10

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OTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

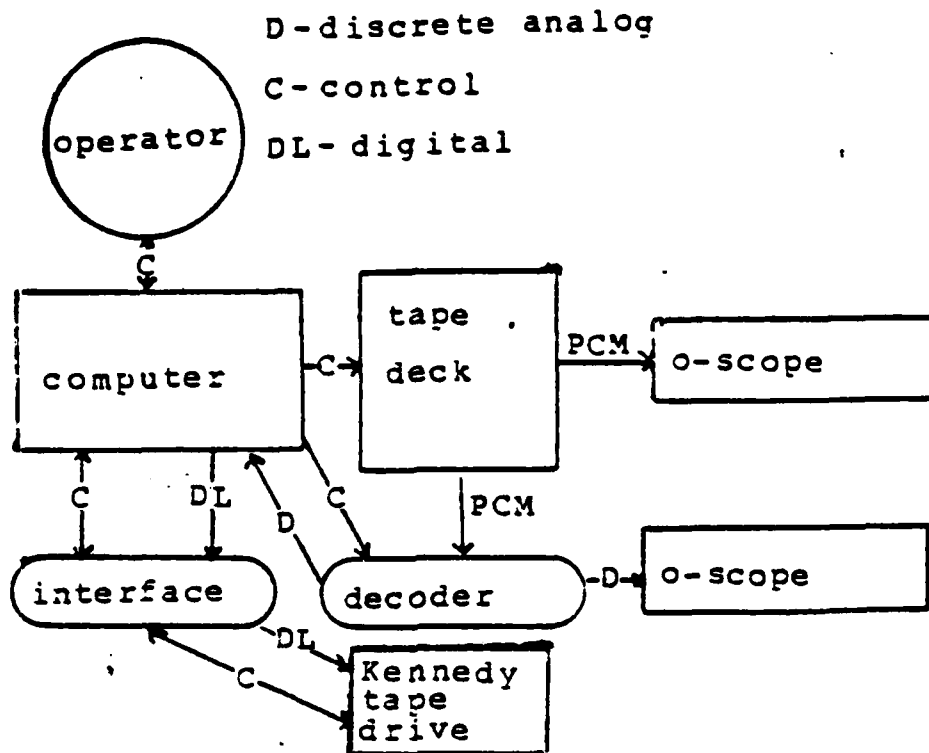


Figure B.1 Decoding System Data Flow and Control.

1. Decoding Procedure

a. Connect a coaxial cable between the output channel desired for decoding of the HP 3964A/3984A tape recorder and channel three of the Model 319 PCM decoder.

b. Energize the HP 3964A/3984A tape recorder, the Monsanto AM-6419/USM-368 oscilloscope, the Kennedy interface and the AANDERAA tape transfer interface, the Model 319 PCM decoder and the HP 9845A computer. Also, on the PCM Model 319 decoder place the fan toggle switch in the UP position and the AC/DC/OFF switch in the AC position.

c. Place into the right hand side tape reader of the HP 9845A computer the program named "PCM PROG". Type the command "MASS STORAGE IS":T15" and press EXECUTE. Then type the command GET "MT" and press EXECUTE.

d. On the PCM decoder place the following functions to the listed positions:

SOURCE - 3

SAMPLE RATE - 64 (for 3 3/4 recorder speed)

INVERT/NORMAL - NORMAL

OUTPUT/SAMPLE RATE - 0

RECORDS/FILE - INFINITY

SYNC CODE - 000

e. Press RUN on the computer, ignore the computer's response "enter Y to skip tape init" and press CONTINUE.

f. The computer now indicates "load tape" into the Kennedy unit and "put on line". To do this energize the Kennedy unit, place a write ring on the digital tape and load the tape according to the diagram located on the inside of the unit's door, press the LOAD button and the ON-LINE button located on the front of the unit.

g. The computer now indicates "enter synch code". Type into the computer 3658 (Chew's Ridge tapes) or 3155 (La Mesa Village tapes) and press CONTINUE.

h. Enter transfer time in minutes and seconds into the computer. For example 30 minutes and 50 seconds would be typed in as 30,50. Most analog tapes lasted 45 - 50 minutes. After this is done, press CONTINUE.

i. Push the STOP switch on the PCM decoder and press CONTINUE on the computer.

j. Push the PLAY button on the Hewlett Packard tape recorder, listening to the WWV time signal over a speaker or headphones. Push the START switch on the PCM decoder to begin the decoding process at a chosen time, using the second "ticks" of the time signal as a count-down. The decoding of the corresponding analog tape from the other recording site must be started at precisely the same time.

k. To end the data transfer early, push the K0 button on the computer. If this option is selected, "T" must be entered on the computer to write end of file on the digital tape.

l. "End of run" will be indicated on the computer CRT. Deenergize the equipment.

APPENDIX C

VOLTR COMPUTER PROGRAM

```

//CHFI1SR JOB (2552,0165),ANTHONY SMC 2123,CLASS=G
//*MAIN ORG=MPGVM1,2992P,LINES=(65)
//*FORMAT PR,DONAME=PLOT,SYSVECTR,DEST=LOCAL
// EXEC FRTXCLGP,PARM.LKED=LIST,MAP,XREF,REGION.GC=2048K
//FORT.SYSIN DD *
C
C THIS PROGRAM GENERATES ROUGH VOLTAGE VS TIME PLOTS. THE DATA IS
C READ FROM A COMPUTER TAPE IN BLOCKS CONTAINING 8192 SAMPLES, OR
C 128 SECONDS OF DATA.
C   INTEGER*2 IN(16)
C   ARRAY *IN, IS USED IN READING DATA FROM TAPE
C   REAL *4 XX(8192),VY(8192),ZZ(8192)
C   THE ABOVE REAL*4 ARRAYS ARE USED TO ORDER INPUT DATA AND
C   INITIALLY REPRESENT VOLTAGE - TIME SERIES INFORMATION.
C   DIMENSION ZZX1(65536),ZZY1(65536),ZZV1(65536)
C   DIMENSION TIME2(65536)
C   INTEGER K,I
C   INTEGER*4 I1B(12)/12*0/
C   REAL*4 I1B(28)/28*0.0/
C   REAL*4 ALAB(3)/CH-X*,CH-Y*,CH-Z*/
C   REAL*8 TITLE(12)
C   EQUIVALENCE(TITLE(1),RTB(5))
C   ARRAYS *ITB,*RTB,*ALAB,AND *TITLE ARE USED IN GENERATING
C   THE VERTICATE PLCTTER OUTPUT.
C   DATA XX,VY/16384*0./
C   DATA ZZ/8192*0./
C   K=0
C   I5=1
C   DO 31 IN1=1,65536
C     ZZX1(IN1)=C.0
C     ZZY1(IN1)=C.0
C     ZZV1(IN1)=C.0
C     TIME2(IN1)=C.0
C   31 CONTINUE
C   THE NEXT FIVE LINES SERVE AS A TIME DELAY IN STARTING THE
C   DATA ANALYSIS. ISEC IS THE NUMBER OF SECONDS DELAYED.
C   ISEC=10
C   I1L=ISEC*64
C   DO 55 JJ=1,I1L
C     CALL RC(20,IN,200,I1REC,IRR)
C   55 CONTINUE
C   IFRAME=8192
C   THE VALUE OF NR DETERMINES THE NUMBER OF DATA BLOCKS THE ARE
C   READ AND ANALYZED.
C   NR=8
C   FNR=FLCAT(INF)
C   DO 70 LI=1,NR
C     THE DC LOOP ENDING WITH STATEMENT 70 ENABLES THE PROGRAM TO

```

102

VOL00970
 VOL00980
 VOL00990
 VOL01000
 VOL01010
 VOL01020
 VOL01030
 VOL01040
 VOL01050
 VOL01060
 VOL01070
 VOL01080
 VOL01090
 VOL01100
 VOL01110
 VOL01120
 VOL01130
 VOL01140
 VOL01150
 VOL01160
 VOL01170
 VOL01180
 VOL01190
 VOL01200
 VOL01210
 VOL01220
 VOL01230
 VOL01240
 VOL01250
 VOL01260
 VOL01270
 VOL01280
 VOL01290
 VOL01300
 VOL01310
 VOL01320
 VOL01330
 VOL01340
 VOL01350
 VOL01360
 VOL01370
 VOL01380
 VOL01390
 VOL01400
 VOL01410
 VOL01420
 VOL01430
 VOL01440

ITB(7)=1
 ITB(12)=0
 RTB(1)=0.0
 RTB(2)=0.0
 RTB(3)=ALAE(1)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZX1,ITB,RTB)
 RTB(3)=ALAE(2)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZY1,ITB,RTB)
 RTB(3)=ALAE(3)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZV1,ITB,RTB)
 ITB(3)=7
 ITB(4)=5
 ITB(12)=0
 RTB(3)=ALAE(1)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZX1,ITB,RTB)
 RTB(3)=ALAE(2)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZY1,ITB,RTB)
 RTB(3)=ALAE(3)
 READ(5,3000)ITILE
 CALL DRAMP(NPTS,TIME2,ZZV1,ITB,RTB)
 FCFORMAT(6A8)
 STOP
 END

3000

SUBROUTINE RD(IUN,IC,IRS,IRES,IRQ)

THIS PROCEDURE FURNISHED BY DR. TIM STANTON,
 DEPARTMENT OF OCEANOGRAPHY.

