COHERENCE STUDY OF GEOMAGNETIC FLUCTUATIONS IN
FREQUENCY RANGE 04 - 06 Hz BETWEEN REMOTE LAND SITES
(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA  S J ANTHONY
UNCLASSIFIED  DEC 83
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.

Approved for public release; distribution unlimited.
Coherence Study of Geomagnetic Fluctuations in Frequency Range 0.04 - 0.6 Hz Between Remote Land Sites

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
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)
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 

NAVAL POSTGRADUATE SCHOOL 
December 1983 

Author: 

Stephen John Anthony 

Approved by: 

Andrew C. O'Neill, Thesis Advisor 

D. Heinz, Co-Advisor 

Chairman, Department of Physics 

Dean of Science and Engineering
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).
TABLE OF CONTENTS

I. INTRODUCTION --------------------------------------- 7

II. BACKGROUND ---------------------------------------- 8
    A. MICROPULSATIONS ---------------------------------- 8
    B. GEOMAGNETIC BACKGROUND NOISE --------------------- 11

III. DATA COLLECTION SYSTEM -------------------------- 13
    A. EQUIPMENT DESCRIPTION -------------------------- 13
    B. PCM TO DIGITAL CONVERSION ---------------------- 17

IV. COMPUTER SOFTWARE -------------------------------- 18

V. TESTING OF PCM SYSTEM AND SOFTWARE -------------- 22

VI. EXPERIMENTAL RESULTS ---------------------------- 29

VII. CONCLUSIONS AND RECOMMENDATIONS ---------------- 92

APPENDIX A: SITE DESCRIPTION ------------------------ 93

APPENDIX B: PCM DECODING PROCEDURES ----------------- 95

APPENDIX C: VOLTR COMPUTER PROGRAM ------------------ 100

APPENDIX D: VODIG COMPUTER PROGRAM ------------------ 107

APPENDIX E: MASS STORAGE COMPUTER PROGRAM ---------- 118

APPENDIX F: MAGFLD COMPUTER PROGRAM ---------------- 123

APPENDIX G: COHER COMPUTER PROGRAM ------------------ 133

REFERENCES ----------------------------------------- 141

INITIAL DISTRIBUTION LIST ---------------------------- 142
ACKNOWLEDGEMENTS

I am indebted to my advisor, Dr. Andrew Ochodlick, for his guidance and assistance during this project. Special thanks is extended to Mr. Robert Smith for his advice and technical expertise in the calibration and operation of the electronic components used.
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. Pcl: (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. **Pil: (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 micropulsion 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.
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 a 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 0.04 - 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 \( \theta_d \) is the magnetic dip angle, which in the Monterey area is 60°.

![Figure 4.1 Total Field Diagram](image)

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

\[
\text{coherence} = \frac{a(t) \cdot b(t)}{\sqrt{a(t) \cdot a(t)} \cdot \sqrt{b(t) \cdot b(t)}} = \frac{A(F)B^*(F)}{\sqrt{a(F)A^*(F)} \cdot \sqrt{b(F)B^*(F)}}
\]

where 'o' 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.
<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>Chart Record (volts)</th>
<th>Computer Plot volts</th>
<th>Error %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large Amplitude Oscillations</td>
<td>Small Amplitude Oscillations</td>
<td>Large Amplitude Oscillations</td>
</tr>
<tr>
<td>0.10</td>
<td>2.10 ± .01</td>
<td>0.67 ± .01</td>
<td>2.08 ± .01</td>
</tr>
<tr>
<td>0.09</td>
<td>2.09</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.08</td>
<td>2.09</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.07</td>
<td>2.09</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.06</td>
<td>2.09</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.05</td>
<td>2.10</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.04</td>
<td>2.10</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.03</td>
<td>2.10</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.02</td>
<td>2.11</td>
<td>0.67</td>
<td>2.08</td>
</tr>
<tr>
<td>0.01</td>
<td>2.11</td>
<td>0.67</td>
<td>2.08</td>
</tr>
</tbody>
</table>
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 6.4 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/\text{inch}) vs Time (200 seconds/\text{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. 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 6.24 Z Coil Voltage
Chew's Ridge, 1802 - 1812 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 6.32 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 6.36 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 6.39 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 Coi Field, 1802 - 1819 Local
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 6.55 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.
COHERENCE STUDY OF GEOMAGNETIC FLUCTUATIONS IN FREQUENCY RANGE 04 - 06 Hz BETWEEN REMOTE LAND SITES (U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA S J ANTHONY UNCLASSIFIED DEC 83 F/G 8/14 NL
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 countdown. 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.

1. "End of run" will be indicated on the computer CRT. Deenergize the equipment.
APPENDIX C

VOLTR COMPUTER PROGRAM
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),YY(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 ZZX(65536),ZZY(65536),ZZZ(65536)
C DIMENSION TIME2(65536)
C INTEGER K,I
C INTEGER*4 ITB(12)/12*0/
C REAL*4 RTB(28)/28*0.0/
C REAL A(3)/'CH-X', 'CH-Y', 'CH-Z'/
C REAL*8 TITLE(12)
C EQUIVALENCE(TITLE(1),RTB(I))
C THE VERTSUSE PLOTTIN OUTPUT.
C DATA XX,YY/16384*0.0/
C DATA ZZ/8192*0.0/
C K=0
C 15=1
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 ITL=ISEC*64
C CALL R(201,IN,200,IREC,IRR)
C 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 DO 70 LI=1,NR
C C THE DC LOCP 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. CNE
SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL
CR 128 SECONDS OF DATA.

THE DO LCCP ENDING WITH 60 READS THE DATA FROM THE PCM FRAME
STRIPS OUT THE SYNC CODE, AND SORTS OUT THE DATA BY CCIL
CHANNEL.

DO 60 JJ=1,IFRAME
CALL RD(20,IN,1000,IREC,IRR)
XX(JJ)=IN(2)
YY(JJ)=IN(3)
ZZ(JJ)=IN(4)
60 CONTINUE

N=8192
FN=FLOTAT(N)
DELAT=1./64.
CC 20 J=1,N
C
THE FOLLOWING CALCULATIONS NORMALIZE THE DATA TO +5V AND -5V.
XX(J)=((XX(J)-2048.)*.5./2048.)
YY(J)=((YY(J)-2048.)*.5./2048.)
ZZ(J)=((ZZ(J)-2048.)*.5./2048.)
YY IS THE Y-CCIL DATA.
ZZ IS THE Z-CCIL DATA.

C
NORTH-SOUTH COMPONENT (XX) AND THE VERTICAL COMPONENT (ZZ)
C
20 CONTINUE
THE FOLLOWING LCCP PUTS THE DATA FROM EACH 8192-SAMPLE ARRAY
C
INTO ONE CONTINUOUS NR*8192 SAMPLE ARRAY
C
CC 91 \[ i = 1, \text{NR} \]
ZZI(15)=XX(13)
ZYY(15)=YY(13)
ZVI(15)=ZZ(13)
TIME(1)=DELTAT*FLOAT(I3)+(128.0*FLOAT(K))
91 CONTINUE
K=K+1
7C CONTINUE

C
VERSATEC PLOT OF V - TIME SERIES VOLTAGE
C
APTS=1020.,ACELAT +.1.
C
*NTS* DETERMINES NUMBER OF POINTS NECESSARY IN CCR CER FOR
THE 0 TO NT S RANGE TO BE PLOTTED.
C
FOR THE FOLLOWING *ITB* AND *RTB* VALUES REVIEW THE WRITE-UP
C
FOR THE SUBROUTINE PROCE EDURE 'DRAW P'.
C
ITB(3)=20
ITB(4)=8
I03

ITB(1)=0
ITB(12)=1
ITB(1)=0.0
ITB(2)=0.0
RTB(3)=ALAE(1)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
RTB(3)=ALAE(1)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,3000)TITLE
CALL DRAWAP(NTS,TIME2,2ZYL,ITB,RTB)
3000 FORMAT(6A8)
STOP
END

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

THIS PROCEDURE FURNISHED BY DR. TIM STANTEN,
DEPARTMENT OF GEOMATIC.

