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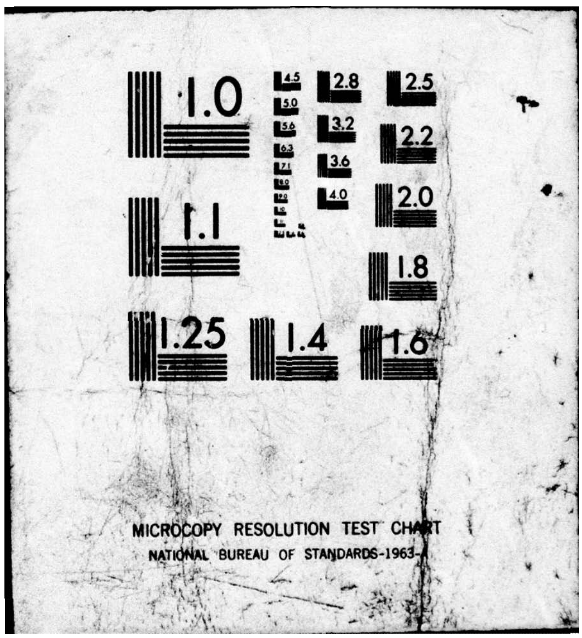
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SUFFIELD MEMORANDUM 29/76

COMPUTER SIMULATION OF ANOMALIES CREATED BY AN ARRAY OF FERROUS OBJECTS IN THE EARTH'S MAGNETIC FIELD (U)

by

R.W. Hemrich

PROJECT NO. 14-60-06

NOVEMBER 1976

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD : RALSTON : ALBERTA

UNCLASSIFIED

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD
RALSTON ALBERTA

(14) DRES-Memo-29/76

SUFFIELD MEMORANDUM NO. 29/76

(6) COMPUTER SIMULATION OF ANOMALIES CREATED BY AN ARRAY OF FERROUS OBJECTS IN THE EARTH'S MAGNETIC FIELD. (U)

(11) Nov 76

by

(12) 26p.

(10) R.W. Hemrich

PROJECT NO. 14-60-06

WARNING
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SUFFIELD MEMORANDUM NO. 29/76

COMPUTER SIMULATION OF ANOMALIES CREATED BY AN ARRAY OF FERROUS OBJECTS IN THE EARTH'S MAGNETIC FIELD (U)

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R.W. Hemrich

ABSTRACT

This report describes a FORTRAN IV computer *simulation of a three-dimensional* array of ferrous objects and its effect on the earth's magnetic field. The program output is a plot of the magnetic anomaly amplitude versus distance along a path similar to that recorded by a total field magnetometer passing over the array. The array size, object mass, direction of the earth's field and the altitude and direction of the path of the magnetometer are controlled by the user. One hundred and one computer words of storage are required for each pass.

This study was done as part of a Range Clearance Technology task leading to the design of equipment for the detection of unexploded ordnance found on military ranges.

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DEFENCE RESEARCH ESTABLISHMENT SUFFIELD
RALSTON ALBERTA

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COMPUTER SIMULATION OF ANOMALIES CREATED BY AN ARRAY OF FERROUS OBJECTS IN THE EARTH'S MAGNETIC FIELD (U)

by

R.W. Hemrich

INTRODUCTION

Previous work involving magnetic anomalies due to a dipole has been restricted to the signal obtained from a single object (1). The purpose of this study was to derive a general expression for the effect of a ferrous object on the earth's magnetic field and adapt it for computer use to allow the calculation of the anomaly due to a three-dimensional array of these objects. This work would not only allow the simulation of the unexploded ordnance scattered about a drop-zone, but would permit the modeling of shrapnel lying near the surface, or the modeling of an area of iron-rich soil of high susceptibility.

Figure 1 shows a plot of anomaly magnitude due to a single ferrous object as seen by a total field magnetometer scanning over the object. Where an array of these objects occurs, it is difficult to visualize the total effect that they will have on the earth's field.