READ DATA FROM IUN, ALIGN, CHECK & RETURN

IUN=TAPE NUMBER, EG 20
 IO=INTEGER*2 ARRAY, 16 LONG, (VALUES 0-4095, SUBTRACT 2048)*5
 /2028. GIVES VOLTAGE
 IRS= NUMBER OF RESINCS ALLOWED (ERRORS)
 IREC= COUNTER OF RECORDS (FRAMES CF DATA)
 BLOCK 512 BITS, 32 BITS = RECORD
 800 RFI TAPE UNLABLED
 IRQ= NUMBER OF ACTUAL RESINCS (ERRORS)

INTEGER * 2 IC(16),IP(16)
 DATA IRR /C/
 IF (IREC.EC.0) IS=0

CCCCCCCCCCCCCCCC

```

20      IER=0
      FORMAT (16A2)
      IF (ICS.NE.0) GO TC 50
      READ (IUN,20,END=900) IP
      IREC=IREC+1
40      IS=IS+1
      IF (IS.LT.17) GO TO 50
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      ICH=IMASK(IP(IS),3,0)+1
      WRITE (6,55) ICH,IS,IUN,IREC
      FORMAT (1 RESYNCH ICH,IS,IUN,IREC ',418)
      C
      C
      IF (ICP.NE.1) GO TC 40
      DC 100 I=1,16
      IO(1)=ISHIFT(IP(IS),4)
      ICH=IMASK(IP(IS),3,0)+1
      IF (ICH.EQ.1) GO TO 80
      IER=IER+1
      WRITE (6,70) IUN,IREC I,ICH,IER
      FORMAT (1,13, RECORD ',16, CHAN & DATA CH ',214,
7C      $
80      * ERRORS ',17)
      IS=IS+1
      IF (IS.LT.17) GO TC 100
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      CONTINUE
      C
100     IF (IER.EQ.0) GO TO 150
      IRR=IRR+1
      IF (IRR.LT.IRS) GC TO 120
      WRITE (6,110)
      FORMAT (11 STOPPED IN SUB RD BECAUSE OF IRR.GT.',16,' AT L11C')
110     IRQ=IRR
      STOP
      CONTINUE
      WRITE (6,120) IREC,IRR
      FORMAT (1 RESYNCH AT FRAME ',16,' WITH TOTAL ERRORS ',17)
120     IER=0
      IRQ=IRR
      GO TO 50
      CONTINUE
      RETURN
130     WRITE (6,130) IUN,IREC
      FORMAT (1 END OF UNIT ',13,' AT REC ',17)
150
900
510     STUP

```

```

VOL01450
VOL01460
VOL01470
VOL01480
VOL01490
VOL01500
VOL01510
VOL01520
VOL01530
VOL01540
VOL01550
VOL01560
VOL01570
VOL01580
VOL01590
VOL01600
VOL01610
VOL01620
VOL01630
VOL01640
VOL01650
VOL01660
VOL01670
VOL01680
VOL01690
VOL01700
VOL01710
VOL01720
VOL01730
VOL01740
VOL01750
VOL01760
VOL01770
VOL01780
VOL01790
VOL01800
VOL01810
VOL01820
VOL01830
VOL01840
VOL01850
VOL01860
VOL01870
VOL01880
VOL01890
VOL01900
VOL01910
VOL01920

```

VOL01930
 VOL01940
 VOL01950
 VOL01960
 VOL01970
 VOL01980
 VOL01990
 VOL02000
 VOL02010
 VOL02020
 VOL02030
 VOL02040
 VOL02050
 VOL02060
 VOL02070
 VOL02080
 VOL02090
 VOL02100
 VOL02110
 VOL02120
 VOL02130
 VOL02140
 VOL02150
 VOL02160
 VOL02170
 VOL02180
 VOL02190
 VOL02200
 VOL02210
 VOL02220
 VOL02230
 VOL02240
 VOL02250
 VOL02260
 VOL02270
 VOL02280
 VOL02290
 VOL02300
 VOL02310
 VOL02320
 VOL02330
 VOL02340
 VOL02350
 VOL02360
 VOL02370
 VOL02380
 VOL02390
 VOL02400

```

END
FUNCTION ISHIFT (IN,NPLC)
  RETURNS SHIFTED VALUE OF I*2 WORD IN
  -VE LEFT,+VE RIGHT SHIFT
  C
  C
  INTEGER * 2 IN
  IP=IN
  IF (IP.LT.0) IP=IP+65536
  IF (NPLC.LT.0) GC=IC 30
  ISHIFT=IP/(2**IABS(NPLC))
  RETURN
  30
  ISHIFT=IP*(2**IABS(NPLC))
  IF (ISHIFT.GT.65535) ISHIFT=MOD(ISHIFT,65536)
  RETURN
END
FUNCTION IMASK (IN,IBL,IBR)
  MASK I*2 WORD IN OUTSIDE BITS IBL & IER
  C
  C
  INTEGER * 2 IN,IO
  IO=IN
  IF (IBR.EQ.0) GO TO 50
  IT=ISHIFT(IN,IBR)
  IO=IT
  IO=ISHIFT(IO,IBL-15-IBR)
  IO=IP
  IMASK=ISHIFT(IO,15-IBL)
  RETURN
  50
  END
  C
  C
  //GC.SYSIN DC *
  XCHW'S RIDGE IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  YCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  ZCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  XCHW'S RIDGE IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  YCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  ZCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  XCHW'S RIDGE IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  YCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  ZCCIL AMP IN VOLTS 4 AUG 83, 1802-1819 LOCAL
  //GO.FT20F001 DD LUNIT=3400-4,VOL=SER=CRDT3A,DISP=(OLD,KEEP),
  // LABEL=(1,NL,IN)
  // DCE=(RECFM=FB,LRECL=32,BLKSIZE=512,DEN=2)
  //GO.SYSDUMP DD SYSOUT=A
  
```

VOL 2410
VOL 2420

1*

APPENDIX D

VODIG COMPUTER PROGRAM

```

//CHFI23S JOB (2552,0165),ANTHONY SMC 2123*,CLASS=G
//*MAIN ORG=NPQVMI,2992P,LINES=(75)
//*FCRMAP PR,DDNAME=PLOT,SYSVECTR,DEST=LOCAL
// EXEC FRTXCLGP,PARM.LKED=LIST,MAP,XREF*,REGION.GC=2048K
//FCRT.SYSIN DD
C THIS PROGRAM READS IN DATA FROM DIGITAL TAPES USING THE
C SUBROUTINE RD, NORMALIZES THE DATA BETWEEN -5 AND +5 VOLTS, APPLIES
C A DIGITAL BANDPASS FILTER BETWEEN .04 AND .6 HZ DEVELOPED BY MIKE
C HLEITE AND THEN PUTS THE DATA THROUGH A 144 POINT DOUBLE RUNNING
C AVERAGE SMOOTHING ROUTINE.
C
C INTEGER*2 IN(16)
C ARRAY *IN* IS USED IN READING DATA FROM TAPE
C REAL*8 XX(8196),YY(8196),ZZ(8196),XXS(8196),YYS(8196),ZZS(8196)
C REAL*8 FIX(18),FOY(18),FIY(18),FOY(18),FIZ(18),FOZ(18)
C THE ABOVE REAL*8 ARRAYS ARE USED TO ORIGIN INPUT DATA AND
C INITIALLY REPRESENT VOLTAGE - TIME SERIES INFORMATION.
C DIMENSION ZZ(165568),ZZV(65568),ZZVI(65568)
C DATA FIX,FIY/36*0./
C DATA FIZ,FIY/16*0./
C INTEGER K,CLMY,SUMZ,SUMT,AVE1,AVE2,AVE3,AVE4
C REAL SUMX,ITB(12)/12*0./
C INTEGER*4 ITB(28)/28*0.0/
C REAL*4 ALAB(4)/CH-X*,CH-Y*,CH-Z*,TOT*/
C REAL*8 TITLE(12)
C EQUIVALENCE(TITLE(1),RTB(5))
C ARRAYS *ITB*,RTB*,ALAB* AND 'TITLE' ARE USED IN GENERATING
C THE VERTSATEC PLOTTER OUTPUT.
C DATA XX,YY/16392*0./
C DATA ZZ/8156*0./
C K=0
C I5=5
C I6=1
C THE FOLLOWING LOOP ADVANCES THE DIGITAL TAPE BY ISEC SECONDS.
C
C ISEC=1940
C ITL=ISEC*64
C CC 55 JJ=1,ITL
C CALL RC(20,IN,200,IREF,IRR)
C CONTINUE
C IFRAME=8196
C NR=3
C FNR=FLOAT(NR)
C DC 70 LI=1,NR
C THE DC LOOP ENDING WITH STATEMENT 70 ENABLES THE PROGRAM TO
C PROCESS A LARGE AMOUNT OF DATA BY REPEATING THE PRCESS IN

```

```

BLOCKS. REPRESENTS THE NUMBER OF DATA SEQUENCES.
'NR' SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL
CR 128 SECNDOS OF DATA.

THE CO LCCP ENDING WITH 60 READS THE DATA FROM THE PCM FRAME
STRIPS OUT THE SYNC CODE, AND SORTS OUT THE DATA BY CCIL
CHANNEL
DC 60 JJ=5, IFRAME
CALL RC(20, IN, 100C, IREC, IRR)
58 XX(JJ)=IN(1)
   YY(JJ)=IN(3)
   ZZ(JJ)=IN(4)
60 CCNTINUE
N=8196
FN=FLOAT(N)
DELTAT=1./64
NORMALIZE THE DATA BETWEEN +5 AND -5 VOLTS. FOR LAMESA DATA, IC
SUBTRACT 1.36, 1.0 AND 1.0 FROM XX, YY AND ZZ RESPECTIVELY, IC
REMOVE DC COMPONENT.
DO 20 J=5, N
XX(J)=((XX(J)-2048.)#5./2048.)
YY(J)=((YY(J)-2048.)#5./2048.)
ZZ(J)=((ZZ(J)-2048.)#5./2048.)
'XX' IS THE X-COIL DATA, 'YY' IS THE Y-COIL DATA,
'ZZ' IS THE Z-COIL DATA
NORTH-SOUTH COMPONENT (XX) AND THE VERTICAL COMPONENT (ZZ)
CCNTINUE
DC 91 I3=5, I196
ZZX1(I3)=XX(I3)
ZZY1(I3)=YY(I3)
ZZV1(I3)=ZZ(I3)
I3=I3+1
51 CCNTINUE
70 CCNTINUE
DCUBLE RUNNING POINT AVERAGE
DC 73 L2=1, 2
Q=0
DC 74 IS=5, 65423
SUMX=0.0
SUMY=0.0
SUMZ=0.0
DO 75 J=5, 149
SUMX=ZZX1(I3+J)+SUMX
SUMY=ZZY1(I3+J)+SUMY
SUMZ=ZZV1(I3+J)+SUMZ
75 CCNTINUE
ZZX1(I3)=SUMX/144.