READ DATA FROM IUN, ALIGN, CHECK & RETURN

IUN=TAPE NUMBER, EC 20
IC=INTEGER*2 ARRAY, 16 LONG, (VALUES 0-4095, SUBTRACT 2048)*5
/2028, GIVES VOLTAGE
IRS=NUMBER OF RESIDUES ALLOWED (ERRORS)
IREC=COINTE OF RECORDS (FRAMES OF DATA)
     BLOCK 512 BITS, 32 BITS = RECORD
800 BIT TAPE UNABLED
IRQ=NUMBER OF ACTUAL RESIDUES (ERRORS)

INTEGER * 2 IG(16), IP(16)
DATA IRR /C/
IF (IREC.EG.0) IS=0
IER=0
20 FORMAT (1642)
   IF (1 .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
   IF (ICH.EQ.1) GO TO 80
   WRITE (6,70) IUN,IREC,ICH,IER
   55 FORMAT (16 RESYNCING ICH,IS,IUN,IREC,4I8)
   50 FORMAT (16 ERRORS ,17)
   70 FORMAT (16 UNIT ,13, RECORD ,16, CHAN & DATA CH ,2I4,
   80 ERRORS ,17)
   IF (1 .LT. 17) GO TO 100
   READ (IUN,20,END=500) IP
   IS=1
   IREC=IREC+1
   CONTINUE
100 FORMAT (16 STOPPED IN SUB RD BECAUSE OF IRR.GT.',16,' AT L110')
   STOP
110 FORMAT (16 IRR=IRR+1
   IF (IRR.LT.1) GO TO 120
   WRITE (6,110)
   WRITE (6,120) IREC,IRR
   110 FORMAT (16 IRR=IRR
   STOP
120 CONTINUE
120 FORMAT (16 RESYNC AT FRAME ,16,' WITH TOTAL ERRORS ,17)
   IER=0
   IRQ=IRR
   GO TO 50
150 CONTINUE
150 RETURN
900 WRITE (6,510) IUN,IREC
510 FORMAT (16 END OF UNIT ,13,' AT REC ,17)
STOP
END

FUNCTION ISHIFT (IN,NPLC)
C
INTEGER * 2 IN
C
IN
IP=IN
IF (IP.LT.C) IP=IP+65536
IF (NPLC.LT.0) GOTO 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)
C
INTEGER * 2 IN,IO
C
IN
IO=IN
IF (IBR.EQ.0) GO TO 50
IO=ISHIFT(IN,IBR)
IO=IT
50
IO=ISHIFT(IO,IBL-15-IBR)
IO=IP
IMASK=ISHIFT(IO,15-IBR)
RETURN
END

*//*GC.SYSIN DC *
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
X COIL AMP IN VOLS
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
Y COIL AMP IN VOLS
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
Z COIL AMP IN VOLS
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
X COIL AMP IN VOLS
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
Y COIL AMP IN VOLS
CHEK'S RIDGE 4 AUG 83, 1802-1819 LOCAL
Z COIL AMP IN VOLS
*/

//GO.FT20F001 DD LUNIT=3400-4, VOL=SER=CRDT3A, DISP=(GLC,KEEP), //
// LABEL=(1, AL, IN)
// DCE=(RECIP=FB, LRECL=32, BLKSIZE=512, DEH=2)
//GO.SYSDUMP DD SYSOUT=A
APPENDIX D

VODIG COMPUTER PROGRAM
//CHFI23S JOB (2592,0165),"ANTHONY SMC 2123",CLASS=G
//MAP ORG=MPGVM',2992P,LINES(75)
//FCRT PRDNAME=PLT-SYSVECT,DEST=LOCAL
//EXEC FRXCLGP PARM,LKED='LIST,MAP,XREF',REIGNA,GC=2048K
//FCRT.SYSS DD \
C THIS PROGRAM READS IN DATA FROM DIGITAL TAPE USING THE
C SUBROUTINE RD. IT NORMALIZES THE DATA BETWEEN -5 AND +5 VOLTS. APPLIES
A DIGITAL LOWPASS FILTER BETWEEN .04 AND .6 HZ DEVELOPED BY MIKE
C HILENE AND THEN PUTS THE DATA THROUGH A 144 POINT DOUBLE RUNNING
C AVERAGE SMOOTHING ROUTINE.
C
INTEGER*2 IN(16)
C ARRAY *IN* IS USED IN READING DATA FROM TAPE
REAL*8 XX(8192),YY(8192),ZS(8192),XXS(8192),YSS(8192),ZSS(8192)
REAL*8 FIX(18),FOX(18),FYY(18),FOY(18),FIZ(18),FOZ(18)
C THE ABOVE REAL*8 ARRAYS ARE USED TO ORDER INPUT DATA AND
C INITIALIZE REAL*8 ARRAYS ARE USED TO ORDER INPUT DATA AND
C DIMENSION Z2X1(65536),Z2Y1(65536),Z2Z1(65536)
C DIMENSION TIME(65536)
DATA FIX,FIY/36*0.4,
DATA FIZ/I8*0.4,
INTEGER K,6,15,14
REAL SUMX, SUMY, SUMT, AVE1, AVE2, AVE3, AVE4
INTEGER*4 ITB(12)/120/
REAL*4 RTB(28)/28*0.4,
REAL ARA(4),CH-X,CH-Y,CH-Z,TOT/
REAL*8 TITLE(12)
C CURVATURE,TITLE(1),RTB(5))
C ARAYS *TIE*,RTB*,ALAB*,AND *TITLE* ARE USED IN GENERATING
C THE VERTSATEC PLTTER OUTPUT.
DATA XX,YY/16392*0.4/ 
DATA ZZ/8156*0.4/ 
K=0 
T=5 
GH=1
C THE FOLLOWING LOOP ADVANCES THE DIGITAL TAPE BY ISEC SECONDS.
C
SEC=ISEC40 
ITL=ISEC*64 
DC 55 JJ=1,ITL 
CALL RE(20,IN,200,I_REC,IRR)
CONTINUE 
IFRAME=8196 
NRE=3 
ER=FLOAT(IIR) 
DC 70 LI=1,IR 
C THE DC LOOP ENDING WITH STATEMENT TO ENABLES THE PROGRAM TO 
C PROCESS A LARGE AMOUNT OF DATA BY REPEATING THE PROCESS IN
BLOCKS.
1. NR* REPRESENTS THE NUMBER OF DATA SEQUENCES.
2. 1 SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL
3. CR 128 SECONDS OF DATA.
4. THE DO LOOP ENDING WITH 60 READS THE DATA FROM THE PCM FRAME
5. STRIPS OUT THE SYNC CODE, AND SORTS OUT THE DATA BY CCIL
6. CHANNEL.
DC 60 JJ=5, IFRAME
CALL RD(20, IN, 100C, IREC, IRR)
58 XX(JJ)=IN(2)
YY(JJ)=IN(3)
ZZ(JJ)=IN(4)
60 CONTINUE
N=8196
FA=FLOAT(N)
DELTAT=1./64.
NORMALIZE THE DATA BETWEEN +5 AND -5 VOLTS. FOR LAMESA DATA,
SUBTRACT 1.36, 1.0 AND 1.0 FROM XX, YY AND ZZ RESPECTIVELY, TC
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.
20 CONTINUE
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 CCMPNEN(T ZZ)
CONTINUE
DC 91 Y=5, 6196
ZZX(15)=XX(13)
ZZY(15)=YY(13)
ZZZ(15)=ZZ(13)
I5=I5+1
51 CONTINUE
DC 73 L2=1,2
C
DO 74 IS=5,65423
SUMX=0.0
SUMY=0.0
SUMZ=0.0
74 CONTINUE
SUMX=ZZX(15)+J*SUMX
SUMY=ZZY(15)+J*SUMY
SUMZ=ZZZ(15)+J*SUMZ
75 CONTINUE
ZZX(15)=SLMX/144.
22VL(I5)=SLWY/144.
22VL(I5)=SLPZ/144.
Q=Q+1
74 CONTINUE
73 CONTINUE
C APPLY DIGITAL FILTER TO DATA BLOCK
K2=5
DC 92 M1=1, NR
DC 100 K1=5, E196
XX(K1)=ZZX1(K2)
YY(K1)=ZZY1(K2)
ZZ(K1)=ZZV1(K2)
K2=K2+1
10G CONTINUE
CALL DIGFIL(XX, FIX, X2, F0X)
CALL DIGFIL(YY, F1Y, Y2, FOY)
CALL DIGFIL(ZZ, F1Z, Z2, F0Z)
DC 21 L=1, T8
FIX(L)=FOX(L)
FYY(L)=FOY(L)
FZZ(L)=FOZ(L)
41 CONTINUE
I4=1
DC 90 I3=5, E196
ZZX1(I6)=X+Z(I3)
ZYY1(I6)=Y+Z(I3)
ZZV1(I6)=Z+Z(I3)
TIME2(I6)=CELAT+FLAT(I4)+(128.0*FLOAT(K1))
I4=I4+1
I6=I6+1
90 CONTINUE
K=K+1
92 CONTINUE
A1=8192*NR-1280
DC 98 I7=1, AL
ZZX1(I7)=ZZX1(I7+1280)
ZYY1(I7)=ZYY1(I7+1280)
ZZV1(I7)=ZZV1(I7+1280)
98 CONTINUE
C VERSATEC PLGT OF V - TIME SERIES VOLTAGE SMCC1=EC
C APNTS=380./CELAT +1.
C 'NPNTS' DETERMINES NUMBER OF POINTS NECESSARY IN ORDER FOR
C THE 0 TO NPNTS SECS RANGE TO BE PLOTTED.
C FOR THE FOLLOWING 'ITB' AND 'RTB' VALUES REVIEW THE WRITE-UP
C ITB(3)=20
VOD00970
VOD00980
VOD00990
VOD01000
VOD01010
VOD01020
VOD01030
VOD01040
VOD01050
VOD01060
VOD01070
VOD01080
VOD01090
VOD01100
VOD01110
VOD01120
VOD01130
VOD01140
VOD01150
VOD01160
VOD01170
VOD01180
VOD01190
VOD01200
VOD01210
VOD01220
VOD01230
VOD01240
VOD01250
VOD01260
VOD01270
VOD01280
VOD01290
VOD01300
VOD01310
VOD01320
VOD01330
VOD01340
VOD01350
VOD01360
VOD01370
VOD01380
VOD01390
VOD01400
VOD01410
VOD01420
VOD01430
VOD01440
SUBROUTINE RD(IUN,IO,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 0-4095, SLBRACT 2048)*5
   /2028. GIVES VOLTAGE
IRS= NUMBER OF RESINCS ALLOWED (ERRORS)
IREC= COLATER OF RECORDS (FRAMES CF DATA)
     BLOCK 512 BITS,  32 BITS = RECORD
     800 EPI TAPE UNLABED
IRQ= NUMBER OF ACTUAL RESINCS (ERRORS)