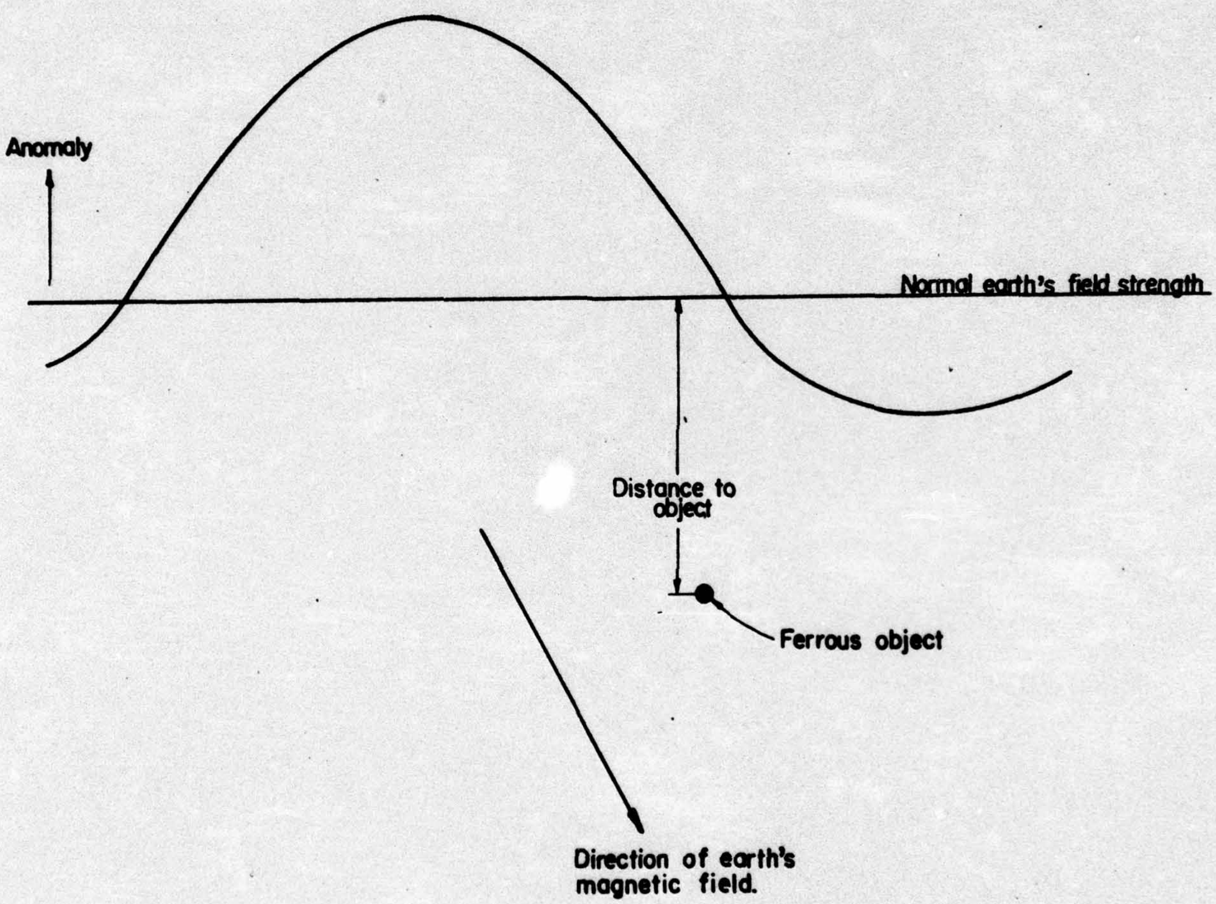

Figure 1 Typical Anomaly Due to a Ferrous Object

In order to create a smooth plot of the total effect due to an array of objects it is necessary to determine the effect at a large number of points on the path. In this simulation, 101 points were used on a 10" x 10" plot. Where the array contains 100 objects the result is 10,100 calculations per pass. For this reason the problem lends itself well to a computer solution.

THEORY

An object in the earth's magnetic field may cause a distortion of the field depending on the permanent and induced magnetization of the object. It is this distortion, or anomaly, which indicates the presence of an object.

Permanent magnetization is determined by the history as well as composition of the object and can add to or cancel the effect of the induced component. For this study only induced magnetization is considered.

Induced magnetization is a function of the intensity of the ambient field and the magnetic susceptibility of the material in the object:

$$I = KH$$

Where I = induced magnetization per unit volume

K = magnetic susceptibility

H = earth's magnetic field

The magnetic moment of the object is

$$M = IV$$

Where V = volume

Therefore $M = KHV$

The magnetic moment for typical, spherical, man-made iron objects is 10^5 to 10^6 cgs units per metric ton (1).

The anomaly created by an object at a point is a function of the distance to the object and is of the form

$$T = \frac{CM}{r^n}$$

Where C = constant

n = constant

r = distance

Objects which have high length to diameter ratios tend to behave as monopoles, especially if magnetized along their length. That is, their field lines radiate straight out from their ends and the resulting anomaly is inversely proportional to r^2, or n = 2. In reality, they are dipoles which have their poles far apart (1).

In this study, objects of interest have low l/d ratios and behave as dipoles. In this case n is equal to 3, and the anomaly is inversely proportional to r^3.

A magnetic anomaly due to a dipole is sometimes expressed as two components. One component is due to the field off the end of a dipole. In this case constant C is equal to 2. The other component is from the side of the dipole where C is 1, as shown in reference 2. The first component is projected onto the line joining the object of detection and the point of interest and becomes the radial component Tr. The other is projected onto the perpendicular to it and becomes the tangential component $T\phi$ as shown in Figure 2.

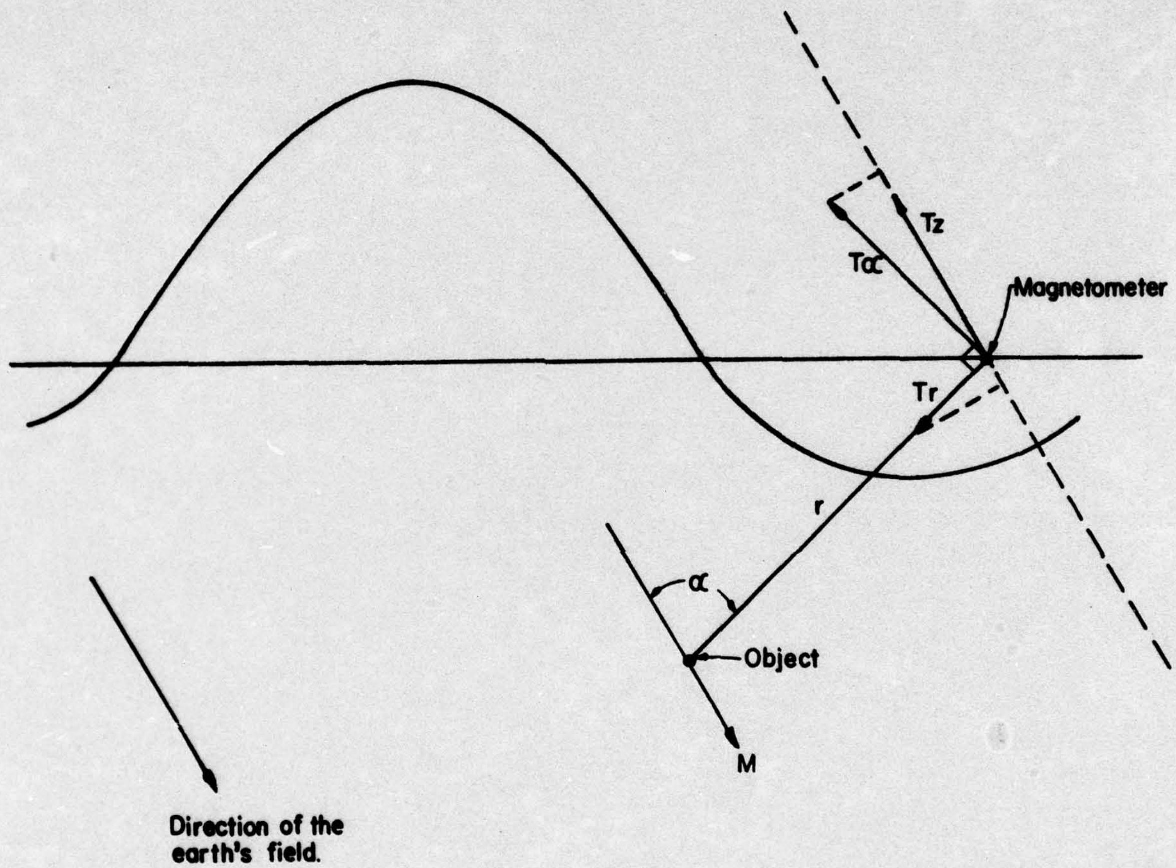

Figure 2 Anomaly Components

The two components are (1)

$$Tr = \frac{2M \cos \alpha}{r^3}$$

$$T\alpha = \frac{-M \sin \alpha}{r^3}$$

A three-dimensional co-ordinate system is used to determine the angle α, which is the angle between the earth's field vector and the line between object and magnetometer. The vector describing this line is projected onto a unit vector representing the earth's field. The angle α can then be determined from this projection. The earth's field vector V1 is defined here (Figure 3).