```

VOD00C490
VOD00500
VOD00510
VOD00520
VOD00530
VOD00540
VOD00550
VOD00560
VOD00570
VOD00580
VOD00590
VOD00600
VOD00610
VOD00620
VOD00630
VOD00640
VOD00650
VOD00660
VOD00670
VOD00680
VOD00690
VOD00700
VOD00710
VOD00720
VOD00730
VOD00740
VOD00750
VOD00760
VOD00770
VOD00780
VOD00790
VOD00800
VOD00810
VOD00820
VOD00830
VOD00840
VOD00850
VOD00860
VOD00870
VOD00880
VOD00890
VOD00900
VOD00910
VOD00920
VOD00930
VOD00940
VOD00950
VOD00960

```

ZZVI(I5)=SLPY/I44.
ZZVI(I5)=SLMZ/I44.
Q=Q+1
CCNT INUE
74 CCNT INUE
75 APPLY DIGITAL FILTER TO DATA BLOCK
K2=5
DC 92 M1=1,NR
DC 100 K1=1,B196
XX(K1)=ZZX1(K2)
YY(K1)=ZZY1(K2)
ZZ(K1)=ZZV1(K2)
K2=K2+1
10C CCNT INUE
CALL DIGFIL(XX,FIX,XXS,FOX)
CALL DIGFIL(YY,FIY,YYS,FOY)
CALL DIGFIL(ZZ,FIZ,ZZS,FOZ)
DC 21 L=1,18
FIX(L)=FOX(L)
FIY(L)=FOY(L)
FIZ(L)=FOZ(L)
21 CCNT INUE
I4=1
DC 90 I3=5,E196
ZZX1(I6)=XS(I3)
ZZY1(I6)=YS(I3)
ZZV1(I6)=ZS(I3)
TIME2(I6)=(CELTAT*FLCAT(I4))+(128.0*FLOAT(K))
I4=I4+1
I6=I6+1
90 CCNT INUE
K=K+1
92 CCNT INUE
NL=8192#NR-1280
DC 98 I7=1,NL
ZZX1(I7)=ZZX1(I7+1280)
ZZY1(I7)=ZZY1(I7+1280)
ZZV1(I7)=ZZV1(I7+1280)
58 CCNT INUE

C VERSATEC PLGT OF V - TIME SERIES VOLTAGE SMCCTEC
C
C NPTS=380./DELTAI +1. NUMBER OF POINTS NECESSARY IN CRDR FOR
C THE O TCNPTS SECS RANGE TO BE PLOTTED.
C FOR THE FCOLLOWING 'ITB' AND 'RTB' VALUES REVIEW THE WRITE-UP
C FOR THE SUBROUTINE PROCEDURE 'DRAWP'.
ITB(3)=20

```

V0D0 1450
V0D0 1460
V0D0 1470
V0D0 1480
V0D0 1490
V0D0 1500
V0D0 1510
V0D0 1520
V0D0 1530
V0D0 1540
V0D0 1550
V0D0 1560
V0D0 1570
V0D0 1580
V0D0 1590
V0D0 1600
V0D0 1610
V0D0 1620
V0D0 1630
V0D0 1640
V0D0 1650
V0D0 1660
V0D0 1670
V0D0 1680
V0D0 1690
V0D0 1700
V0D0 1710
V0D0 1720
V0D0 1730
V0D0 1740
V0D0 1750
V0D0 1760
V0D0 1770
V0D0 1780
V0D0 1790
V0D0 1800
V0D0 1810
V0D0 1820
V0D0 1830
V0D0 1840
V0D0 1850
V0D0 1860
V0D0 1870
V0D0 1880
V0D0 1890
V0D0 1900
V0D0 1910
V0D0 1920

```

ITB(4)=8
ITB(7)=1
ITB(12)=0
RTB(1)=0.0
RTB(2)=0.0
RTB(3)=ALAE(1)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZX1,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZY1,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZV1,ITB,RTB)
ITB(3)=7
ITB(4)=5
ITB(12)=0
RTB(3)=ALAE(1)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZX1,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZY1,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,3000)ITILE
CALL DRAMP(NPTS,TIME2,ZZV1,ITB,RTB)
FCRMT(16A8)
STOP
END
3000

```

SUBROUTINE RD(IUN,IC,IRS,IREC,IRQ)
THIS PROCEDURE FURNISHED BY DR. TIM STANTON,
DEPARTMENT OF OCEANOGRAPHY.
READ DATA FROM IUN, ALIGN, CHECK & RETURN

IUN=TAPE NUMBER, EG 20
IO=INTEGER#2 ARRAY, 16 LONG, (VALUES 0-4095, SLBTRACT 2048)*5
IRS= NUMBER OF RESINCS ALLOWED (ERRORS)
IREC= COUNTER OF RECORDS (FRAMES OF DATA)
BLOCK 512 BITS, 32 BITS = RECORD
800 EPI TAPE UNABLED
IRQ= NUMBER OF ACTUAL RESINCS (ERRORS)

INTEGER * 2 IO(16),IP(16)
DATA IRR /C/

```

20      IF (IER.EC.0) IS=0
      IER=0
      FORMAT (16#2)
      IF (IS.NE.0) GO TO 50
      READ (IUN,20,END=900) IP
      IREC=IREC+1
      IS=IS+1
      IF (IS.LT.17) GO TO 50
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      ICH=IMASK(IP(IS),3,0)+1
      WRITE (6,55) ICH,IS,IUN,IREC
      FORMAT (16#5) RESYNCHING ICH,IS,IUN,IREC ,41E)
      C
      IF (ICH.NE.1) GO TO 40
      CL 100 I=1,16
      IO(1)=1 SHIFT(IP(IS),4)
      ICH=IMASK(IP(IS),3,0)+1
      IF (ICH.EQ.1) GO TO 80
      IER=IER+1
      WRITE (6,70) IUN,IREC ,1,ICH,IER
      FORMAT (16#5) UNIT ,13, RECORD ,16, CHAN & DATA CH ,214,
      *ERRORS ,17)
      IS=IS+1
      IF (IS.LT.17) GO TO 100
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      CONTINUE
      C
      IF (IER.EC.0) GO TO 150
      IRR=IRR+1
      IF (IRR.LT.IRS) GO TO 120
      WRITE (6,110)
      FORMAT (16#5) STOPPED IN SUB RD BECAUSE OF IRR.GT.,16, AT L11C)
      IRR=IRR
      STOP
      CONTINUE
      WRITE (6,120) IREC,IRR
      FORMAT (16#5) RESYNC AT FRAME ,16, WITH TOTAL ERRORS ,17)
      IER=0
      GO TO 50
      CONTINUE
      RETURN
      WRITE (6,910) IUN,IREC
      FORMAT (16#5) END OF UNIT ,13, AT REC ,17)
      C
      500
      510

```

```

VOD01930
VOD01940
VOD01950
VOD01960
VOD01970
VOD01980
VOD01990
VOD02000
VOD02010
VOD02020
VOD02030
VOD02040
VOD02050
VOD02060
VOD02070
VOD02080
VOD02090
VOD02100
VOD02110
VOD02120
VOD02130
VOD02140
VOD02150
VOD02160
VOD02170
VOD02180
VOD02190
VOD02200
VOD02210
VOD02220
VOD02230
VOD02240
VOD02250
VOD02260
VOD02270
VOD02280
VOD02290
VOD02300
VOD02310
VOD02320
VOD02330
VOD02340
VOD02350
VOD02360
VOD02370
VOD02380
VOD02390
VOD02400

```


$A1 = 1. + A * T / 2. + B * (T ** 2) / 4.$
 $B1 = -2. + B * (T ** 2) / 2.$
 $C1 = 1. - A * T / 2. + B * (T ** 2) / 4.$
 $D1 = 1. + C * T / 2. + D * (T ** 2) / 4.$
 $E1 = -2. + D * (T ** 2) / 2.$
 $F1 = 1. - C * T / 2. + D * (T ** 2) / 4.$
 $G1 = 1. + E * T / 2. + F * (T ** 2) / 4.$
 $H1 = -2. + F * (T ** 2) / 2.$
 $I1 = 1. - E * T / 2. + F * (T ** 2) / 4.$

CODE IS "ASHP41" MEANS "A1 COEFFICIENT FOR THE SELECTABLE HIGH
 PASS FILTER WITH LOWER LIMIT 0.04 HZ"

$ASHP41 = 1. / (A1 * D1 * G1)$
 $ASHP42 = - (C1 / A1)$
 $ASHP43 = - (B1 / A1)$
 $ASHP44 = - (E1 / D1)$
 $ASHP45 = - (F1 / D1)$
 $ASHP46 = - (H1 / G1)$
 $ASHP47 = - (I1 / G1)$

COEFFICIENTS FOR SELECTABLE LOW PASS FILTER WITH UPPER FREQ
 OF 0.6 HZ

$A = 1. / 0.03452$
 $B = 0.35804 / C.03492$
 $C = 1. / 0.03452$
 $D = 0.20696 / 0.02779$
 $E = 1. / 0.02779$
 $F = 1. / 0.02779$
 $G = 1. / 0.02779$

$A1 = 2. * A$
 $B1 = A1$
 $D1 = D * (T ** 2) / 4.$

$E1 = 2. * C1$
 $F1 = D1$
 $G1 = (1. + B * T / 2. + C * (T ** 2) / 4.)$
 $H1 = (-2. + C * (T ** 2) / 2.)$
 $I1 = (1. - B * T / 2. + C * (T ** 2) / 4.)$
 $J1 = (1. + E * T / 2. + F * (T ** 2) / 4.)$
 $K1 = (-2. + F * (T ** 2) / 2.)$
 $L1 = (1. - E * T / 2. + F * (T ** 2) / 4.)$
 $ASLP61 = - (G1 * K1 + H1 * J1) / (G1 * J1)$
 $ASLP62 = - (G1 * L1 + H1 * K1 + I1 * J1) / (G1 * J1)$
 $ASLP63 = - (H1 * L1 + I1 * K1) / (G1 * J1)$
 $ASLP64 = - (I1 * L1) / (G1 * J1)$
 $BSLP60 = (A1 * C1) / (G1 * J1)$
 $BSLP61 = (A1 * E1 + B1 * C1) / (G1 * J1)$