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

VOD0 1450
VOD0 1460
VOD0 1470
VOD0 1480
VOD0 1490
VOD0 1500
VOD0 1510
VOD0 1520
VOD0 1530
VOD0 1540
VOD0 1550
VOD0 1560
VOD0 1570
VOD0 1580
VOD0 1590
VOD0 1600
VOD0 1610
VOD0 1620
VOD0 1630
VOD0 1640
VOD0 1650
VOD0 1660
VOD0 1670
VOD0 1680
VOD0 1690
VOD0 1700
VOD0 1710
VOD0 1720
VOD0 1730
VOD0 1740
VOD0 1750
VOD0 1760
VOD0 1770
VOD0 1780
VOD0 1790
VOD0 1800
VOD0 1810
VOD0 1820
VOD0 1830
VOD0 1840
VOD0 1850
VOD0 1860
VOD0 1870
VOD0 1880
VOD0 1890
VOD0 1900
VOD0 1910
VOD0 1920
IF (IREC.EQ.0) IS=0
IER=0
FORMAT (16/2)
IF (IS.NE.0) GO TO 50
READ (IUN,20,END=90C) IP
IREC=IREC+1
IS=IS+1
IF (IS.LT.17) GO TO 50
READ (IUN,20,END=90C) IP
IS=1
IREC=IREC+1
WRITE (6,55) ICH,IS,ILN,IREC
FORMAT (1 RESYNCING ICH,IS,IUN,IREC ' ,416)
C
IF (ICH.NE.1) GO TO 40
DC 10C I=1,16
IO(I)=ISH(IP(IS),4)
ICH=IMASK(IP(IS),3,0)+1
IF (ICH.EQ.1) GO TO 80
IER=IER+1
WRITE (6,7C) IUN,IREC ,1,ICH,IER
$ 'ERRORS ' ,17)
FORMAT (1 'UNIT ' ,13,' RECORD ' ,16,'CHAN & DATA CH ' ,214,
80 IS=IS+1
IF (IS.LT.17) GO TO 100
READ (IUN,20,END=90C) IP
IS=1
IREC=IREC+1
CONTINUE
C
IF (IER.EQ.0) GO TO 150
IER=IER+1
IF (IER.LT.IRS) GO TO 120
WRITE (6,110)
FORMAT (1 'STCPPEE IN SUB RD BECAUSE OF IRR.GT. ' ,16,' AT LI1C')
IR=IRR
STOP
CONTINUE
WRITE (6,120) IREC,IRR
FORMAT (1 RESYNC AT FRAME ' ,16,' WITH TOTAL ERRORS ' ,17)
IER=0
IR=IRR
GO TO 50
CONTINUE
RETURN
WRITE (6,510) IUN,IREC
FORMAT (1 END OF UNIT ' ,13,' AT REC ' ,17)
STOP
END

C SLBRUTINE SIGFIL(INFDL,FILE,SIG,FOLE)
C THE ABOVE REAL*4 ARRAYS ARE USED TO ORDER INPUT DATA AND
C INITIALLY REPRESENT VOLTAGE - TIME SERIES INFORMATION.
C REAL*8 INFDL(8196).OUTFLD(8196).SIG(8196).
C CATA XI(16392).CATA XIII(16392).
C CATA XIV(16392).CATA XV(16392).
C CATA YO(8196).CATA YO(8196).
C INTEGER K9
C THE COMPLEX*8 ARRAYS ARE USED TO ORDER INPUT DATA AND REPRESENT
C VOLTAGE-TIME SERIES INFORMATION.
C REAL*8 T,TAHF,P1,TAHF,P2,BAHF,P0,BAHF,P1,BAHF,P2,A,B,C,D,E,F,A1
C REAL*8 BI1,CI1,DI1,E1,F1,G1,HAL1,II,J1,I1,C111111
C REAL*8 JJ1,JI,K1,K11
C REAL*8 ASHF,P1,ASHF,P2,ASHF,P4,ASHF,P6,ASHF,P4,ASHF,P4,ASHF,P4
C REAL*8 A,B,L6,BL,L6,BL,L6,BL,L6,BL,L6,BL,L6,BL,L6
C REAL*8 A,B,L6,BL,L6,BL,L6,BL,L6,BL,L6,BL,L6,BL,L6
C DEFINE AND COMPUTE ALL COEFFICIENTS
C T=1./64.
C COEFFICIENTS FOR FIXED HIGH PASS FILTER
C BAFHP0=(1.)/(1.+T/8.+T**2/320.)
C BAFHP1=(2.)/(1.+T/8.+T**2/320.)
C TFHP2=(1.)/(1.+T/8.+T**2/320.)
C COEFFICIENTS FOR SELECTIVE HIGH PASS FILTER
C IN THIS CASE, FREQ(LOWER)=0.04 HZ
C A=12.52096/4C.08234
C B=1./4C.08234
C C=1./4C.08234
C D=1./4C.08234
C E=7.41498/57.57668
C F=1./57.57668
\[ A_1 = 1.0 + A \cdot T / 2.0 + B \cdot (T^{**2}) / 4. \\
B_1 = -2.0 \cdot B \cdot (T^{**2}) / 2.0 \\
C_1 = -1.0 - A \cdot T / 2.0 + B \cdot (T^{**2}) / 4. \\
C_2 = -1.0 + C \cdot T / 2.0 + D \cdot (T^{**2}) / 4. \\
E_1 = -2.0 + D \cdot (T^{**2}) / 2.0 \\
F_1 = -1.0 - C \cdot T / 2.0 + D \cdot (T^{**2}) / 4. \\
G_1 = 1.0 + E \cdot T / 2.0 + F \cdot (T^{**2}) / 4. \\
H_1 = -2.0 + F \cdot (T^{**2}) / 2.0 \\
I_1 = -1.0 - E \cdot T / 2.0 + F \cdot (T^{**2}) / 4. \]