$$A1 = \cos A \cos B$$

$$B1 = \sin A \cos B$$

$$C1 = \sin B$$

where V1 = 1

The vector V2 describing the direction and distance from the magnetometer to any object in the array is defined below (Figure 4).

$$A2 = IX2 - y \sin \theta + x \cos \theta$$

$$B2 = IY2 + y \cos \theta + x \sin \theta$$

$$C2 = H$$

where H is the height of the magnetometer above the top 2-dimensional array of objects.

and $V2 = \sqrt{A2^2 + B2^2 + C2^2}$

Vectors $\overline{V1}$ and $\overline{V2}$ can be described as

$$\overline{V1} = A1i + B1j + C1k$$

$$\overline{V2} = A2i + B2j + C2k$$

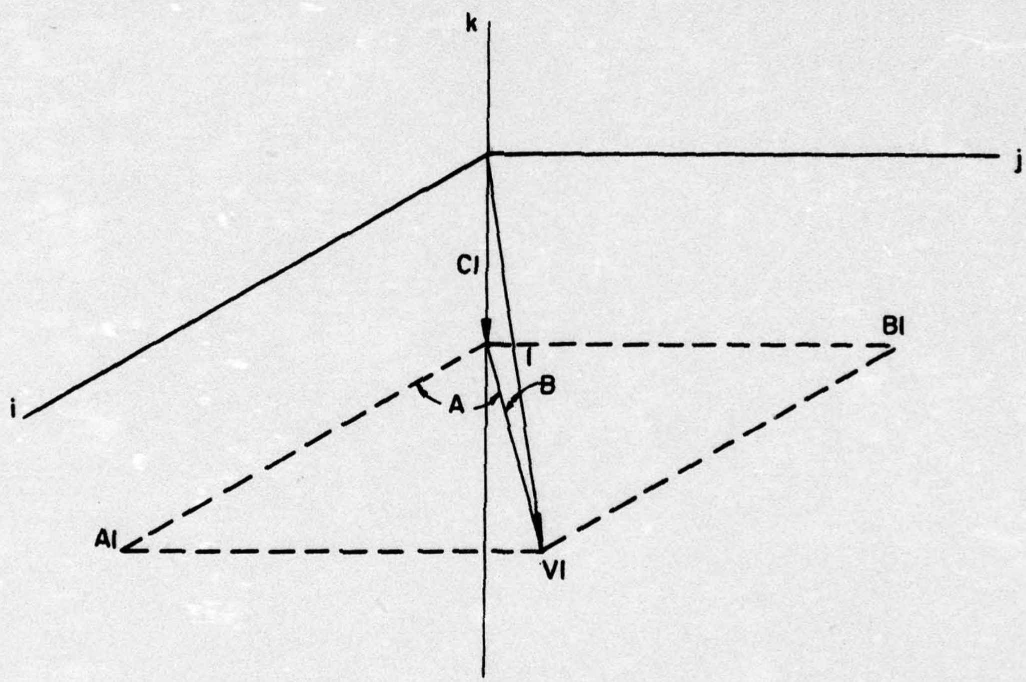

Figure 3 Earth's Field Vector

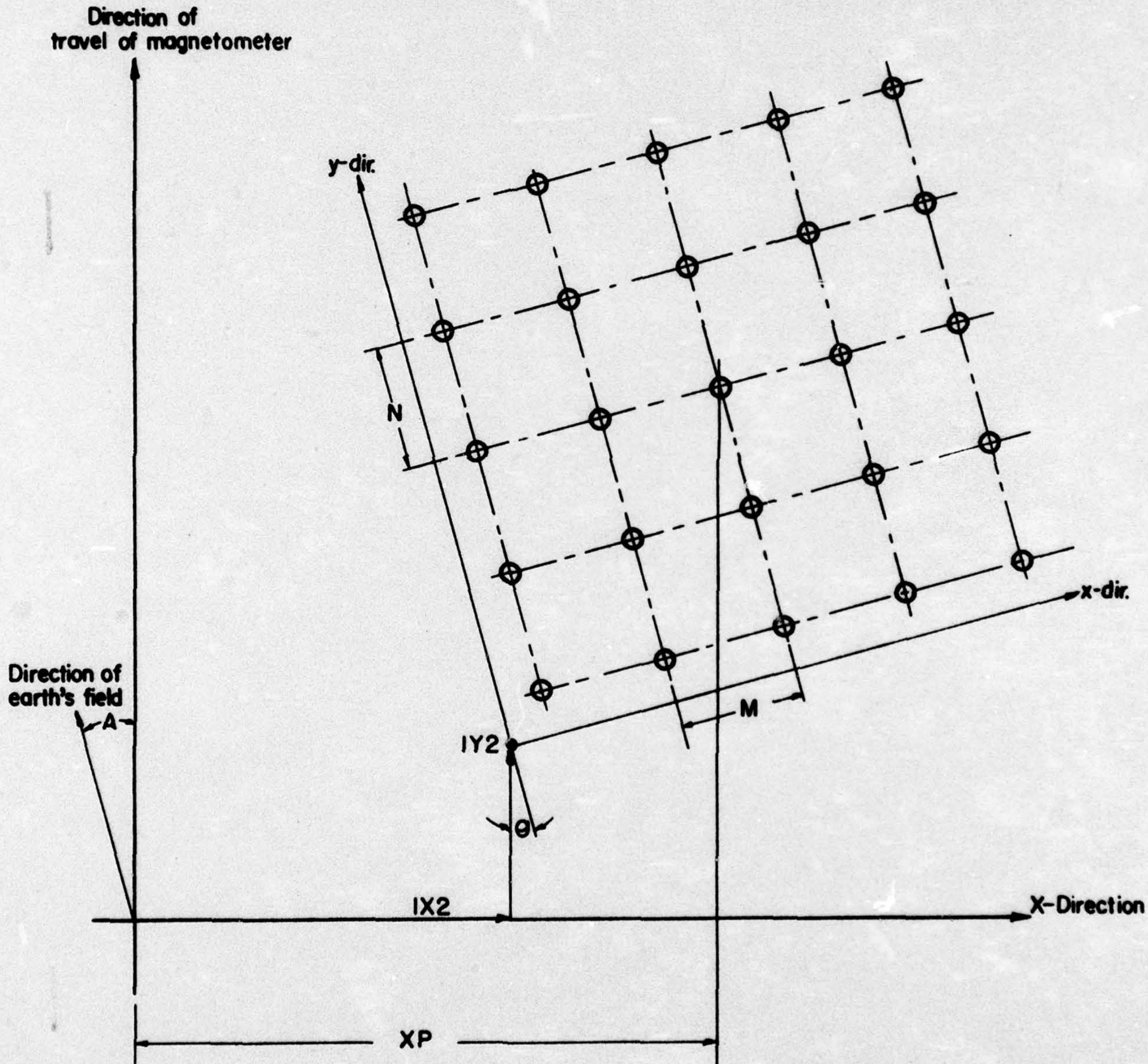

Figure 4 Plan View of Array

The dot product is used to project one vector on another:

$$\overline{V1} \cdot \overline{V2} = V1V2 \cos \alpha$$

or

$$\cos \alpha = \frac{\overline{V1} \cdot \overline{V2}}{V1V2}$$

but

$$\overline{V1} \cdot \overline{V2} = A1A2 + B1B2 + C1C2$$

and

$$V1V2 = \sqrt{A2^2 + B2^2 + C2^2}$$

Therefore

$$\cos \alpha = \frac{A1A2 + B1B2 + C1C2}{\sqrt{A2^2 + B2^2 + C2^2}}$$

and

$$\sin \alpha = \sqrt{1 - \cos^2 \alpha}$$

We can now find Tr and $T\alpha$ since

$$Tr = \frac{2M\cos \alpha}{r^3}$$

and

$$T\alpha = \frac{-M\sin \alpha}{r^3}$$

These components are then projected into the earth's field vector. This is done because a total field magnetometer measures the component of an anomaly very nearly in the direction of the earth's field (1). The direction of the earth's field is easily determined and remains quite constant for a given area.

$$Tz = Tr \cos \alpha + T\alpha \sin \alpha$$

Tz is the anomaly detected by the magnetometer for one object.

The computer program adds the anomalies for each object in the array and produces plots like those shown in figures 5 - 7. Figure 5 is a west-to-east scan over an array of objects 5 x 5 x 1. Each object appears in a scan this close to the array whereas a scan such as that shown in Figure 6 is far enough above the array of 2 x 2 x 3 to hide the detail of each object. Figure 6 is also an example of a south-to-north scan in a location where the inclination of the earth's field is 45°. All positive inclinations are below the horizontal in this program. Figure 7 shows a scan where the inclination is 73°, approximately the angle in south-eastern Alberta. The symmetry which occurs in a vertical field is noticeably absent at this angle. A magnetic moment of 5 x 10^5 cgs units/metric ton has been used to produce these curves.

PROGRAM OPERATION

A. Inputs and Operation

The program inputs and its basic operation are explained here. Refer to the main program listing in the Appendix for input formats.

PROBS	number of independent plots done in a run.
THETA	angle of rotation of the array in degrees about a vertical line through the reference point (Figure 4).
A	declination of the earth's field in degrees when the magnetometer heading is north (Figure 3).
B	inclination or dip of the earth's field in degrees.