V000 2890
 V000 2900
 V000 2910
 V000 2920
 V000 2930
 V000 2940
 V000 2950
 V000 2960
 V000 2970
 V000 2980
 V000 2990
 V000 3000
 V000 3010
 V000 3020
 V000 3030
 V000 3040
 V000 3050
 V000 3060
 V000 3070
 V000 3080
 V000 3090
 V000 3100
 V000 3110
 V000 3120
 V000 3130
 V000 3140
 V000 3150
 V000 3160
 V000 3170
 V000 3180
 V000 3190
 V000 3200
 V000 3210
 V000 3220
 V000 3230
 V000 3240
 V000 3250
 V000 3260
 V000 3270
 V000 3280
 V000 3290
 V000 3300
 V000 3310
 V000 3320
 V000 3330
 V000 3340
 V000 3350
 V000 3360

V000 3370
V000 3380
V000 3390
V000 3400
V000 3410
V000 3420
V000 3430
V000 3440
V000 3450
V000 3460
V000 3470
V000 3480
V000 3490
V000 3500
V000 3510
V000 3520
V000 3530
V000 3540
V000 3550
V000 3560
V000 3570
V000 3580
V000 3590
V000 3600
V000 3610
V000 3620
V000 3630
V000 3640
V000 3650
V000 3660
V000 3670
V000 3680
V000 3690
V000 3700
V000 3710
V000 3720
V000 3730
V000 3740
V000 3750
V000 3760
V000 3770
V000 3780
V000 3790
V000 3800
V000 3810
V000 3820
V000 3830
V000 3840

BSLP62=(A1*F1+B1*E1+C1*D1)/(G1*J1)
BSLP63=(B1*F1+C1*E1)/(G1*J1)
BSLP64=(C1*F1)/(G1*J1)

SET TRANSFERRED VALUES EQUAL TC INITIAL ARRAY VALUES AND
APPLY DIGITAL FILTER TO ARRAY INFLO

YC(4)=FILE(1)
YQ(3)=FILE(2)
XI(4)=FILE(3)
XIII(4)=FILE(4)
XIII(3)=FILE(5)
XV(4)=FILE(6)
XV(3)=FILE(7)
XV(3)=FILE(8)
YPO(4)=FILE(9)
YPO(3)=FILE(10)
YPO(2)=FILE(11)
YFO(1)=FILE(12)
CUTFLD(4)=FILE(13)
CUTFLD(3)=FILE(14)
CUTFLD(2)=FILE(15)
CUTFLD(1)=FILE(16)
INFLO(4)=FILE(17)
INFLO(3)=FILE(18)

N=8196
DC 92 I=5,N
I1=I-1
I2=I-2
I3=I-3
I4=I-4

YC(I)=BFHP C*INFLO(I)+BFHP1*INFLO(I1)+BFHP2*INFLO(I2)+AFT*P1*YQ(I1)
\$+AFHP2*YQ(I2)
XI(I)=ASHP41*YQ(I)+ASHP42*XI(I2)+ASHP43*XI(I1)
XII(I)=XI(I1)+XI(I2)-2*XI(I1)
XIII(I)=XI(I1)+ASHP44*XI(I1)+ASHP45*XI(I2)
XIV(I)=XI(I1)-2*XI(I1)+XI(I2)
XV(I)=XIV(I1)+ASHP46*YV(I1)+ASHP47*YV(I2)
YPO(I)=XV(I1)+XV(I2)-2*YV(I1)
GP1=ASLP61*CUTFLD(I1)+ASLP62*OUTFLD(I2)+ASLP63*CUTFLD(I3)+ASLP64
\$*CUTFLD(I4)
GP2=BSLP60*YPO(I)+BSLP61*YPO(I1)+BSLP62*YPC(I2)+BSLP63*YPO(I3)
\$+BSLP64*YPC(I4)
CUTFLD(I)=GF1+GP2
SIG(I)=OUTFLD(I)
WRITE(6,1) INFLO(I),YQ(I),XI(I),XIII(I),XIV(I)
1 FCRMAT(1) A,6G10.5)
2 WRITE(6,2) YV(I),YPO(I),GP1,GP2,OUTFLD(I),SIG(I)
2 FCRMAT(1) B,6G10.5)

C
C
C
C

V0D0 3850
V0D0 3860
V0D0 3870
V0D0 3880
V0D0 3890
V0D0 3900
V0D0 3910
V0D0 3920
V0D0 3930
V0D0 3940
V0D0 3950
V0D0 3960
V0D0 3970
V0D0 3980
V0D0 3990
V0D0 4000
V0D0 4010
V0D0 4020
V0D0 4030
V0D0 4040
V0D0 4050
V0D0 4060
V0D0 4070
V0D0 4080
V0D0 4090
V0D0 4100
V0D0 4110
V0D0 4120
V0D0 4130
V0D0 4140
V0D0 4150
V0D0 4160
V0D0 4170
V0D0 4180
V0D0 4190
V0D0 4200
V0D0 4210
V0D0 4220
V0D0 4230
V0D0 4240
V0D0 4250
V0D0 4260
V0D0 4270
V0D0 4280
V0D0 4290
V0D0 4300
V0D0 4310
V0D0 4320

```

92 CCNT INUE
  FCLE(1)=Y0(8196)
  FCLE(2)=Y0(8195)
  FCLE(3)=X1(8196)
  FCLE(4)=X1(8195)
  FCLE(5)=X111(8196)
  FCLE(6)=X111(8195)
  FCLE(7)=XV(8196)
  FCLE(8)=XV(8195)
  FCLE(9)=YPC(8196)
  FCLE(10)=YPC(8195)
  FCLE(11)=YFC(8194)
  FCLE(12)=YFC(8193)
  FCLE(13)=01TFLD(8196)
  FCLE(14)=01TFLD(8195)
  FCLE(15)=01TFLD(8194)
  FCLE(16)=01TFLD(8193)
  FCLE(17)=1NFLD(8196)
  FCLE(18)=1NFLD(8195)
  RETURN
END
FUNCTION ION ISHIFT (IN,NPLC)
  RETURNS SHIFTED VALUE OF I*2 WORD IN
  -VE LEFT,+VE RIGHT SHIFT
  INTEGER * 2 IN
  IP=IN
  IF (IP.LT.C) IP=IP+65536
  IF (NPLC.LT.0) GC TC 30
  ISHIFT=IP/(2**IABS(NPLC))
  RETURN
  ISHIFT=IP*(2**IABS(NPLC))
  IF (ISHIFT.GT.65535) ISHIFT=MOD(ISHIFT,65536)
  RETURN
END
FUNCTION IMASK (IN,IBL,IBR)
  MASK I*2 WCRD IN OUTSIDE BITS IBL & IBR
  INTEGER * 2 IN,IO
  IO=IN
  IF (IBR.EQ.0) GO TC 50
  IT=ISHIFT(IN,IBR)
  IO=IT
  IP=ISHIFT(IO,IBL-15-IBR)
  IO=IP
  IMASK=ISHIFT(IO,15-IBL)
  RETURN
END

```

92

C C C

30

C C

50

```

//GC.SYSIN DE *
CHEN'S RIDGE IN VOLTS 4 AUG 83, 1834-1840 LOCAL
X COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
Y COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
Z COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
CHEN'S RIDGE IN VOLTS 4 AUG 83, 1834-1840 LOCAL
X COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
Y COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
Z COIL AMP IN VOLTS 4 AUG 83, 1834-1840 LOCAL
//GC.FI20F001 DD UNIT=3400-4,VOL=SER=CRDT3A,DISP=(OLC,KEEP),
// LABEL=(1,AL,IN),
// DCF=(RECFM=F8,LRECL=32,BLKSIZE=512,DEN=2)
//GC.SYSDUMP DD SYSOUT=A
//

```

```

VDD0 4330
VDD0 4340
VDD0 4350
VDD0 4360
VDD0 4370
VDD0 4380
VDD0 4390
VDD0 4400
VDD0 4410
VDD0 4420
VDD0 4430
VDD0 4440
VDD0 4450
VDD0 4460
VDD0 4470
VDD0 4480
VDD0 4490
VDD0 4500
VDD0 4510
VDD0 4520
VDD0 4530

```

APPENDIX E

MASS STORAGE COMPUTER PROGRAM

```

C //TAPEMS5 JOB (2592,0165), 'ANTHONY SMC 2123', CLASS=G
C // *MAIN ORG=NPGVPI.2992P
C // EXEC FORTXCLG
C // FORT.SYSIN DD *
C
C THIS PROGRAM READS DATA FROM A COMPUTER TAPE, NORMALIZES THE DATA
C BETWEEN +5 AND -5 VOLTS AND STORES IT IN THE IBM 3033 MASS STORAGE
C SYSTEM FOR FUTURE RECALL. THE DATA IS READ AND TRANSFERRED IN
C BLOCKS OF 8152 SAMPLES (128 SECONDS OF DATA IN EACH BLOCK).
C THE ARRAY 'IN' WILL BE USED TO
C RECEIVE THE DATA PASSED FROM
C THE SUBROUTINE 'RD' AND THEN
C TRANSFERRED TO THE APPROPRIATE
C XXX OR YYY OR ZZZ ARRAY.
C
C INTEGER*2 IN(16)
C COMPLEX*8 XXX(8192), YYY(8192), ZZZ(8192)
C DATA XXX, YYY/16384*(C.0,0.0)/
C DATA ZZZ/8152*(0.0)/
C THE FOLLOWING SECTION READS THE FIRST
C ISEC SECONDS OF DATA FROM THE TAPE
C AND DISCARDS THIS DATA.
C
C ISEC=200
C ITL=ISEC*64
C DO 55 JJ=1, ITL
C CALL RC(20, IN, 200, IREC, IRR)
C CONTINUE
C IFRAME=8192
C THE VARIABLE NR SPECIFIES THE NUMBER OF BLOCKS OF DATA TO BE
C READ FROM THE TAPE AND STORED IN THE MSS.
C NR=19
C DC 70 LI=1, NR
C
C THE NEXT LOOP READS NR FRAMES OF DATA (EACH FRAME
C 128 SECS LONG AT 64 HZ SAMPLING RATE) USING THE
C SUBROUTINE RC, PROVIDED BY DR. TIM STANTON OF THE
C NAVAL POSTGRADUATE SCHOOL.
C
C DO 60 JJ=1, IFRAME
C CALL RC(20, IN, 1000, IREC, IRR)
C XXX( JJ )=IN(2)
C YYY( JJ )=IN(3)
C ZZZ( JJ )=IN(4)
C CONTINUE
C N=8192
C DO 20 J=1, N
C
C THE NEXT 4 STEPS CONVERT THE