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

\[ \text{ASHP41} = 1.0 / \{ A_1 \cdot D_1 \cdot G_1 \} \]
\[ \text{ASHP42} = \{ C_1 / A_1 \} \]
\[ \text{ASHP43} = \{ B_1 / A_1 \} \]
\[ \text{ASHP44} = \{ E_1 / D_1 \} \]
\[ \text{ASHP45} = \{ F_1 / D_1 \} \]
\[ \text{ASHP46} = \{ H_1 / G_1 \} \]
\[ \text{ASHP47} = \{ I_1 / G_1 \} \]

COEFFICIENTS FOR SELECTABLE LOW PASS FILTER WITH UPPER FREQ 0.6 Hz

\[ A = 1.0 \cdot 0.03452 \]
\[ B = 0.35804 / C \cdot 0.03492 \]
\[ C = 1.0 \cdot 0.03452 \]
\[ C = 1.0 \cdot 0.2775 \]
\[ E = 0.20696 / 0.02779 \]
\[ F = 1.0 / 0.02775 \]
\[ A = A_1 \cdot (I^{**2}) / 4. \]
\[ B = 2.0 \cdot A_1 \]
\[ C = A_1 \]
\[ D_1 = D_1 \cdot (T^{**2}) / 4. \]
\[ E = 2.0 \cdot C_1 \]
\[ F = D_1 \]
\[ G_1 = (1.0 \cdot B \cdot T / 2.0 \cdot C \cdot (T^{**2}) / 4. \]
\[ H_1 = (-2.0 \cdot C \cdot (T^{**2}) / 2.0 \]
\[ I_1 = (1.0 \cdot B \cdot T / 2.0 \cdot C \cdot (T^{**2}) / 4. \]
\[ J_1 = (1.0 \cdot E \cdot T / 2.0 \cdot F \cdot (T^{**2}) / 4. \]
\[ K_1 = (-2.0 \cdot F \cdot (T^{**2}) / 2.0 \]
\[ L_1 = (1.0 \cdot E \cdot T / 2.0 \cdot F \cdot (T^{**2}) / 4. \]
\[ \text{ASLP61} = \{ G_1 \cdot K_1 + H_1 \cdot J_1 \} / (G_1 \cdot J_1) \]
\[ \text{ASLP62} = \{ G_1 \cdot L_1 + H_1 \cdot K_1 + I_1 \cdot J_1 \} / (G_1 \cdot J_1) \]
\[ \text{ASLP63} = \{ H_1 \cdot L_1 + I_1 \cdot K_1 \} / (G_1 \cdot J_1) \]
\[ \text{ASLP64} = \{ I_1 \cdot L_1 \} / (G_1 \cdot J_1) \]
\[ \text{BSLP60} = (A_1 \cdot C_1) / (G_1 \cdot J_1) \]
\[ \text{BSLP61} = (A_1 \cdot E_1 + B_1 \cdot C_1) / (G_1 \cdot J_1) \]
BSLP62=(A1*F1+B1*C1+D1)/(G1*J1)
BSLP63=(B1*F1+C1*E1)/(G1*J1)
BSLP64=(C1*F11)/(G1*J1)

SET TRANSFERRED VALUES EQUAL TO INITIAL ARRAY VALUES AND APPLY DIGITAL FILTER TO ARRAY INFLOD

YC(4)=FILE(1)
YO(3)=FILE(2)
XI(4)=FILE(3)
XI(3)=FILE(4)
XI(4)=FILE(5)
XIII(3)=FILE(6)
XV(4)=FILE(7)
XV(3)=FILE(8)
YPO(4)=FILE(9)
YPO(3)=FILE(10)
YPO(2)=FILE(11)
YPO(1)=FILE(12)
CUTFLOD(4)=FILE(13)
CUTFLOD(3)=FILE(14)
CUTFLOD(2)=FILE(15)
CUTFLOD(1)=FILE(16)
INFLOD(4)=FILE(17)
INFLOD(3)=FILE(18)

N=8196
DC 92 I=5,A
I=1-1
I=1-2
I=1-3
I=1-4

YC(1)=BFHP1*INFLOD(1)+BFHP2*INFLOD(11)+BFHP3*INFLOD(12)+AF+1*YG(11)

*AFHP1*YO(12)
X(1)=ASHP4*YO(1)+ASHP42*XI(12)+ASHP43*XI(11)
XII(1)=XI(1)+XII(12)-2.*XI(11)
XIII(1)=XI(1)+XIII(11)+ASHP44*XIII(12)
XIV(1)=XIII(1)+XIV(12)
XP(1)=XV(1)+XV(12)
GP1=ASLP61*CUTFLOD(1)+ASLP62*OUTFLD(12)+ASLP63*CUTFLOD(13)+ASLP64

*G2BP66*YP0(11)+BSLP61*YP0(11)+BSLP62*YP0(12)+BSLP63*YP0(13)

*BSLP6*YP0(11)
CUTFLOD(1)=GP1,GP2
SIGN(1)=OUTFLD(1)
WRITE(6,1) INFLOD(1),YO(1),XI(1),XII(1),XIII(1),XIV(1)
WRITE(6,2) XV(1),YP0(1),GP1,GP2,CUTFLOD(1),SIGN(1)

1 FCRMAT("A",6G10.5)
2 FCRMAT("B",6G10.5)
92 CONTINUE
FCLE(1)=VO(8196)
FCLE(2)=VO(8196)
FCLE(3)=XI(8196)
FCLE(4)=XI(8195)
FCLE(5)=XI(8196)
FCLE(6)=XI(8195)
FCLE(7)=XVI(8196)
FCLE(8)=XVI(8195)
FCLE(9)=YPC(8196)
FCLE(10)=YPC(8195)
FCLE(11)=YPC(8194)
FCLE(12)=YPC(8193)
FCLE(13)=OLIFLD(8156)
FCLE(14)=OLIFLD(8155)
FCLE(15)=OLIFLD(8154)
FCLE(16)=OLIFLD(8193)
FCLE(17)=IAIFLD(8196)
FCLE(18)=IAIFLD(8155)
RETURN
END

FUNCTION ISHIFT(IN,NPLC)
RETURNS SHIFTED VALUE OF I*2 WORD IN
-VE LEFT,*VE RIGHT SHIFT

INTEGER * 2 IN
IP=IN
IF (IP.LT.0) IP=IP+65536
IF (NPLC.LT.0) GE TC 30
ISHIFT=IP/2**IAES(NPLC))
RETURN
30 ISHIFT=IP*2**IAES(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

INTEGER * 2 IN,IO
IO=IN
IF (IBR.EQ.0) GO TO 50
IT=ISHIFT(IN,IBR)
IO=IT
50 IP=ISHIFT(IO,IBL-15-IBR)
IP=IP
IMASK=ISHIFT(IO,15-IBL)
RETURN
END
/*
//GO.SYSIN DC *
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
X COIL AMP IN VOLTS
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
Y COIL AMP IN VOLTS
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
Z COIL AMP IN VOLTS
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
X COIL AMP IN VOLTS
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
Y COIL AMP IN VOLTS
CHEM'S RIDGE 4 AUG 83, 1834-1840 LOCAL
Z COIL AMP IN VOLTS

//GO.FT20F001 DD LNNI=3400-4, VOL=SER=CRDT3A, DISP=(QLC,KEEP),
// LABEL=(L,AL,IN),
// DCE=(RECFM=F8, LRECL=32, BLKSIZE=512, DEA=2)
//GO.SYSDUMP DD SYSOUT=A
*/
APPENDIX E

MASS STORAGE COMPUTER PROGRAM
THIS PROGRAM READS DATA FROM A COMPUTER TAPE, NORMALIZES THE DATA BETWEEN +5 AND -5 VOLTS AND STORES IT IN THE IBM 3033 MASS STORAGE SYSTEM FOR FUTURE RECALL. THE DATA IS READ AND TRANSFERRED IN BLOCKS OF 8152 SAMPLES (128 SECONDS OF DATA IN EACH BLOCK).

THE ARRAY 'IN' WILL BE USED TO RECEIVE THE DATA PASSED FROM THE SUBROUTINE 'RD' AND THEN TRANSFERRED TO THE APPROPRIATE XXX OR YYY OR ZZZ ARRAY.