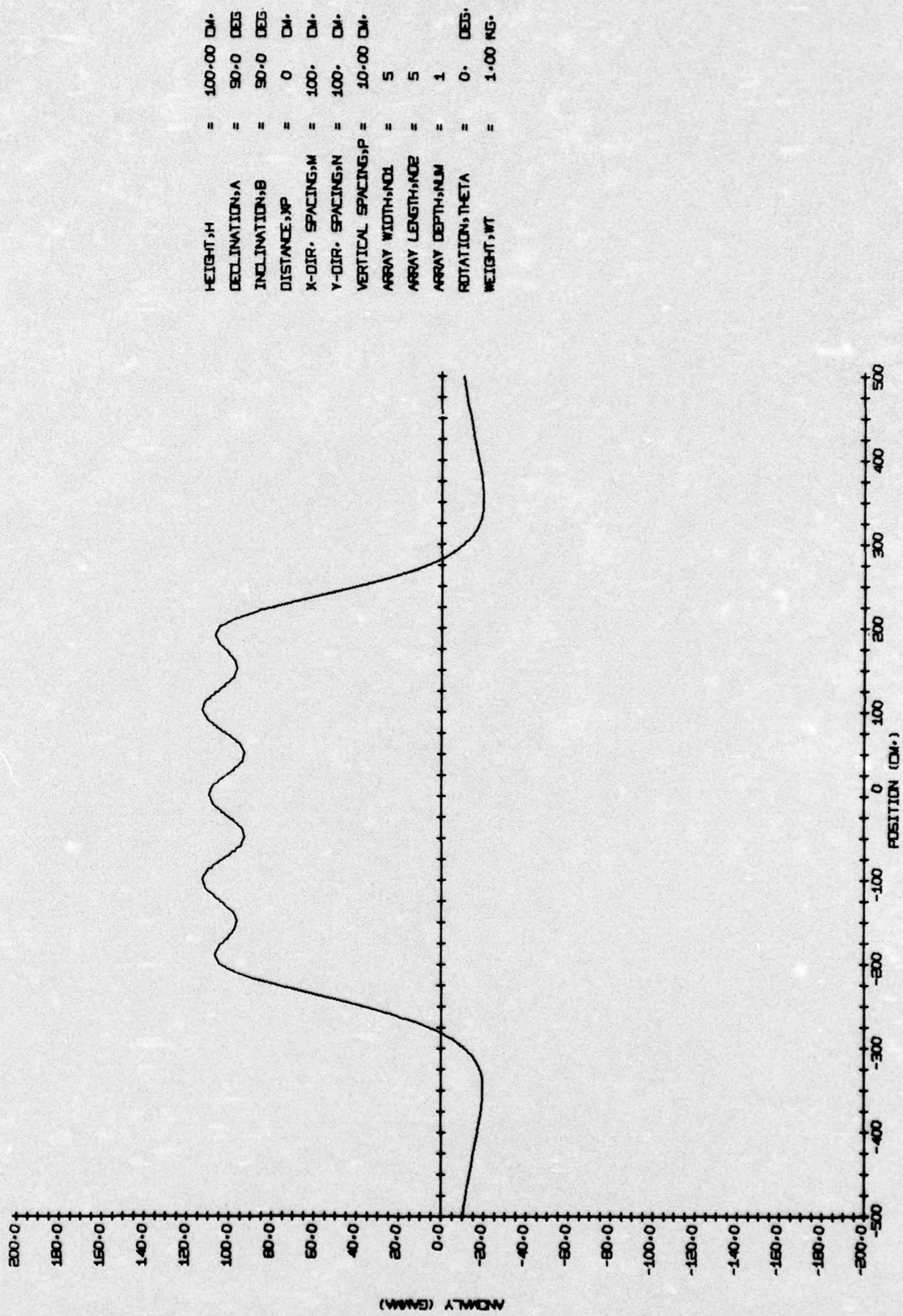

Figure 5 Anomaly From An Array of Five Objects

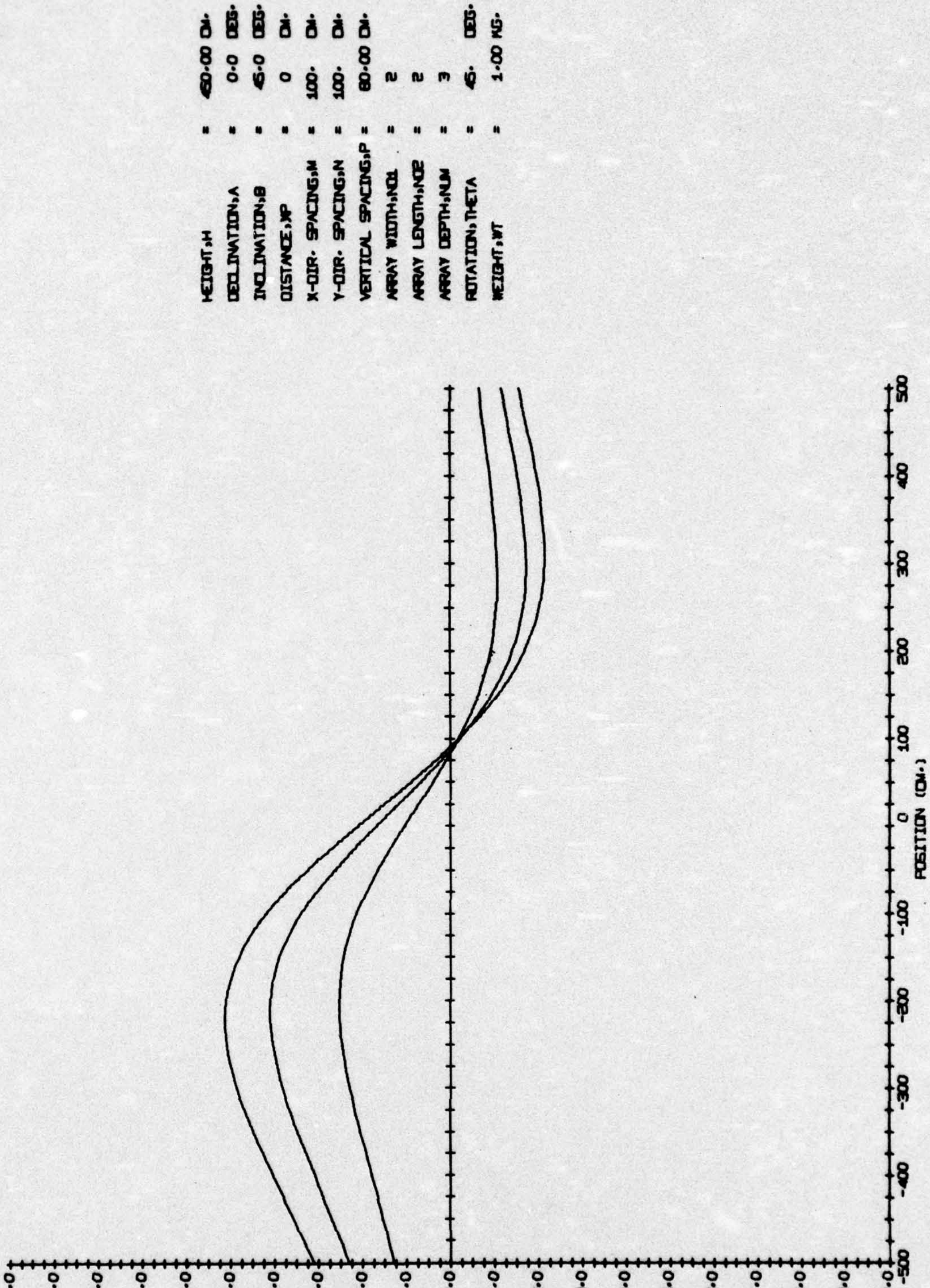

Figure 6 Anomaly at a Field Inclination of 45^0

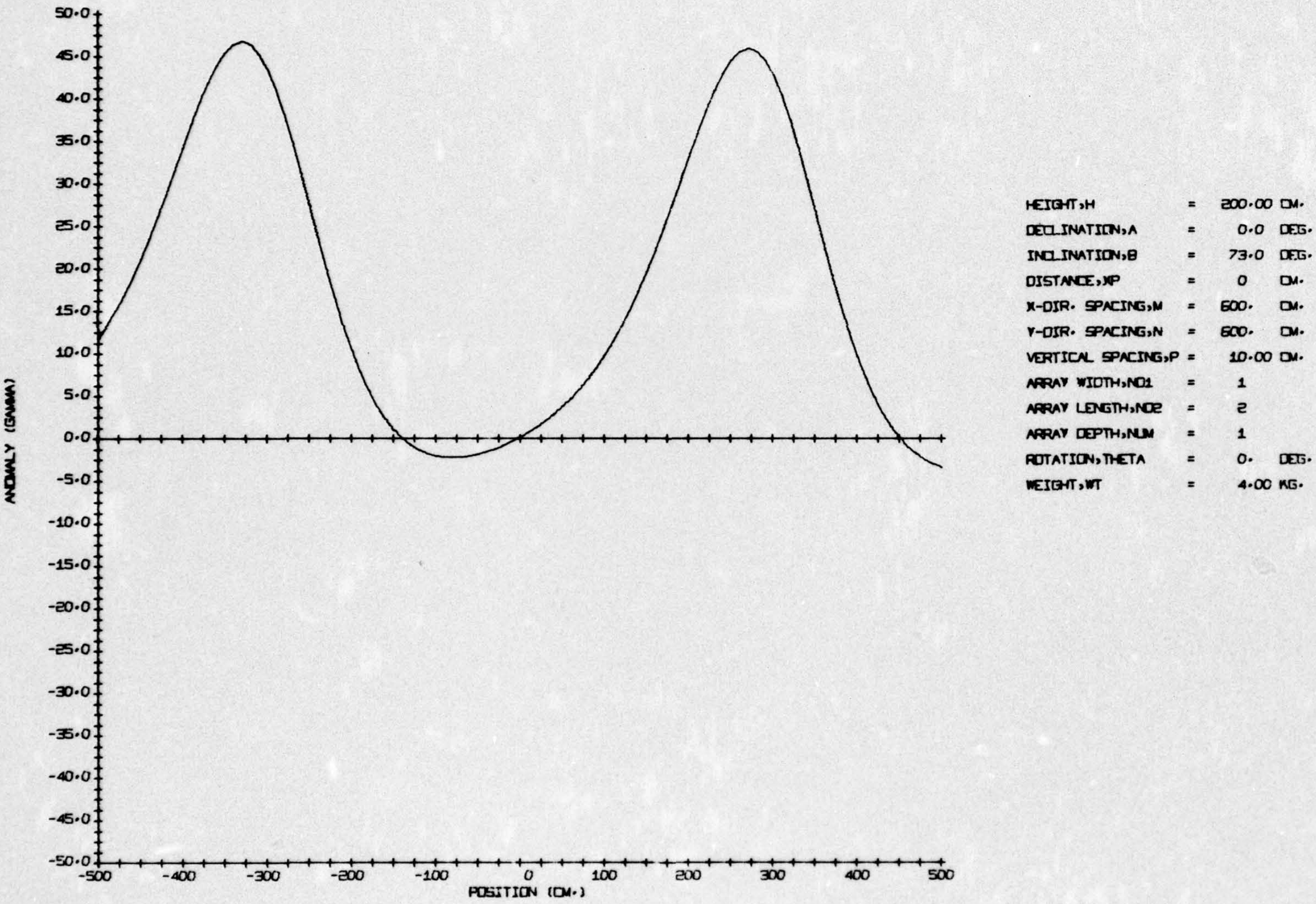

Figure 7 Typical Anomaly from Two Objects in South-East Alberta

XP horizontal distance in centimeters from the center of the array to the nearest point of approach on the magnetometer path.

S horizontal distance in centimeters from the center of the array to the start of the magnetometer path.

F horizontal distance in centimeters from the center of the array to the end of the magnetometer path.

NO1 number of objects in the array in the X-direction (Figure 4).

NO2 number of objects in the array in the Y-direction (Figure 4).

H vertical distance in centimeters from the top two-dimensional array to the nearest point on the magnetometer path.

M distance in centimeters between objects in the array in the X-direction.

N distance in centimeters between objects in the array in the Y-direction.

WT weight of the objects in the array in kilograms.

NUM maximum number of objects in the array in the vertical direction.

P vertical distance in centimeters between each two-dimensional horizontal array.

The main program reads in the data cards in the order given above. Then the reference points (XXR, YYR) are defined relative to the center of the array.

Subroutine SCAN is called to do the anomaly calculations. These calculations are all made relative to the reference point. The distance IX2 from the reference point to the closest point on the magnetometer path is printed out prior to SCAN. The subroutine sets the location of the simulated magnetometer according to the user instructions. Then at 101 equally spaced points along this path it determines the anomaly.

The anomaly at a point is determined by finding the angle α and the distance to each object and using the expression derived earlier to obtain the total anomaly from the array. This data is stored in computer core in a two-dimensional array called AA which is dimensioned to AA (101,4). It has room for four magnetometer passes on one graph. Three are shown in Figure 6. The first line plotted is for the top two-dimensional array. A new line is then plotted as an additional two-dimensional array is added below the last and the effect of all present arrays is calculated. In Figure 6 three lines are shown indicating a three-dimensional array, three layers vertically, the last line being calculated for the entire array. Array size is set by the user. As the data is being stored, the maximum anomaly among the 303 points is determined for use later. When storage is complete, control is returned to the main program.

Subroutine SKALE is called and uses the maximum anomaly point found in SCAN to set an appropriate scale for the y-axis of the plotter output.