```



```

20      INTEGER * 2 IO(16),IP(16)
        DATA IRR /C/
        IF (IREC.EQ.0) IS=0
        IER=0
        FORMAT (16A2)
        IF (IS.NE.0) GO TO 50
        READ (IUN,20,END=900) IP
        IREC=IREC+1
        IS=IS+1
        IF (IS.LT.17) GO TO 50
        READ (IUN,20,END=900) IP
        IS=1
        IREC=IREC+1
        ICH=IMASK(IP(IS),3,0)+1
        WRITE (6,55) ICH,IS,IUN,IREC
        FORMAT (1,RESYNCRING ICH,IS,IUN,IREC,4I8)
        C
        IF (ICF.NE.1) GO TO 40
        DO 100 I=1,16
        IO(I)=ISHIFT(IP(IS),4)
        ICH=IMASK(IP(IS),3,0)+1
        IF (ICF.EQ.1) GO TO 80
        IER=IER+1
        WRITE (6,70) IUN,IREC,I,ICH,IER
        FORMAT (1,UNIT,13,RECORD,16,CHAN & DATA CH,2I4,
        $,ERRORS,17)
        IS=IS+1
        IF (IS.LT.17) GO TO 100
        READ (IUN,20,END=900) IP
        IS=1
        IREC=IREC+1
        CONTINUE
        C
        IF (IER.EQ.0) GO TO 150
        IRR=IRR+1
        IF (IRR.LT.IRS) GO TO 120
        WRITE (6,110)
        FORMAT (1,STOPPED IN SUB RD BECAUSE OF IRR.GT.,16,AT L110)
        IRR=IRR
        STOP
        CONTINUE
        WRITE (6,120) IREC,IRR
        FORMAT (1,RESYNCR AT FRAME,16,WITH ICIAL ERRORS,17)
        IER=0
        IRR=IRR
        GO TO 50
        CONTINUE
        RETURN
150

```

JOE00970
 JOE00980
 JOE00990
 JOE01000
 JOE01010
 JOE01020
 JOE01030
 JOE01040
 JOE01050
 JOE01060
 JOE01070
 JOE01080
 JOE01090
 JOE01100
 JOE01110
 JOE01120
 JOE01130
 JOE01140
 JOE01150
 JOE01160
 JOE01170
 JOE01180
 JOE01190
 JOE01200
 JOE01210
 JOE01220
 JOE01230
 JOE01240
 JOE01250
 JOE01260
 JOE01270
 JOE01280
 JOE01290
 JOE01300
 JOE01310
 JOE01320
 JOE01330
 JOE01340
 JOE01350
 JOE01360
 JOE01370
 JOE01380
 JOE01390
 JOE01400
 JOE01410
 JOE01420
 JOE01430
 JOE01440

```

500 WRITE (6,510) IUN,IREC
910 FORMAT (11 END OF UNIT ',13,' AT REC ',17)
STOP
END

C
C
C
FUNCTION ISHIFT (IN,NPLC)
  RETURNS SHIFTED VALUE OF I*2 WORD IN
  -VE LEFT,+VE RIGHT SHIFT
C
C
C
INTEGER * 2 IN
IP=IN
IF (IP.LT.C) IP=IP+65536
IF (NPLC.LT.0) GC=TC-30
ISHIFT=IP/(2**IABS(NPLC))
RETURN
ISHIFT=IP*(2**IABS(NPLC))
IF (ISHIFT.GT.65535) ISHIFT=MOD(ISHIFT,65536)
RETURN
END
FUNCTION IMASK (IN,IBL,IBR)
  MASK I*2 WORD IN OUTSIDE BITS IBL & IBR
C
C
C
INTEGER * 2 IN,IC
IO=IN
IF (IBR.EC.0) GO TC 50
IT=ISHIFT(IN,IBR)
IO=IT
IP=ISHIFT(IO,IBL-15-IBR)
IO=IP
IMASK=ISHIFT(IO,15-IBL)
RETURN
END

C
C
C
//GO.FT21F001 DD LUNIT=3330V,MSVGP=PUB4A,DISP=(NEW,CATLG),
//DSN=MSS.S2992.LMDT3D,
//DCE=(RECFM=VBS,BLKSIZE=4096,LRECL=4092),
//SPACE=(CYL,(8,4))
//GC.FT20F001 DD LUNIT=3400-4,VOL=SER-LMDT3,DISP=(OLC,PASS),
//LABEL=(11NL,IN),
//DCE=(RECFM=FB,LRECL=32,BLKSIZE=512,DEN=2)
//

```

JOE01450
 JOE01460
 JOE01470
 JOE01480
 JOE01490
 JOE01500
 JOE01510
 JOE01520
 JOE01530
 JOE01540
 JOE01550
 JOE01560
 JOE01570
 JOE01580
 JOE01590
 JOE01600
 JOE01610
 JOE01620
 JOE01630
 JOE01640
 JOE01650
 JOE01660
 JOE01670
 JOE01680
 JOE01690
 JOE01700
 JOE01710
 JOE01720
 JOE01730
 JOE01740
 JOE01750
 JOE01760
 JOE01770
 JOE01780
 JOE01790
 JOE01800
 JOE01810
 JOE01820
 JOE01830
 JOE01840
 JOE01850

APPENDIX F

MAGFLD COMPUTER PROGRAM

LFV00C490
LFV000500
LFV000510
LFV000520
LFV000530
LFV000540
LFV000550
LFV000560
LFV000570
LFV000580
LFV000590
LFV000600
LFV000610
LFV000620
LFV000630
LFV000640
LFV000650
LFV000660
LFV000670
LFV000680
LFV000690
LFV000700
LFV000710
LFV000720
LFV000730
LFV000740
LFV000750
LFV000760
LFV000770
LFV000780
LFV000790
LFV000800
LFV000810
LFV000820
LFV000830
LFV000840
LFV000850
LFV000860
LFV000870
LFV000880
LFV000890
LFV000900
LFV000910
LFV000920
LFV000930
LFV000940
LFV000950
LFV000960

```

AVE4=0.0
DC 31 IN1=1.65536
ZZX1(IN1)=C.0
ZZY1(IN1)=C.0
ZZV1(IN1)=C.0
ZZT1(IN1)=C.0
TIME2(IN1)=C.0
31 CCNT INUE
    THE NEXT FIVE LINES SERVE AS A TIME DELAY IN STARTING THE
    DATA ANALYSIS
    ISEC=10
    ITL=1 ISEC*64
    CC 55 JJ=1, ITL
    CALL RD(20, IN, 200, IREC, IRR)
55 CCNT INUE
    IFRAME=8192
    NR=8
    FNR=FLCAT(NR)
    CC 70 LI=1, NR
    THE DO LOOP ENDING WITH STATEMENT 70 ENABLES THE PROGRAM TO
    PROCESS A LARGE AMOUNT OF DATA BY REPEATING THE PROCESS IN
    BLOCKS.
    *NR* REPRESENTS THE NUMBER OF DATA SEQUENCES TO BE AVERAGED.
    1 SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL
    CR 256 SECONDS OF DATA.

    THE DO LOOP ENDING WITH 60 READS THE DATA FROM THE PCM FRAME
    STRIPS OUT THE SYNC CODE, AND SORTS OUT THE DATA BY COIL
    CHANNEL
    CC 60 JJ=1, IFRAME
    CALL RC(20, IN, 1000, IREC, IRR)
    XX(JJ)=IN(2)
    YY(JJ)=IN(3)
    ZZ(JJ)=IN(4)
60 CCNT INUE
    THE FOLLOWING SECTION GENERATES THE TIME AND FREQUENCY
    ARRAYS AND NORMALIZES THE INPUT PCM DATA TO VOLTAGE FORM
    IN PREPARATION FOR FAST FOURIER TRANSFORM TO THE FREQUENCY
    DOMAIN.
    N=8192
    FN=FLOAT(N)
    DELTAT=1./64.
    DELTAF=1./ (FN*DELTAT)
    CC 20 J=1, N
    TIME(J)=DELTAT*FLCAT(J)
    FREQ(J)=DELTAF*FLCAT(J)
    XX(J)=((XX(J)-2048.)*5./2048.)-1.36
    YY(J)=REAL(XX(J))