INTEGER*2 IN(16)
C
CMPLEX*8 XXX(8192), YYY(8192), ZZZ(8192)
C
DATA XXX, YYY, ZZZ, (C, 0.0, 0.0) /
C
THE FOLLOWING SECTION READS THE FIRST ISEC SECONDS OF DATA FROM THE TAPE AND DISCARDS THIS DATA.
C
ISEC=200
IIL=ISEC*64
LC 55 JJ=1, IIL
CALL RD(20, IN, 200, IREC, IRR)
55 CONTINUE
IFrame=8192
C
THE VARIABLE NR SPECIFIES THE NUMBER OF BLOCKS OF DATA TO BE READ FROM THE TAPE AND STORED IN THE MSS.
C
NR=19
DC 70 LI=1, NR
C
THE NEXT LOOP READS NR FRAMES OF DATA (EACH FRAME 128 SECS LONG AT 64 HZ SAMPLING RATE) USING THE SUBROUTINE RD, PROVIDED BY DR. TIM STANTON OF THE NAVAL POSTGRADUATE SCHOOL.
C
DO 60 JJ=1, IFrame
CALL RD(20, IN, 1000, IREC, IRR)
XXX(JJ)=IN(2)
YYY(JJ)=IN(3)
ZZZ(JJ)=IN(4)
60 CONTINUE
N=8192
DO 20 J=1, N
C
THE NEXT 4 STEPS CONVERT THE
DATA IC VOLTAGE BETWEEN +5 AND -5 VOLTS AND SETS THE
IMAGINARY PART OF THE COMPLEX NUMBER EQUAL TO ZERO.

XXX(J) = ((XXX(J) - 2048.) * 5./2048.) - 1.36
YYY(J) = REAL(XXX(J))
YYY(J) = REAL(YYY(J))
ZZZ(J) = ((ZZZ(J) - 2048.) * 5./2048.) - 1.0
ZZZ(J) = REAL(ZZZ(J))

20 CONTINUE
THE NEXT WRITE STATEMENTS SEND
THE CONVERTED DATA TO MSS
FOR FUTURE MANIPULATION AND RECALL.

WRITE(21), XXX
WRITE(6,*), XXX(1), XXX(8192)
WRITE(21), YYY
WRITE(6,*), YYY(1), YYY(8192)
WRITE(21), ZZZ
WRITE(6,*), ZZZ(1), ZZZ(8192)

70 CONTINUE
WRITE(6,71)
71 FORMAT(' FINISHED WRITING TO MASS STORAGE')
ENDFILE 21
STOP
END

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
ID = INTEGER*2 ARRAY, 16 LONG (VALUES 0-4095, SUBTRACT 2048) * 5
/2028. GIVES VOLTAGE
IRS = NUMBER OF RESINS ALLOWED (ERRORS)
IREC = COUNTER OF RECORDS (FRAMES OF DATA)
BLOCK 512 BITS, 32 BITS = RECORD
800 BPI TAPE UNLABELED
IRQ = NUMBER OF ACTUAL RESINS (ERRORS)
INTEGER * 2 I0(16), IP(16)

DATA IRR, IER />
IF (IREC.EQ.0) I$=0
IER=0
20 FORMAT (1E2)
IF (IS.NE.0) GO TO 50
READ (IUN, 20, END=900) IP
IER=IER+1
40 IS=IS+1
IF (IS.LT.17) GO TO 50
READ (IUN, 20, END=56C) IP
IS=1
IER=IER+1
50 ICH=IMASK(IP(IS), 3, 0)+1
WRITE (6, 55) ICH, IS, IUN, IREC
55 FORMAT (' RESYNG ICH, IS, IUN, IREC * ,418)
C
IF (ICH.NE.1) GO TO 40
DO 100 I=1, 16
10 I=ISHFT(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
70 FORMAT (' UNIT * ,I3, RECORD * ,16, 'CHAN & DATA CH * ,2I4,
* ERRORS '*,17)
80 IS=IS+1
IF (IS.LT.17) GO TO 100
READ (IUN, 20, END=900) IP
IS=1
IER=IER+1
100 CONTINUE
C
IF (IER.EQ. 0) GO TO 150
IRR=IRR+1
IF (IRR.LT.IRS) GO TO 120
WRITE (6, 110)
110 FORMAT ('I STOPPED IN SUB RD BECAUSE OF IRR.GT.* ,16,* AT L110*)
IRR=IRR
STOP
120 CONTINUE
WRITE (6, 130) IREC, IRR
130 FORMAT (' RESYNG AT FRAME * ,16,* WITH TCTAL ERRORS '*,17)
IER=0
IRR=IRR
GO TO 50
150 CONTINUE
RETURN
500 WRITE (6,510) IUA,IREC
910 FORMAT (11 END OF UNIT ',I3,' AT REC ',I7)
STOP
END

FUNCTION ISHIFT (IN,NPLC)
C
END OF SUBROUTINE ISHIFT

C RETURNS SHIFTED VALUE OF I*2 WORD IN
-VE LEFT, +VE RIGHT SHIFT

C
INTEGER *2 IN
IP=IN
IF (IP.LT.C) IP=IP+65536
IF (NPLC.LT.0) GC TO 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)
C
MASK I*2 WORD IN OUTSIDE BITS IBL & IBR

C
INTEGER *2 IN,IC
IO=IN
IF (IBR.EQ.0) GO TO 50
IT=ISHIFT(IN,IBR)
IO=IT
50 I=ISHIFT(IO,IBL-15-IBR)
IO=IO
IMASK=ISHIFT(IO,15-IBL)
RETURN
END

/*GE.FT21F001 DD LNIT=3330V,MSVGR=PB4A,DISP=(NEW,CATLG),

DSA=MSS,S2992,LDFT3D,

DCE=(RECFM=F8S,BLKSIZE=4096,LRECL=4092),

SPACE=(CYL,8,4))

/*GC.FT20F001 DD LNIT=3400-4,VAL=SER-LMDT3,DISP=(OLC,PASS),

LABEL=1NL,IN,

DCE=(RECFM=FB,LRECL=32,PKT=512,DEK=2)*/
APPENDIX F

MAGFLD COMPUTER PROGRAM
INTEGER K,14,15,0
REAL SUMX,SLNY,SMZ,SMI,AVE1,AVE2,AVE3,AVE4
REAL CCNSTX,CCNSTY,CCNSTZ,CCNSTT
INTEGER*4 TBL1(121)/12*0/
REAL*4 RTB1(28)/28*0.0/
REAL ALAB(4)/'CH-X','CH-Y','CH-Z','TOT'/
REAL*8 TITLE(12)
EQUIVALENCE(TITLE(1),RTB1(5))
C
ARRAYS 'ITL','RTB1','ALAB' AND 'TITLE' ARE USED IN GENERATING
THE VERTSATEC PLOTTER OUTPUT.
DATA XX,YY/16384*(0.,0.)/
DATA ZI,TF/16384*(0.,0.)/
DATA ZI,XY1/16384*(0.,0.)/
DATA ZI,XY2/16384*(0.,0.)/
DATA TIME,FREQ/16384*0./
AVG4 = 0.0
DG 31 IN1 = 1.65536
ZV1(IN1) = 0.0
ZVII(IN1) = 0.0
ZVIII(IN1) = 0.0
TIME2(IN1) = C.0

31 CONTINUE

THE NEXT FIVE LINES SERVE AS A TIME DELAY IN STARTING THE
DATA ANALYSIS
ISEC=10
ITL=ISEC+64
CC 55 JJ=1, ITL
CALL RC(20, IN, 200, IREC, IRR)

55 CONTINUE
IFRAME=8192
AR=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
OR 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)=IN1(2)
YY(JJ)=IN1(3)
ZZ(JJ)=IN1(4)

60 CONTINUE

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
FA=FLOAT(N)
DELTAT=1./64.
DELTAF=1./((FNR*DELTAT)
CC 20 J=1, N
TIME(J)=DELTAT#FLCAT(J)
FREQ(J)=DELTAF#FLCAT(J)
XX(J)=((XX(J)-2048.145./2048.)-1.36
XX(J)=REAL(XX(J))
YY(J) = ((YY(J) - 2048.1) * 5. / 2048.1) - 1.0
YY(J) = REAL(YY(J))
ZZ(J) = ((ZZ(J) - 2048.1) * 5. / 2048.1) - 1.0
ZZ(J) = REAL(ZZ(J))

C 'XX' IS THE X-CCIL DATA, 'YY' IS THE Y-CCIL DATA.
C 'ZZ' IS THE Z-CCIL DATA, AND 'TF' IS THE PROJECTION OF THE
C NORTH-SOUTH COMPONENT (XX) AND THE VERTICAL COMPONENT (ZZ)
C ON THE TCIAL GEOMAGNETIC FIELD VECTOR.