Again control is returned to the main program. The line printer will output the maximum anomaly point T and the maximum scale height XMAX which were found in SCAN and SKALE.

The grid is set with four tick marks per inch for ten inches on both the X and Y axis of the plotter.

Subroutine ROWND is called to round off the X axis scale if necessary. The main program then instructs the plotter to print the X axis numbers, one per inch as required by the scale, and the X axis title is printed. The same procedure occurs for the Y axis.

The rest of the main program plots the data stored in array AA. When the plot is finished the plotter pen moves to a new location ready to begin another graph if instruction PROB requires it.

B. Output

The main program output is a graph of the magnetic anomaly due to an array of ferrous objects. At the side of the graph is a listing of the input parameters to the program. The anomaly scale in gammas is printed along the vertical axis. The distances in centimeters printed on the horizontal axis give the horizontal component of the distance from the geometric center of the object array to the simulated location of the magnetometer. The program input lists the desired start and finish distance from the magnetometer to the array center. These values are transformed into the horizontal scale of the graph.

As mentioned in SECTION A, the magnetometer heading is always assumed to be north. However, by adding to the declination angle, the effective heading can be changed. Also, the entire array may be rotated about its reference point (SECTION A) to compensate for this new heading (Figure 4).

The distance XP indicates the closest distance that the magnetometer comes to the array center. When XP is zero, the detector is passing directly over the geometric center of the array.

Appendix A Program Listing

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE SCAN(M,N,H,NO1,NO2,WT,AA,THETA,A,B,IX2,L,NUM,Z,P,T,S,F)
      INTEGER S,F
      REAL M,N,MM
      DIMENSION AA(101,4)
      T = 0.
      MM = 5.E 10
      A1 = COS(A) * COS(B)
      B1 = SIN(A) * COS(B)
      C1 = SIN(B)
      V1 = 1.
      DO 200 K=1,NUM
      IY2=L
      LL=1
   10 X = 0.0
      ANOM = 0.0
      DO 100 I = 1,NO1
      IF (I-1)2,2,3
    2 X = X + M/2.
      GO TO 4
    3 X = X + M
    4 Y = C.0
      DO 100 J = 1,NO2
      IF (J-1)5,5,6
    5 Y = Y + N/2
      GO TO 7
    6 Y = Y + N
    7 A2 = IX2 - Y * SIN(THETA) + X * COS (THETA)
      B2 = IY2 + Y * COS (THETA) + X * SIN (THETA)
      C2 = H
      V2 = SQRT(A2**2 + B2**2 + C2**2)
      COSTH = (A1*A2+B1*B2+C1*C2)/SQRT((A1**2+B1**2+C1**2)*(A2**2+B2**2+
     1      C2**2))
      SINTH = SQRT(1.-COSTH**2)
      TR = 2*MM*COSTH/V2**3*WT
      TTH= -MM*SINTH/V2**3*WT
      TZ = TR*COSTH + TTH * SINTH
      ANOM = ANOM + TZ
  100 CONTINUE
      AA (LL,K) = ANOM
      D = 0.
      DO   9 I1 = 1,K
    9 D = D + AA(LL,I1)
      IF(ABS(T)-ABS(D))11,13,13