```

LFV00970
LFV00980
LFV00990
LFV01000
LFV01010
LFV01020
LFV01030
LFV01040
LFV01050
LFV01060
LFV01070
LFV01080
LFV01090
LFV01100
LFV01110
LFV01120
LFV01130
LFV01140
LFV01150
LFV01160
LFV01170
LFV01180
LFV01190
LFV01200
LFV01210
LFV01220
LFV01230
LFV01240
LFV01250
LFV01260
LFV01270
LFV01280
LFV01290
LFV01300
LFV01310
LFV01320
LFV01330
LFV01340
LFV01350
LFV01360
LFV01370
LFV01380
LFV01390
LFV01400
LFV01410
LFV01420
LFV01430
LFV01440

```

YY(J)=(YY(J)-2048.)#5./2048.)-1.0
YY(J)=REAL(YY(J))
ZZ(J)=(ZZ(J)-2048.)#5./2048.)-1.0
ZZ(J)=REAL(ZZ(J))
*XX* IS THE X-CCIL DATA, 'YY' IS THE Y-CCIL DATA,
*ZZ* IS THE Z-CCIL DATA, AND 'IF' IS THE PROJECTICN OF THE
NORTH-SOUTH COMPONENT (XX) AND THE VERTICAL COMPONENT (ZZ)
ON THE CTIAL GEOMAGNETIC FIELD VECTOR.
20 CCNT INUE
CC 21 J=1,N
FRQ2(J)=ALCG10(FREQ(J))
21 CCNT INUE
THE NEXT FOUR STATEMENTS PERFORM AN FFT CN THE INPUT
TIME SERIES DATA. SEE THE WRITEUP ON 'FCLRT' FOR
FURTHER INFORMATION.
CALL FCURT(XX,N,1,-1.0,WORK)
CALL FCURT(YY,N,1,-1.0,WORK)
CALL FCURT(ZZ,N,1,-1.0,WORK)
THE NEXT BLOCK OF STATEMENTS APPLY THE SYSTEM (VOLTAGE TO
E-FIELD) TRANSFER FUNCTION TO THE TRANSFORMED FREQUENCY
DOMAIN DATA. THIS BLOCK ENDS AT STATEMENT 9.
THE TRANSFER FUNCTION CONVERTS VOLTS TO NANOTESLAS (GAMMAS).
***WARNING*** THIS BLOCK TRANSFER FUNCTIONS YIELDS AN INACCURATE
PHASE. USE A DIFFERENT TRANSFER FUNCTION IF PHASE INFCRMATION
NEEDED.
DC 9 L=1,N
FRQ=FREQ(L)
IF (FRQ.LE.25.)GO TO 1
XX(L)=XX(L)/28.
GC TO 8
1 IF (FRQ.LE.15.)GO TO 2
XX(L)=XX(L)/(105.5-3.14*FRQ)
YY(L)=YY(L)/(181.32-7.588*FRQ)
ZZ(L)=ZZ(L)/(177.26-7.484*FRQ)
GC TO 8
2 IF (FRQ.LE.10.)GO TO 3
XX(L)=XX(L)/(5.958*FRQ-30.97)
YY(L)=YY(L)/(7.166*FRQ-39.99)
ZZ(L)=ZZ(L)/(6.49*FRQ-32.35)
GC TO 8
3 IF (FRQ.LE.7.5)GO TO 4
XX(L)=XX(L)/(3.492*FRQ-6.31)
YY(L)=YY(L)/(4.252*FRQ-10.85)
ZZ(L)=ZZ(L)/(4.044*FRQ-7.89)
GC TO 8
4 IF (FRQ.LE.5.)GO TC 5
XX(L)=XX(L)/(2.6311*FRQ+0.14667)
YY(L)=YY(L)/(3.012*FRQ-1.55)

```

LFV01450
LFV01460
LFV01470
LFV01480
LFV01490
LFV01500
LFV01510
LFV01520
LFV01530
LFV01540
LFV01550
LFV01560
LFV01570
LFV01580
LFV01590
LFV01600
LFV01610
LFV01620
LFV01630
LFV01640
LFV01650
LFV01660
LFV01670
LFV01680
LFV01690
LFV01700
LFV01710
LFV01720
LFV01730
LFV01740
LFV01750
LFV01760
LFV01770
LFV01780
LFV01790
LFV01800
LFV01810
LFV01820
LFV01830
LFV01840
LFV01850
LFV01860
LFV01870
LFV01880
LFV01890
LFV01900
LFV01910
LFV01920

```

ZZ(L)=ZZ(L)/(3.184*FRQ-1.44)
GC TO 8
5 IF(FRQ.LE.3.)GC TC 6
7 XX(L)=XX(L)/(2.6311*FRQ+0.14667)
  YY(L)=YY(L)/(2.702*FRQ)
  ZZ(L)=ZZ(L)/(2.92*FRQ)
GC TO 8
6 XX(L)=XX(L)/(2.72*FRQ)
GC TO 7
8 CCNT INU
  TF(L)=(XX(L)*.5 + ZZ(L)*.866)
5 CCNT INU
  CALL FCURT(XX,N,1,1,1,WORK)
  CALL FCURT(YY,N,1,1,1,WORK)
  CALL FCURT(ZZ,N,1,1,1,WORK)
  CALL FCURT(TF,N,1,1,1,WORK)
DC 57 J=1,N
XX(J)=XX(J)/FN
YY(J)=YY(J)/FN
ZZ(J)=ZZ(J)/FN
TF(J)=TF(J)/FN
57 CCNT INU
  J3=1,N
  ZX1(I3)=CABS(XX(I3))
  ZY1(I3)=CABS(YY(I3))
  ZV1(I3)=CABS(ZZ(I3))
  ZT1(I3)=CABS(TF(I3))
56 CCNT INU
  44 LINES OF CODE CORRECT DATA BLOCK END JUMPS.
  TFE NEXT 44 LINES OF CODE CORRECT DATA BLOCK END JUMPS.
  IF(K.NE.0) GO TO 36
DC 66 IS=8C48,8192
SUMX=ZX1(I3)+SUMX
SUMY=ZY1(I3)+SUMY
SUMZ=ZV1(I3)+SUMZ
SUMT=ZT1(I3)+SUMT
66 CCNT INU
  CCNSTX=SUMX/144.
  CCNSTY=SUMY/144.
  CCNSTZ=SUMZ/144.
  CCNSTT=SUMT/144.
DC 67 IS=1,8192
ZZX1(I4)=ZX1(I3)
ZZY1(I4)=ZY1(I3)
ZZV1(I4)=ZV1(I3)
ZZT1(I4)=ZT1(I3)
I4=I4+1
67 CCNT INU
  GC TO 37

```

LFV01930
LFV01940
LFV01950
LFV01960
LFV01970
LFV01980
LFV01990
LFV02000
LFV02010
LFV02020
LFV02030
LFV02040
LFV02050
LFV02060
LFV02070
LFV02080
LFV02090
LFV02100
LFV02110
LFV02120
LFV02130
LFV02140
LFV02150
LFV02160
LFV02170
LFV02180
LFV02190
LFV02200
LFV02210
LFV02220
LFV02230
LFV02240
LFV02250
LFV02260
LFV02270
LFV02280
LFV02290
LFV02300
LFV02310
LFV02320
LFV02330
LFV02340
LFV02350
LFV02360
LFV02370
LFV02380
LFV02390
LFV02400

```

36 CCNT INLE
SUMX=0.0
SUMY=0.0
SUMZ=0.0
SUMT=0.0
DC 68 IS=1,144
SUMX=ZXL(IIS)+SUMX
SUMY=ZYL(IIS)+SUMY
SUMZ=ZYL(IIS)+SUMZ
SUMT=ZTL(IIS)+SUMT
CCNT INUE
AVE1=SUMX/144.
AVE2=SUMY/144.
AVE3=SUMZ/144.
AVE4=SUMT/144.
DC 69 IS=1,144
ZXL(IIS)=ZXL(IIS)+(CCNSTX-AVE1)
ZYL(IIS)=ZYL(IIS)+(CCNSTY-AVE2)
ZYL(IIS)=ZYL(IIS)+(CCNSTZ-AVE3)
ZTL(IIS)=ZTL(IIS)+(CCNSTT-AVE4)
I4=I4+1
CCNT INUE
CCNT INUE
CC 91 I3=1,144
TIME2(I5)=DELTA T*FLCAT(I3)+(128.0*FLOAT(K))
I5=I5+1
CCNT INUE
CC 73 L2=1,2
CCNT INUE
CC 74 IS=1,144
SUMX=0.0
SUMY=0.0
SUMZ=0.0
SUMT=0.0
DC 75 J=1,144
SUMX=ZXL(J+J)+SUMX
SUMY=ZYL(J+J)+SUMY
SUMZ=ZYL(J+J)+SUMZ
SUMT=ZTL(J+J)+SUMT
CCNT INUE
ZXL(IIS)=SUMX/144.
ZYL(IIS)=SUMY/144.
ZYL(IIS)=SUMZ/144.
ZTL(IIS)=SUMT/144.

```

C C
C THE FOLLOWING LINES OF CODE PERFORMS A DOUBLE RUNNING PCINT
AVERAGE ON THE DATA.


```

100      IREC=IREC+1
      C
      CONTINUE
      IF (IER.EC.0) GO TO 150
      IRR=IRR+1
      IF (IRR.LT.IRS) GO TO 120
      WRITE (6,110)
      FORMAT (11 STOPPED IN SUB RD BECAUSE OF IRR.GT.',16,' AT L110')
      IRR=IRR
      STOP
110      CONTINUE
      WRITE (6,120) IREC,IRR
      FORMAT (11 RESYNC AT FRAME ',16,' WITH TOTAL ERRORS ',17)
      IER=0
      IRQ=IRR
      GO TO 50
      CONTINUE
      RETURN
120      WRITE (6,130) IUN,IREC
      FORMAT (11 END OF UNIT ',13,' AT REC ',17)
      STOP
      END
      FUNCTION ISHIFT (IN,NPLC)
      RETURNS SHIFTED VALUE OF I*2 WORD IN
      -VE LEFT,+VE RIGHT SHIFT
      C
      C
      C
      INTEGER * 2 IN
      IP=IN
      IF (IP.LT.0) IP=IP+65536
      IF (NPLC.LT.0) GC TC 30
      ISHIFT=IP/(2**IABS(NPLC))
      RETURN
30      ISHIFT=IP*(2**IABS(NPLC))
      IF (ISHIFT.GT.65535) ISHIFT=MOD(ISHIFT,65536)
      RETURN
      END
      FUNCTION IMASK (IN,IBL,IBR)
      MASK I*2 WORD IN OUTSIDE BITS IBL & IER
      C
      C
      C
      INTEGER * 2 IN,IC
      IO=IN
      IF (IBR.EC.0) GO TO 50
      IT=ISHIFT(IN,IBR)
      IO=IT
      IP=ISHIFT(IO,IBL-15-IBR)
      IO=IP
      IMASK=ISHIFT(IO,15-IBL)
      RETURN
50