CONTINUE
DC 21 J = 1, A
FRQ(J) = ALCG10(FREQ(J))
CONTINUE

C THE NEXT FOUR STATEMENTS PERFORM AN FFT ON THE INPUT
C TIME SERIES DATA. SEE THE WRITEUP ON 'FCLRT' FOR
C FURTHER INFORMATION.
CALL FCLRT(XX,N,1,-1,0,WORK)
CALL FCLRT(YY,N,1,-1,0,WORK)
CALL FCLRT(ZZ,N,1,-1,0,WORK)

C THE NEXT BLOCK OF STATEMENTS APPLY THE SYSTEM (VOLTAGE TO
C FIELD) TRANSFER FUNCTION TO THE TRANSFORMED FREQUENCY
C DOMAIN DATA. THIS BLOCK ENDS AT STATEMENT 9.
C THE TRANSFER FUNCTION CONVERTS VOLTS TO NANTESLAS (GAMMAS).
C WARNING: THE TRANSFER FUNCTIONS YIELDS AN INACCURATE
C PHASE. USE A DIFFERENT TRANSFER FUNCTION IF PHASE INFORMATION
C NEEDS.

DC 9 L = 1, N
FRQ = FREQ(L)
IF(FRQ .LE. 25., GO TO 1
XX(L) = XX(L) / 28.
GO TO 8

1 IF(FRQ .LE. 15.) GO TO 2
XX(L) = XX(L) / 10.5 - 3.14 * FRQ
YY(L) = YY(L) / (18.) - 2.56 * FRQ
ZZ(L) = ZZ(L) / (177.) - 7.48 * FRQ
GO TO 8

2 IF(FRQ .LE. 10.) GO TO 3
XX(L) = XX(L) / (5.958 * FRQ - 30.97)
YY(L) = YY(L) / (17.166 * FRQ - 30.29)
ZZ(L) = ZZ(L) / (16.499 * FRQ - 32.35)
GO 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)
GO TO 8

4 IF(FRQ .LE. 5.) GO TO 5
XX(L) = XX(L) / (2.6311 * FRQ + 0.14667)
YY(L) = YY(L) / (3.012 * FRQ + 1.551)

GO TO 8

5 GO TO 21

\[
ZZ(L) = ZZ(L) / (3.184*FRQ-1.44)
\]

\[
\text{GO TO 8}
\]

5 IF (FRQ.LT.3.) GO TO 6

6 XX(L) = XX(L) / (2.72*FRQ)

7 YY(L) = YY(L) / (2.92*FRQ)

8 CONTINUE

15 CONTINUE

9 CONTINUE

CALL FCURT (XX,N,1,1,WORK)

CALL FCURT (YY,N,1,1,WORK)

CALL FCURT (ZZ,N,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

56 CONTINUE

The NEXT 44 LINES OF CODE CORRECT DATA BLOCK END JUMPS.

66 IF K.NE.0 GO TO 36

67 CONTINUE

GC TO 37
36 CONTINUE
SUMX=0.0
SUMY=0.0
SUMZ=0.0
SUMT=0.0
DC 68 IS=1,144
SLMX=ZX1(I)+SUMX
SUMY=ZY1(I)+SUMY
SLMZ=ZV1(I)+SUMZ
SLMT=ZT1(I)+SUMT
68 CONTINUE
AVE1=SLMX/144.
AVE2=SUMY/144.
AVE3=SUMZ/144.
AVE4=SUMT/144.
CC 69 IS=1,5192
ZZX1(I4)=ZX1(I)+ZCX-AVEL
ZZY1(I4)=ZY1(I)+ZCY-AVE2
ZZZ1(I4)=ZV1(I)+ZCV-AVE3
ZZT1(I4)=ZT1(I)+ZCT-AVE4
14=14+1
69 CONTINUE
CC 91 IS=1,5192
TIME2(I5)=DELTA*FLOAT(I3)+(128.0*FLOAT(K))
91 CONTINUE
K=K+1
70 CONTINUE
C THE FOLLOWING LINES OF CODE PERFORMS A DOUBLE RUNNING POINT
C AVERAGE ON THE DATA.
CC 73 L2=1,2
C=0
DC 74 IS=1,5318
SUMX=0.0
SUMY=0.0
SUMZ=0.0
SUMT=0.0
DC 75 J=1,144
SLMX=ZXJ(I)+SUMX
SUMY=ZYJ(I)+SUMY
SLMZ=ZVJ(I)+SUMZ
SLMT=ZTJ(I)+SUMT
75 CONTINUE
ZZX1(I)=SLPX/144.
ZZY1(I)=SLPY/144.
ZZZ1(I)=SLPZ/144.
ZZT1(I)=SLPT/144.
Q=Q+1
CONTINUE
CONTINUE

VERSATEC PLCI OF B - MAGNETIC FIELD (Smoother)

APTS=1020/CELTAT+1.

"APTS" DETERMINES NUMBER OF POINTS NEEDED TO PLOT FOR
THE DATA. 2041 SECS RANGE TO BE PLOTTED.

FOR THE FOLLOWING "ITB" AND "RTB" VALUES REVIEW THE WRITE-UP
FOR THE SUBROUTINE PROCEDURE "DRAWP".

ITB(3)=20
ITB(4)=8
ITB(7)=1
RTB(12)=0
RTB(11)=0.0
RTB(2)=0.0
RTB(3)=ALAE(1)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZX1,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZY1,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZZ1,ITB,RTB)
ITB(12)=1
RTB(3)=ALAB(4)
READ(5,3000)ITLE
CALL DRAWP(NTS,TIME2,ZZT1,ITB,RTB)
ITB(4)=7
ITB(12)=0
RTB(3)=ALAE(1)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZX1,ITB,RTB)
RTB(3)=ALAE(2)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZY1,ITB,RTB)
RTB(3)=ALAE(3)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZZ1,ITB,RTB)
ITB(12)=1
RTB(3)=ALAE(4)
READ(5,300C)ITLE
CALL DRAWP(NTS,TIME2,ZZT1,ITB,RTB)

3000 FORMAT(6A8)
STOP
END
SUBROUTINE RD(IUN, IC, IRS, IREC, IRQ)

C
C THIS PROCEDURE FURNISHED BY DR. TIM STAATCN,
C DEPARTMENT OF OCEANOGRAPHY.
C
C READ DATA FROM IUN, ALLIGN, CHECK & RETURN
C
IUN=TAPE NUMBER, EC 20
IDO=INTEGER*2 ARRAY, 16 LONG, (VALUES 0-4095, SLBTRACT 2048)*5
GIVES VOLTAGE
IRS= NUMBER OF RESINS ALLOWED (ERRORS)
IREC= COLON OF RECORDS (FRAMES CF DATA)
BLOCK 512 BITS, 32 BITS = RECORD
800 EPI TAPE UNLABELED
IRQ= NUMEB OF ACTILAL RESINS (ERRORS)

INTEGER * 2 IO(16), IP(16)

DATA IRR /C/
IF (IREC.EQ.0) I S=0
IER=0
F0MAT (16.2)
IF (IS.NE.C) 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=50C) IP
IS=1
IREC=IREC+1
ICH=IMASK(IP(16),3,0)+1
WRITE (6,55) ICH,IS,IUN,IREC

C
FORMAT ( ' RESYNCING ICH,IS,IUN,IREC ',418)

C
IF (ICH.NE.1) GO TO 40
DC 100 I=1,16
IO(I)=ISHFT(IP(I),16)
ICH=IMASK(IF(IS),3,0)+1
IF (ICH.EQ.1) GO TO 80
IER=IER+1
WRITE (6,7C) IUN,IREC,ICH,IER

C
FORMAT ( ' LIMIT ',13,' RECORD ',16,' CHAN & DATA CH ',214,
\' ERRORS ',17)
IS=IS+1
IF (IS.LT.17) GO TO 100
READ (IUN,20,END=90C) IP
IS=1

LV03000
LV03010
LV03020
LV03030
LV03040
LV03050
LV03060
LV03070
LV03080
LV03090
LV03100
LV03110
LV03120
LV03130
LV03140
LV03150
LV03160
LV03170
LV03180
LV03190
LV03200
LV03210
LV03220
LV03230
LV03240
LV03250
LV03260
LV03270
LV03280
LV03290
LV03300
LV03310
LV03320
LV03330
LV03340
LV03350
LV03360
IREC=IREC+1
CONTINUE