PAGE   3

   11 T = ABS(D)
   13 IY2 = IY2-( S+F)/100
      LL=LL+1
      IF(LL-101 )10,10,15
   15 H=Z+(P*K)
  200 CONTINUE
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR SCAN
 COMMON       0  VARIABLES      64  PROGRAM     526

RELATIVE ENTRY POINT ADDRESS IS 004D (HEX)

END OF COMPILATION

// DUP
```

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE SKALE(T,TMAX)
      DIMENSION TEST(29)
      DATA TEST/100000.,50000.,25000.,20000.,10000.,5000.,2500.,2000.,
     11000.,500.,250.,200.,100.,50.,25.,20.,10.,5.,2.5,2.0,1.0,0.5,0.25,
     20.20,0.1,0.05,0.025,0.02,0.01/
      IF(T-100000.)20,30,30
20    IF(T-.01)30,30,40
30    TMAX=T
      RETURN
40    DO 50 I=2,29
      IF(T-TEST(I))50,50,60
50    CONTINUE
60    TMAX=TEST(I-1)
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR SKALE
 COMMON       0  VARIABLES      60  PROGRAM      74

RELATIVE ENTRY POINT ADDRESS IS 0042 (HEX)

END OF COMPILATION

// DUP

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE ROWND (WORD,NUM)
      DIMENSION TENS(6)
      DATA TENS/1.0,10.0,100.0,1000.0,10000.0,100000.0/
      DO 1 I = 1,6
      IF (TENS(I)-ABS(WORD))1,99,2
2     IF(ABS(NUM)-(7-I))3,3,99
1     CONTINUE
3     IF (NUM)99,99,10
10    IF (NUM-6)15,15,99
15    TEMP = WORD*TENS(NUM)
      IF(TEMP-32767)4,4,99
4     ITEMP=IFIX(TEMP)
      TEST = TEMP-FLOAT(ITEMP)
      TEMP = FLOAT (ITEMP)
      IF (TEST)20,99,30
20    IF (TEST+0.5)22,22,25
22    TEMP = TEMP-1.0
25    WORD = TEMP/TENS(NUM)
      RETURN
30    IF (TEST-0.5)40,35,35
35    TEMP = TEMP + 1.0
40    WORD = TEMP/TENS(NUM)
99    RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR ROWND
 COMMON       0  VARIABLES      22  PROGRAM     176

RELATIVE ENTRY POINT ADDRESS IS 001E (HEX)

END OF COMPILATION

// DUP
```

```
// FOR
*IOCS(CARD)
*IOCS(1132 PRINTER)
*ONE WORD INTEGERS
* IOCS(PLOTTER)
*LIST SOURCE PROGRAM
      INTEGER PROBS, XP,S,F
      REAL M,N
      DIMENSION AA(101,4)
      READ (2, 2)PROBS
    2 FORMAT(I3)
      DO 7 JLL=1,PROBS
      READ (2,  4)THETA
    4 FORMAT(F5.1)
      THETA = THETA * 2.*  3.14/360.
      READ(2,  6)A,B
    6 FORMAT(F5.1,F5.1)
      A = A + 90.
      A = A * 2.*3.14/360.
      B = B * 2.*3.14/360.
      READ(2,  8)XP
    8 FORMAT(I10)
      READ(2, 10)S,F
   10 FORMAT(I10,I10)
      READ (2,12)NO1,NO2
   12 FORMAT (I5,I5)
      READ (2,14)H
   14 FORMAT (F10.2)
      2 = H
      READ (2,16)M,N
   16 FORMAT (F10.2,F10.2)
      READ (2,18)WT
   18 FORMAT (F10.2)
C     CONVERT TO METRIC TONS
      WT = WT/1000.0
      READ (2,20)NUM
   20 FORMAT (I3)
      READ (2,22)P
   22 FORMAT (F10.2)
      XXR = M*(NO1-1)/2. + M/2.
      YYR = N*(NO2-1)/2. + N/2.
      TL = SORT (XXR**2 + YYR**2)
      AN = ATAN (YYR/XXR)
      ANTH = AN + THETA
      XU= COS (ANTH) * TL
      CALL ROWND (XU,1)

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      IX2 = XP - IFIX(XU)
      WRITE (3,1)
    1 FORMAT ('1')
      WRITE(3,  24)IX2
   24 FORMAT(' ','IX2 =',I10)
      RAY = SIN(ANTH)*TL
      CALL ROWND (RAY,1)
      L = S - IFIX(RAY)
      IY = S + F + L
      CALL SCAN (M,N,H,NO1,NO2,WT,AA,THETA,A,B,IX2,L,NUM,Z,P,T,S,F)
      CALL SKALE (T,XMAX)
      WRITE (3,26)T,XMAX
   26 FORMAT('0','T =',F15.6,3X,'XMAX =',E15.6)
      Y=1./XMAX*10./2.
      X=10./FLOAT(S+F)
      PF=-FLOAT(L)
      PU=-XMAX
      CALL SCALF(X,Y,PF,PU)
      XXY=.025*FLOAT(S+F)
      CALL FGRID(0,PE,PU,XXY,40)
      CALL FGRID (0,PE,0.0,XXY,40)
      YY = XMAX/40.
      CALL FGRID(1,PE,PU,YY,80)
      PO=-.35*FLOAT( S+F)/10.-FLOAT(L)
      KO = -S
      DO  9 II = 1,11
      YYY=-.04*XMAX-XMAX
      CALL FCHAR (PO, YYY ,.1,.1,0.)
      WRITE (7,28)KO
   28 FORMAT(I5)
      PO=PO+FLOAT( S+F)/10.
      KO=KO+( S+F)/10
    9 CONTINUE
      XY=.44*FLOAT( S+F)-FLOAT(L)
      XX=-.08*XMAX-XMAX
      CALL FCHAR (  XY,   XX ,0.1,0.1,0.0)
      WRITE (7,30)
   30 FORMAT('POSITION (CM.)')
      PO=-.005*XMAX-XMAX
      OK = -XMAX
      DO 11 JJ = 1,21
      XYX=-FLOAT( S+F)*.07-FLOAT(L)
      CALL FCHAR (XYX,PO,.1,.1,0.0)
      CALL ROWND (OK,2)
      WRITE (7,32)OK
   32 FORMAT(F6.1)

PAGE   9

      PO = PO + .1 * XMAX
      OK=-XMAX+FLOAT(JJ)/10.0*XMAX
   11 CONTINUE
      YX = -FLOAT( S+F)/10.-FLOAT(L)
      XXX=.85 *XMAX-XMAX