```

```

LFV03370
LFV03380
LFV03390
LFV03400
LFV03410
LFV03420
LFV03430
LFV03440
LFV03450
LFV03460
LFV03470
LFV03480
LFV03490
LFV03500
LFV03510
LFV03520
LFV03530
LFV03540
LFV03550
LFV03560
LFV03570
LFV03580
LFV03590
LFV03600
LFV03610
LFV03620
LFV03630
LFV03640
LFV03650
LFV03660
LFV03670
LFV03680
LFV03690
LFV03700
LFV03710
LFV03720
LFV03730
LFV03740
LFV03750
LFV03760
LFV03770
LFV03780
LFV03790
LFV03800
LFV03810
LFV03820
LFV03830
LFV03840

```

```

END
//GC.SYSIN DC *
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//X CCIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//Y COIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//Z CCIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//TCTAL FIELD AMP IN NT 4 AUG 83 1802-1819 LOCAL
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//X CCIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//Y COIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//Z CCIL AMP IN NT 4 AUG 83 1802-1819 LOCAL
//LAMESA VILLAGE IN NT 4 AUG 83 1802-1819 LOCAL
//TCTAL FIELD AMP IN NT 4 AUG 83 1802-1819 LOCAL
//GO.FT20F001 DD LNIT=3400-4,VOL=SER=LMDT3A
//LABEL=(1,1,AL,IN)
//DCB=(RECFM=FB,LRECL=32,BLKSIZE
//GO.SYSDUMP DD SYSOUT=A
//
//

```

APPENDIX G

COHER COMPUTER PROGRAM

```

//CCPER32 JOB (2592,0165),ANTHONY SMC 2123,CLASS=G
//*MAIN ORG=NGVMI-2992P,LINES=(75)
//*FORMAT PR,DDNAME=PLOT,SYSVECT,DEST=LOCAL
// EXEC FRTXCLGP,PARM=LKEC=L1ST,MAP,XREF,RREGION,GC=2048K
//FORT:SYSIN DD DSN=MSS.SYS3.NONIMSL.SOURCE(FOUR),DISP=SPR
// DD *
C THIS PROGRAM READS IN DATA FROM DIGITAL TAPES USING THE
C SUBROUTINE RD, NORMALIZES THE DATA BETWEEN -5 AND +5 VOLTS,
C PERFORMS A FOURIER TRANSFORM ON THE DATA INTO FREQUENCY SPACE
C AND THEN CALCULATES THE COHERENCE OF EACH INDIVIDUAL AXIS BETWEEN
C THE LAMESA VILLAGE AND CHEW'S RIDGE SITES.
C
C INTEGER*2 IN(16)
C ARRAY*8 IN IS USED IN READING DATA FROM TAPE
C COMPLEX*8 XX(8192),YY(8192),ZZ(8192)
C COMPLEX*8 XL(8192),YL(8192),ZL(8192)
C COMPLEX*8 XC(8192),YC(8192),ZC(8192)
C DIMENSION CILX(8192),CILY(8192),CILZ(8192)
C DIMENSION CILCX(8192),CILCY(8192),CILCZ(8192)
C DIMENSION CILCX(8192),CILCY(8192),CILCZ(8192)
C DIMENSION CILCX(8192),CILCY(8192),CILCZ(8192)
C COMPLEX*8 CILCX(8192),CILCY(8192),CILCZ(8192)
C BY THE FOURIER TRANSFORM SUBROUTINE 'FOUR'.
C
C DATA CILX,CILY,CILZ/24576*0./
C DATA CILCX,CILCY,CILCZ/24576*0./
C DATA COHLCX,COHLCY,COHLCZ/24576*0./
C DIMENSION FREQ(8192),FRQ2(8192),WORK(16384)
C INTEGER*4 ITB(12)/12*0/
C REAL*4 RTB(28)/28*0./
C REAL ALAB(4),COHX,COHY,COHZ,'TOT'
C EQUIVALENCE(TITLE(1),RTB(5))
C ARRAY*8 TITLE(12)
C THE VERTSATEC PLCTTER OUTPUT.
C THE FOLLOWING LOOP ADVANCES THE DIGITAL TAPE BY ISEC SECONDS.
C
C ISEC=200
C ITL=ISEC*64
C DC 55 JJ=1,ITL
C CALL RD(20,IN,200,IREC,IRR)
C 55 CCNT INUE
C NR=19
C FNR=FLOAT(NR)
C DC 70 LI=1,NR
C THE DC LOOP ENDING WITH STATEMENT 70 ENABLES THE PROGRAM TO
C PROCESS A LARGE AMOUNT OF DATA BY REPEATING THE PROCESS IN
C BLOCKS.
C
COHO0010
COHO0020
COHO0030
COHO0040
COHO0050
COHO0060
COHO0070
COHO0080
COHO0090
COHO0100
COHO0110
COHO0120
COHO0130
COHO0140
COHO0150
COHO0160
COHO0170
COHO0180
COHO0190
COHO0200
COHO0210
COHO0220
COHO0230
COHO0240
COHO0250
COHO0260
COHO0270
COHO0280
COHO0290
COHO0300
COHO0310
COHO0320
COHO0330
COHO0340
COHO0350
COHO0360
COHO0370
COHO0380
COHO0390
COHO0400
COHO0410
COHO0420
COHO0430
COHO0440
COHO0450
COHO0460
COHO0470
COHO0480

```

```

C      *NR* REPRESENTS THE NUMBER OF DATA SEQUENCES.
C      1 SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL
C      CR 128 SECONDS OF DATA.
C
C      THE CO LCCP ENDING WITH 60 READS THE DATA FROM THE PCM FRAME,
C      STRIPS OUT THE SYNC CODE, AND SORTS OUT THE DATA BY COIL
C      CHANNEL. FIRST, THE NEXT THREE STATEMENTS READS THE DATA
C      FROM THE LAMESA SITE THAT WAS PREVIOUSLY STORED IN THE
C      IBM 3033 MASS STORAGE SYSTEM.
C      READ(21) XXX
C      READ(21) YYY
C      READ(21) ZZZ
C      SET THE IMAGINARY PART OF THE COMPLEX NUMBERS EQUAL TO ZERO.
C      DC 43 I=1,8192
C      XXL(I)=REAL(XXX(I))
C      YYL(I)=REAL(YYY(I))
C      ZLL(I)=REAL(ZZZ(I))
C      CCNT INUE
C
C      43 NOW READ THE CHEW'S RIDGE DATA FROM THE COMPUTER TAPE.
C      DC 60 JJ=1,8192
C      CALL RC(20,IN,1000,IREC,IRR)
C      XXC(JJ)=IN(2)
C      YYC(JJ)=IN(3)
C      ZYC(JJ)=IN(4)
C      CCNT INUE
C
C      6C N=8192
C      FA=FLCAT(N)
C      DELTAT=1./64.
C      T=FN*DELTAT
C      DELTAF=1./T
C      NCRMALIZE THE CHEW'S RIDGE DATA BETWEEN +5 AND -5 VCLTS AND SET
C      THE IMAGINARY PART EQUAL TO ZERO. THE LAMESA VILLAGE DATA HAS
C      ALREADY BEEN NORMALIZED IN THE MASS STORAGE PROGRAM.
C      CC 20 J=1,8192
C      XXC(J)=((XXC(J)-2048.)*5./2048.)
C      XXC(J)=REAL(XXC(J))
C      YYC(J)=((YYC(J)-2048.)*5./2048.)
C      YYC(J)=REAL(YYC(J))
C      ZYC(J)=((ZYC(J)-2048.)*5./2048.)
C      ZYC(J)=REAL(ZYC(J))
C      CCNT INUE
C
C      2C TRANSFORM THE DATA FROM ALL THREE COILS AT BOTH SITES INTO THE
C      FREQUENCY CCMAIN.
C      CALL FCURT(XXL,N,1,-1,0,WORK)
C      CALL FCURT(YYL,N,1,-1,0,WORK)
C      CALL FCURT(ZYL,N,1,-1,0,WORK)
C      CALL FCURT(XXC,N,1,-1,0,WORK)
C      CALL FCURT(YYC,N,1,-1,0,WORK)

```

```

COH00490
COH00500
COH00510
COH00520
COH00530
COH00540
COH00550
COH00560
COH00570
COH00580
COH00590
COH00600
COH00610
COH00620
COH00630
COH00640
COH00650
COH00660
COH00670
COH00680
COH00690
COH00700
COH00710
COH00720
COH00730
COH00740
COH00750
COH00760
COH00770
COH00780
COH00790
COH00800
COH00810
COH00820
COH00830
COH00840
COH00850
COH00860
COH00870
COH00880
COH00890
COH00900
COH00910
COH00920
COH00930
COH00940
COH00950
COH00960