IF (IER.EQ.0) GO TO 150
IRE=IRE+1
IF (IRE.LT.IRS) GO TO 120
WRITE (6,110)

110 FORMT (''I STOPPED IN SUB RD BECAUSE OF IRR.CT.'',16,'' AT L110')
IRQ=IRE
STOP

CONTINUE
WRITE (6,130) IREC, IRR

130 FORMT (''RESYNC AT FRAME '',16,'' WITH TOTAL ERRORS '',17)
IER=0
IRQ=IRE
GO TO 50

CONTINUE
RETURN

500 WRITE (6,510) IUN,IREC

910 FORMT (''I 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

INTEGER * 2 IN
IP=IN
IF (IP.LT.0) IP=IP+65536
IF (NPLC.LT.0) GC TC 30
ISHIFT=IP/(2**1ABS(NPLC))
RETURN

30 ISHIFT=IP*(2**1ABS(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,IC
IO=IN
IF (IBR.EQ.0) GO TO 50
IT=ISHIFT(IN,IBR)
IO=IT

50 IP=ISHIFT(IO,IBL-15-IBR)
IO=IP
IMASK=ISHIFT(IO,15-IBL)
RETURN
END

//GC,SYSIN DC *
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
X CCIL AMP IN NT
Y CCIL AMP IN NT
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
Z CCIL AMP IN NT
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
TCTAL FIELD AMP IN NT
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
X CCIL AMP IN NT
Y CCIL AMP IN NT
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
Z CCIL AMP IN NT
LAMESA VILLAGE , 4 AUG 83, 1802-1819 LOCAL
TCTAL FIELD AMP IN NT

//GO,FT20F001 DD UNIT=3400-4, VOL=SER=LMDT3A, DISP=(COL,KEEP),
LABEL={1, ALL, IN},
DCP=(RECFM=PB, LRECL=32, 8LKSIZ=512, CEA=2)
//GO,SYSDUMP DD SYSOUT=A
APPENDIX G

COHER COMPUTER PROGRAM
//CCFEP32 JOB (2562.0165),'ANTHONY ' SMC 2123',CLASS=G
//**MAIN ORG=PGMPL.2992 P,LINES=(75)
///FORMAT PR DONAME=PLOT,SYSTEXT,DEST=LOCAL
///EXEC FRXCLG.PARM,LKE='LIST,MAP,XREF,REGION,GC=2048K
///FORT,SYSIN DD CSN=SYS3.SSML,SOURCE(FOURT),CISP=S-FR
COHO0010
DD *
CGHO0020
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 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 CHEM'S RIDGE SITES.
C
C INTEGER*2 IN(16)
C ARRAY 'IN' IS USED IN READING DATA FROM TAPE
C COMPLEX*8 XXX(8192),YYY(8192),ZZZ(8192)
C COMPLEX*8 XXX(8192),YYY(8192),ZZZ(8192)
C DIMENSION CTLY(8192),CTLY(8192),CTLY(8192)
C DIMENSION CTLY(8192),CTLY(8192),CTLY(8192)
C DIMENSION CTLY(8192),CTLY(8192),CTLY(8192)
C COMPLEX*8 ARRAYS ARE USED BECAUSE COMPLEX NUMBERS ARE REQUIRED
C BY THE FOURIER TRANSFORM SUBROUTINE 'FOURT'.
C DATA CTLY,CTLY,CTLY/24576*0./
C DATA CTLY,CTLY,CTLY/24576*0./
C DATA CTLY,CTLY,CTLY/24576*0./
C DATA CTLY,CTLY,CTLY/24576*0./
C DIMENSION FREQ(8192),FRQ(8192),WORK(16384)
C INTEGER*4 ITB(12),12*0/
C REAL*4 RTB(28)/28*0./
C REAL*4 ALAB(4), COXY, COXY, COHY, COH2, TOT/
C REAL*8 TITLE(12)
C EQUIVALENCE Ital(1),RTB(5)
C ARRAYS 'ITB', 'RTB', 'ALAB', AND 'TITLE' ARE USED IN GENERATING
C THE VERTSATOEC PLOTTER 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 RC(20,IN,200,IREC,IRRE)
C CONTINUE
C NR=19
C FNR=FLOAT(NR)
C DC 70 LL=1,AR
C THE DD LOOP ENDING WITH STATEMENT 70 ENABLES THE PROGRAM TO
C PROCESS A LARGE AMOUNT OF DATA BY REPEATING THE PROCESS IN
C BLOCKS.
*NR* REPRESENTS THE NUMBER OF DATA SEQUENCES.
1 SEQUENCE CURRENTLY EQUALS 8192 DATA POINTS FOR EACH CHANNEL.
128 SECONDS 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. FIRST, THE NEXT THREE STATEMENTS READS THE DATA
FROM THE LAMESÁ SITE THAT WAS PREVIOUSLY STORED IN THE
IBM 3033 MASS STORAGE SYSTEM.
READ(21) XXX
READ(21) YYY
READ(21) ZZZ
SET THE IMAGINARY PART OF THE COMPLEX NUMBERS EQUAL TO ZERO.
DC 43 I=1, E192
XXL(I)=REAL(XXX(I))
YY(L)=REAL(YYY(I))
ZZL(I)=REAL(ZZZ(I))
43 CONTINUE
NOW READ THE CHEW'S RIDGE DATA FROM THE COMPUTER TAPE.
DC 60 JJ=1, E192
CALL RC(20, IN, 1000, IREC, IRR)
XXC(JJ)=IN(2)
YYC(JJ)=IN(3)
ZZC(JJ)=IN(4)
60 CONTINUE
N=8192
FA=FLOAT(N)
DELAT=1./FA.
T=FN*DELAT
DELAF=1./T
NORMALIZE THE CHEW'S RIDGE DATA BETWEEN +5 AND -5 VCLIS AND SET THE IMAGINARY PART EQUAL TO ZERO. THE LAMESÁ VILLAGE DATA HAS ALREADY BEEN NORMALIZED IN THE MASS STORAGE PROGRAM.
CC 20 J=1, E192
XXC(J)=(XXC(J)-2048.)*5./2048.
XXC(J)=REAL(XXC(J))
YYC(J)=(YYC(J)-2048.)*5./2048.
YYC(J)=REAL(YYC(J))
ZZC(J)=(ZZC(J)-2048.)*5./2048.
ZZC(J)=REAL(ZZC(J))
20 CONTINUE
TRANSFORM THE DATA FROM ALL THREE COILS AT BOTH SITES INTO THE FREQUENCY CCMAIN.
CALL FCURT(XXL,N,1,-1,0,WORK)
CALL FCURT(YYL,N,1,-1,0,WORK)
CALL FCURT(ZZL,N,1,-1,0,WORK)
CALL FCURT(XXR,N,1,-1,0,WORK)
CALL FCURT(YYR,N,1,-1,0,WORK)
CALL FCURT(ZZR,N,1,-1,0,WORK)
CALL FCURT(YYYY,N,1,-1,0,WORK)
CALL FOURT(ZXC,N,1,-1,0,WORK)
C THE NEXT LOOP IS REQUIRED AFTER TRANSFORMATION. SEE THE WRITEUP
C FOR THE SUBROUTINE 'FOURT'.
DC 40 K=1,N
XXL(K4)=XXL(K4)/FN
YYL(K4)=YYL(K4)/FN
ZXLK(K4)=ZXLK(K4)/FN
XXC(K4)=XXC(K4)/FN
YYC(K4)=YYC(K4)/FN
ZZC(K4)=ZZC(K4)/FN
C CONTINUE
C
4C CONTINUE
C THE NEXT LOOP SUMS EACH DATA SAMPLE OVER THE NR BLOCKS OF
C DATA.
C DO 30 II=1,N
C TLX[II]=C TLX[II]+CABS{XXL[II]}*CONJG{XXL[II]})
C TLZ[II]=C TLZ[II]+CABS{ZZL[II]}*CONJG{ZZL[II]})
C CTCX[II]=CTCX[II]+CABS{XXC[II]}*CONJG{XXC[II]})
C CTCAY[II]=CTCAY[II]+CABS{YYC[II]}*CONJG{YYC[II]})
C CTCZ[II]=CTCZ[II]+CABS{ZZC[II]}*CONJG{ZZC[II]})
C CTC[II]=CTC[II]+CABS{XXC[II]}*CONJG{XXC[II]})
C CTC[II]=CTC[II]+CABS{XXC[II]}*CONJG{XXC[II]})
C 3C CONTINUE
C NOW GO BACK AND GET THE NEXT BLOCK OF DATA AND PERFORM THE SAME
C ANALYSES EA IT.
C 7C CONTINUE
C CALCULATE THE COHERENCE OF EACH COIL AND THE FREQUENCY SCALE
C (LOG) IT IS PLOTTED AGAINST.
C DC 44 I=1,N
C CTLCX[14]=CTLCX[14]/SORT{CTLX[14]}*SORT{CTCX[14]})
C CTC[14]=CTC[14]/SORT{CTCY[14]}*SORT{CTCZ[14]})
C FREQ[14]=DELTAF*FLOAT[14]
C FREQ[14]=ALCG1O{FREQ[14]}
C 44 CONTINUE
C NPTS=1/DELTAF +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 'KTB' VALUES REVIEW THE WRITE-UP
C FOR THE SUBROUTINE PROCEDURE 'DRAWP'.
C ITB[1]=20
C ITB[4]=8
C ITB[7]=1
C ITB[12]=0
C RTB[11]=0.0
RTB(2)=0.0
RTB(3)=ALAE(1)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCX, ITB, RTB)
RTB(3)=ALAE(2)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCY, ITB, RTB)
RTB(3)=ALAE(3)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCZ, ITB, RTB)
ITB(3)=7
ITB(4)=5
ITB(12)=0
RTB(3)=ALAE(1)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCX, ITB, RTB)
RTB(3)=ALAE(2)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCY, ITB, RTB)
RTB(3)=ALAE(3)
READ(5,3000) TITLE
CALL DRAWP(NPTS, FRQ2, COHLCZ, ITB, RTB)
3000 FCMAT(6A8)
STOP
END
SUBROUTINE RD(IUN, IC, IRS, IREC, IRQ)
C
C THIS PROCEDURE FURNISHED BY DR. TIM STANTON,
C DEPARTMENT OF OCEANOGRAPHY.
C
C READ DATA FROM IUN, ALIGN, CHECK & RETURN
C
IUN=TAPE NUMBER, EC 20
IO=INTEGER*2 ARRAY, 16 LUNG, VALUES 0-4095, SLBRACT 2048)*5
2028. GIVES VOLTAGE
IRS= NUMBER OF RECORDS ALLOWED (ERRORS)
IREC= COLUMN OF RECORDS (FRAMES OF DATA)
BLOCK 512 BITS, 32 BITS = RECORD
800 BPI TAPE UNLABLED
IRQ= NUMBER OF ACTUAL RECORDS (ERRORS)
C
INTEGER * 2 IO(16), IP(16)
C
DATA IRR /C/
IF (IREC.EQ.0) IS=0
IER=0
20 FORMAT (16A2)
IF (IS.NE.0) GO TO 50
READ (IUN, 20, END=550) IP
ICL=IREC+1
IF (I$ .LT. 17) GO TO 50
READ (IUN, 20, END=550) IP
ICL=IREC+1
ICH=IMASK(IP(IS), 3, 0, 1)
WRITE (6, 55) ICH, IS, IUN, IREC
C
FORMAT (1 RESYNCING ICH, IS, IUN, IREC ', 418)
C
IF (ICH .NE. 1) GO TO 40
DC 100 I=1, 16
IF (I .NE. ISH) FT(IP(IS), 1)
ICH=IMASK(IP(IS), 3, 0, 1)
IF (ICH .EQ. 1) GO TO 80
IER=IER+1
WRITE (6, 7C) IUN, IREC, ICH, IER
$ 'ERRORS ', 17)
IS=IS+1
IF (IS .LT. 17) GO TO 100
READ (IUN, 20, END=550) IP
IS=1
IER=IREC+1
CONTINUE
C
IF (IER .EQ. 0) GO TO 150
IER=IER+1
IF (IER .LT. IRS) GO TO 120
WRITE (6, 110)
FORMAT ('1 STOPPED IN SUB RD BECAUSE OF IRR.GT.', 16, ' AT L110')
IER=IRM
STOP
CONTINUE
WRITE (6, 130) IREC, IRR
FORMAT ('1 RESYNC AT FRAME ', 16, ' WITH TOTAL ERRORS ', 17)
IER=0
IER=IRM
GO TO 50
CONTINUE
RETURN
WRITE (6, S10) IUN, IREC
S10 FORMAT ('1 END OF UNIT ', 13, ' AT REC ', 17)
STOP
END
C
FUNCTION ISHIFT (IN, NPLC)
C