      CALL FCHAR (  YX,  XXX,0.1,0.1,1.57)
      WRITE (7,34)
   34 FORMAT ('ANOMALY (GAMMA)')
      H = Z
      WRITE (3, 3)
    3 FORMAT ('0')
      DO  13 K=1,NUM
      LL=1
      HH=-FLOAT(L)
   25 A1=0.
      DO  15 I1=1,K
   15 A1=A1+AA(LL,I1)
      IF(A1-XMAX) 17,19,21
   17 IF(A1+XMAX) 23,19,19
   23 A1=-XMAX
      GO TO 19
   21 A1= XMAX
      GO TO 19
   19 CALL FPLOT(-2,HH,A1)
      LL=LL+1
      HH=HH+FLOAT(( S+F)/100)
      IF(HH-(IY-2*L)) 25,25,27
   27 CALL FPLOT (+1,HH,A1)
   13 CONTINUE
      A = A/2./3.14*360.
      B = B/2./3.14*360.
      CALL FCHAR ((-L + 11./X), 0.54 * XMAX, 0.1,0.1,0.0)
      WRITE(7,  36)H
   36 FORMAT ('HEIGHT,H'11X'=',F9.2,1X'CM.')
      CALL FCHAR ((-L + 11./X), 0.48 * XMAX, 0.1,0.1,0.0)
      A = A - 90.
      WRITE (7,38)A
   38 FORMAT ('DECLINATION,A'6X'=',F8.1,2X'DEG.')
      CALL FCHAR ((-L + 11./X), 0.42 * XMAX, 0.1,0.1,0.0)
      WRITE(7,  40)B
   40 FORMAT ('INCLINATION,B'6X'=',F8.1,2X'DEG.')
      CALL FCHAR ((-L + 11./X), 0.36 * XMAX, 0.1,0.1,0.0)
      WRITE (7,42)XP
   42 FORMAT ('DISTANCE,XP'8X'=',I6,4X'CM.')
      CALL FCHAR ((-L + 11./X), 0.30 * XMAX, 0.1,0.1,0.0)
      THETA = THETA / 2./  3.14*360.

PAGE  10

      WRITE(7,  44)M
   44 FORMAT ('X-DIR. SPACING,M'3X'=',F7.0,3X'CM.')
      CALL FCHAR ((-L + 11./X), 0.24 * XMAX, 0.1,0.1,0.0)
      WRITE(7,46)N
   46 FORMAT ('Y-DIR. SPACING,N'3X'=',F7.0,3X'CM.')
      CALL FCHAR ((-L + 11./X), 0.18 * XMAX, 0.1,0.1,0.0)
      WRITE (7,58) P
   58 FORMAT ('VERTICAL SPACING,P',1X'=',F9.2,1X,'CM.')
      CALL FCHAR ((-L + 11./X), 0.12 * XMAX, 0.1,0.1,0.0)
      WRITE (7,48)NO1
   48 FORMAT ('ARRAY WIDTH,NO1'4X'=',I6)
      CALL FCHAR ((-L + 11./X), 0.06 * XMAX, 0.1,0.1,0.0)
      WRITE (7,50) NO2
   50 FORMAT ('ARRAY LENGTH,NO2'3X'=',I6)
      CALL FCHAR ((-L + 11./X), 0.00 * XMAX, 0.1,0.1,0.0)
      WRITE (7,56)NUM
   56 FORMAT ('ARRAY DEPTH,NUM',4X'=',I6)
      CALL FCHAR ((-L + 11./X),-0.06 * XMAX, 0.1,0.1,0.0)
      WRITE (7,52) THETA
   52 FORMAT ('ROTATION,THETA'5X'=',F7.0,3X'DEG.')
      CALL FCHAR ((-L + 11./X),-0.12 * XMAX, 0.1,0.1,0.0)
C     CONVERT TO KG.
      WT = WT * 1000.0
      CALL ROWND (WT,3)
      WRITE (7,54)WT
   54 FORMAT ('WEIGHT,WT'10X'=',F9.2,1X'KG.')
      APP = 1.7*(FLOAT( S+F))-FLOAT(L)
      CALL FPLOT (+3,APP,-XMAX)
    7 CONTINUE
      CALL EXIT
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON      0  VARIABLES    904  PROGRAM   1656

END OF COMPILATION

// DUP
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UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATING ACTIVITY DEFENCE RESEARCH ESTABLISHMENT SUFFIELD	2a. DOCUMENT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. DOCUMENT TITLE
COMPUTER SIMULATION OF ANOMALIES CREATED BY AN ARRAY OF FERROUS OBJECTS IN THE EARTH'S MAGNETIC FIELD (U)

4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Memorandum

5. AUTHOR(S) (Last name, first name, middle initial)

Hemrich, R.W.

6. DOCUMENT DATE November 1976	7a. TOTAL NO. OF PAGES 23	7b. NO. OF REFS 4
8a. PROJECT OR GRANT NO. PROJECT NO. 14-60-06	9a. ORIGINATOR'S DOCUMENT NUMBER(S)	
8b. CONTRACT NO.	9b. OTHER DOCUMENT NO.(S) (Any other numbers that may be assigned this document)	

10. DISTRIBUTION STATEMENT

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13. ABSTRACT

This report describes a FORTRAN IV computer simulation of a three-dimensional array of ferrous objects and its effect on the earth's magnetic field. The program output is a plot of the magnetic anomaly amplitude versus distance along a path similar to that recorded by a total field magnetometer passing over the array. The array size, object mass, direction of the earth's field and the altitude and direction of the path of the magnetometer are controlled by the user. One hundred and one computer words of storage are required for each pass.

This study was done as part of a Range Clearance Technology task leading to the design of equipment for the detection of unexploded Ordnance found on military ranges.

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KEY WORDS

Magnetic Anomaly

Computer Simulation

Range Clearance

Induced Magnetization

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