```

```

C      CALL FOURT(ZZC,N,1,-1,0,WORK)
C      THE NEXT LOOP IS REQUIRED AFTER TRANSFORMATION. SEE THE WRITEUP
C      FOR THE SUBROUTINE 'FOURT'.
      DC 40 K4=1,N
      XXL(K4)=XXL(K4)/FN
      YYL(K4)=YYL(K4)/FN
      ZZL(K4)=ZZL(K4)/FN
      XXC(K4)=XXC(K4)/FN
      YYC(K4)=YYC(K4)/FN
      ZZC(K4)=ZZC(K4)/FN
      4C CCNT INUE
C      THE NEXT LOOP SUMS EACH DATA SAMPLE OVER THE NR BLCKCS OF
C      DATA.
      DO 30 I1=1,N
      CILX(I1)=CILX(I1)+CABS(XXL(I1))*CONJG(XXL(I1))
      CILY(I1)=CILY(I1)+CABS(YYL(I1))*CONJG(YYL(I1))
      CILZ(I1)=CILZ(I1)+CABS(ZZL(I1))*CONJG(ZZL(I1))
      CILCX(I1)=CILCX(I1)+CABS(XXC(I1))*CONJG(XXC(I1))
      CILCY(I1)=CILCY(I1)+CABS(YYC(I1))*CONJG(YYC(I1))
      CILCZ(I1)=CILCZ(I1)+CABS(ZZC(I1))*CONJG(ZZC(I1))
      CILCX(I1)=CILCX(I1)+CABS(XXL(I1))*CONJG(XXC(I1))
      CILCY(I1)=CILCY(I1)+CABS(YYL(I1))*CONJG(YYC(I1))
      CILCZ(I1)=CILCZ(I1)+CABS(ZZL(I1))*CONJG(ZZC(I1))
      3C CCNT INUE
C      NOW GO BACK AND GET THE NEXT BLOCK OF DATA AND PERFORM THE SAME
C      ANALYSIS ON IT.
      7C CCNT INUE
C      CALCULATE THE COHERENCE OF EACH COIL AND THE FREQUENCY SCALE
C      (LOG) IT IS PLOTTED AGAINST.
      DC 44 I4=1,N
      COHLCX(I4)=CILCX(I4)/(SQRT(CILX(I4))*SQRT(CILX(I4)))
      COHLCY(I4)=CILCY(I4)/(SQRT(CILY(I4))*SQRT(CILY(I4)))
      COHLCZ(I4)=CILCZ(I4)/(SQRT(CILZ(I4))*SQRT(CILZ(I4)))
      FREQ(I4)=DELTA F*FLOAT(I4)
      FRQZ(I4)=ALCGLO(FREQ(I4))
      44 CCNT INUE
C
C      NPTS=1/DELTA F +1.
C      NPTS DETERMINES NUMBER OF POINTS NECESSARY IN ORDER FOR
C      THE 0 TO NPTS FREQUENCY RANGE TO BE PLOTTED.
C      FOR THE FOLLOWING 'ITB' AND 'RTB' VALUES REVIEW THE WRITE-UP
C      FOR THE SUBROUTINE PROCEDURE 'DRAWP'.
      ITB(3)=20
      ITB(4)=8
      ITB(7)=1
      ITB(12)=0
      RTB(1)=0.0

```

COH00970
 COH00980
 COH00990
 COH01000
 COH01010
 COH01020
 COH01030
 COH01040
 COH01050
 COH01060
 COH01070
 COH01080
 COH01090
 COH01100
 COH01110
 COH01120
 COH01130
 COH01140
 COH01150
 COH01160
 COH01170
 COH01180
 COH01190
 COH01200
 COH01210
 COH01220
 COH01230
 COH01240
 COH01250
 COH01260
 COH01270
 COH01280
 COH01290
 COH01300
 COH01310
 COH01320
 COH01330
 COH01340
 COH01350
 COH01360
 COH01370
 COH01380
 COH01390
 COH01400
 COH01410
 COH01420
 COH01430
 COH01440

COH01450
COH01460
COH01470
COH01480
COH01490
COH01500
COH01510
COH01520
COH01530
COH01540
COH01550
COH01560
COH01570
COH01580
COH01590
COH01600
COH01610
COH01620
COH01630
COH01640
COH01650
COH01660
COH01670
COH01680
COH01690
COH01700
COH01710
COH01720
COH01730
COH01740
COH01750
COH01760
COH01770
COH01780
COH01790
COH01800
COH01810
COH01820
COH01830
COH01840
COH01850
COH01860
COH01870
COH01880
COH01890
COH01900
COH01910
COH01920

```

RTB(2)=0.0
RTB(3)=ALAE(1)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCX,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCY,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCZ,ITB,RTB)
ITB(3)=7
ITB(4)=5
ITB(12)=0
RTB(3)=ALAE(1)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCX,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCY,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,300C)TITLE
CALL DRAWP(NPTS,FRQ2,COHLCZ,ITB,RTB)
FCRMT(6A8)
3000 STOP
END
SUBROUTINE RD(IUN,IC,IRS,IREC,IRQ)
THIS PROCEDURE FURNISHED BY DR. TIM STANTCN,
DEPARTMENT OF OCEANOGRAPHY.
READ DATA FROM IUN, ALIGN, CHECK & RETURN
IUN=TAPE NUMBER, EG 20
IO=INTEGER*2 ARRAY, 16 LONG, (VALUES 0-40$5, SUBTRACT 2048)*5
IRS= NUMBER OF RESINCS ALLOWED (ERRORS)
IREC= COUNTER OF RECORDS (FRAMES CF DATA)
      BLOCK 512 BITS, 32 BITS = RECORD
      800 BPI TAPE UNLABLED
      IRQ= NUMBER OF ACTUAL RESINCS (ERRORS)
INTEGER * 2 IO(16), IP(16)
DATA IRR /C/
IF (IREC.EQ.0) IS=0
IER=0
FORMAT (16A2)
IF (IS.NE.0) GO TO 50

```

CCCCCCCCCCCCCCCC

20

```

40      READ (IUN,20,END=900) IP
      IREC=IREC+1
      IS=IS+1
      IF (IS.LT.17) GO TO 50
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      ICH=IMASK(IP(IS),3,0)+1
      WRITE (6,55) ICH,IS,IUN,IREC
      FORMAT (' RESYNCH ICH,IS,IUN,IREC ',4I8)
C
C
      IF (ICH.NE.1) GO TO 40
      DO 100 I=1,16
      IO(I)=IS+IFT(IP(IS),4)
      ICH=IMASK(IP(IS),3,0)+1
      IF (ICH.EQ.1) GO TO 80
      IER=IER+1
      WRITE (6,70) IUN,IREC,I,ICH,IER
      FORMAT (' UNIT ',13,' RECORD ',16,' CHAN & DATA CH ',2I4,
      $ ' ERRORS ',17)
      IS=IS+1
      IF (IS.LT.17) GO TO 100
      READ (IUN,20,END=900) IP
      IS=1
      IREC=IREC+1
      CONTINUE
C
      IF (IER.EQ.0) GO TO 150
      IRR=IRR+1
      IF (IRR.LT.IRS) GO TO 120
      WRITE (6,110)
      FORMAT (' STOPPED IN SUB RD BECAUSE OF IRR.GT.',16,' AT L110')
      IRQ=IRR
      STOP
      CONTINUE
      WRITE (6,130) IREC,IRR
      FORMAT (' RESYNCH AT FRAME ',16,' WITH TOTAL ERRORS ',17)
      IER=0
      IRQ=IRR
      GO TO 50
      CONTINUE
      RETURN
      WRITE (6,510) IUN,IREC
      FORMAT (' END OF UNIT ',13,' AT REC ',17)
      STOP
      END
C
      FUNCTION ISHIFT (IN,NPLC)

```

```

C
C
C      RETURNS SHIFTED VALUE OF I*2 WORD IN
C      -VE LEFT,+VE RIGHT SHIFT
C
C      INTEGER * 2 IN
C      IP=IN
C      IF (IP.LT.0) IP=IP+65536
C      IF (NPLC.LT.0) GC TC 30
C      ISHIFT=IP/(2**IABS(NPLC))
C      RETURN
C
C      ISHIFT=IP*(2**IABS(NPLC))
C      IF (ISHIFT.GT.65535) ISHIFT=MOD(ISHIFT,65536)
C      RETURN
C      END
C
C      FUNCTION IMASK (IN,IBL,IBR)
C      MASK I*2 WORD IN OUTSIDE BITS IBL & IER
C
C      INTEGER * 2 IN,IC
C      IO=IN
C      IF (IBR.EQ.0) GO TO 50
C      IT=ISHIFT(IN,IBR)
C      IO=IT
C      IP=ISHIFT(IO,IBL-15-IBR)
C      IO=IP
C      IMASK=ISHIFT(IO,15-IBL)
C      RETURN
C      END
C
C
C      50
C
C      //GO.SYSIN DC *
C      LAMESA-CHEW,S RIGGE,4 AUG 83, 1700-1740 LCCAL
C      X CCIL COHERENCE
C      LAMESA-CHEW,S RIGGE,4 AUG 83, 1700-1740 LCCAL
C      Y CCIL COHERENCE
C      LAMESA-CHEW,S RIGGE,4 AUG 83, 1700-1740 LOCAL
C      Z CCIL COHERENCE
C      LAMESA-CHEW,S RIGGE, 4 AUG 83, 1700-1740 LOCAL
C      X CCIL COHERENCE
C      LAMESA-CHEW,S RIGGE,4 AUG 83, 1700-1740 LOCAL
C      Y CCIL COHERENCE
C      LAMESA-CHEW,S RIGGE,4 AUG 83, 1700-1740 LOCAL
C      Z CCIL COHERENCE
C
C      //GO.FT20F001 DD UNIT=340C-4,VOL=SER=CRDT3,DISP=(OLC,KEEP),
C      LABEL=(1,IN,IN)
C      DCE=(RECFM=FB,LRECL=32,BLKSIZE=512,CEN=2)
C      //GO.FT21F001 DD UNIT=3330V,MSGP=PU84A,DISP=(CLC,KEEP),
C      DSN=MSS.S2992.LMDT3D,
C      DCE=(RECFM=VBS,BLKSIZE=4096,LRECL=4092)
C      //GO.SYSDUMP DD SYSOUT=A

```

```

COHO 2410
COHO 2420
COHO 2430
COHO 2440
COHO 2450
COHO 2460
COHO 2470
COHO 2480
COHO 2490
COHO 2500
COHO 2510
COHO 2520
COHO 2530
COHO 2540
COHO 2550
COHO 2560
COHO 2570
COHO 2580
COHO 2590
COHO 2600
COHO 2610
COHO 2620
COHO 2630
COHO 2640
COHO 2650
COHO 2660
COHO 2670
COHO 2680
COHO 2690
COHO 2700
COHO 2710
COHO 2720
COHO 2730
COHO 2740
COHO 2750
COHO 2760
COHO 2770
COHO 2780
COHO 2790
COHO 2800
COHO 2810
COHO 2820
COHO 2830
COHO 2840
COHO 2850
COHO 2860
COHO 2870
COHO 2880

```

COHO 289C
COHO 2900

//

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