#RETURNS SHIFTED VALUE OF I*2 WORD IN
#-VE LEFT,*VE RIGHT SHIFT

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)

C

INTEGER * 2 IN,IC
IO=IN
IF (IBR.EQ.0) GO TO 50
IT=IShift(IN,IBR)
IO=IT
50
IP=IShift(IO,IBL-15-IBR)
IO/IP
IMask=IShift(IO,15-IBR)
RETURN
END

F0-SYSIN D E *
LAMESA-CHEW'S RICCE, 4 AUG 83, 1700-1740 LCCAL
X CCIL COHERENCE
Y COIL COHERENCE
Z CCIL COHERENCE
LAMESA-CHEW'S RICCE, 4 Aug 83, 1700-1740 LOCAL
X CCIL COHERENCE
Y CCIL COHERENCE
Z CCIL COHERENCE
LAMESA-CHEW'S RICCE, 4 AUG 83, 1700-1740 LOCAL
X CCIL COHERENCE
Y CCIL COHERENCE
Z CCIL COHERENCE
LAMESA-CHEW'S RICCE, 4 AUG 83, 1700-1740 LOCAL
X CCIL COHERENCE
Y CCIL COHERENCE
Z CCIL COHERENCE

F0.FT20F00 DD LNI1=340C-4, VOL=SER=CRDT3, DISP=(OCL,KEEP),
   LABEL=(1,AL,IN).
F0.FT21F00 DD LNI1=3330V, MSV=I=PUB4A, DISP=(OCL,KEEP),
   DSN=MsS-S2992,LMDT30,
   DCe=(RECFM=VS, BLSIZE=4096, LRECL=4092)
F0.SYSDUMP DD SYSDOUT=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
REFERENCES


### INITIAL DISTRIBUTION LIST

<table>
<thead>
<tr>
<th>No.</th>
<th>Copies</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2</td>
<td>Defense Technical Information Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cameron Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alexandria, Virginia 22314</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>Library, Code 0142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Postgraduate School</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monterey, California 93943</td>
</tr>
<tr>
<td>3.</td>
<td>2</td>
<td>Dr. Otto Heinz, Code 61Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department of Physics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Postgraduate School</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monterey, California 93943</td>
</tr>
<tr>
<td>4.</td>
<td>2</td>
<td>Dr. Andrew R. Ochadlick Jr., Code 3012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Air Development Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warminster, Pennsylvania 18974</td>
</tr>
<tr>
<td>5.</td>
<td>1</td>
<td>Dr. Paul Moose, Code 62Me</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department of Electrical Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Postgraduate School</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monterey, California 93943</td>
</tr>
<tr>
<td>6.</td>
<td>2</td>
<td>Dr. Michael Thomas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applied Physics Lab, JHU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Submarine Technology Division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Johns Hopkins Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laurel, MD 20707</td>
</tr>
<tr>
<td>7.</td>
<td>2</td>
<td>LT Stephen J. Anthony</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1522 Lydia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>St. Paul, Minnesota 55113</td>
</tr>
<tr>
<td>8.</td>
<td>1</td>
<td>Office of Naval Research</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attn: Mr. John G. Heacock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Code 425 GG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800 North Quincy Street</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arlington, VA 22217</td>
</tr>
<tr>
<td>9.</td>
<td>1</td>
<td>Naval Air Development Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attn: Mr. Edward Yannuzzi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Code 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warminster, Pennsylvania 18974</td>
</tr>
</tbody>
</table>
10. Naval Air Systems Command
   Attn: Mr. Barry Dillon
   Code AIR-340J
   Washington, DC 20361

11. Dr. A. C. Fraser-Smith
    Radio Science Laboratory
    Stanford Electronics Laboratories
    Stanford University
    Palo Alto, California 94305