LAMPIRAN - LAMPIRAN

LAMPIRAN A

Tabel suseptibilitas magnetik batuan
(Telford,1976)

No.	Tipe batuan	Suseptibilitas ($x10^6$ emu)	
		Interval	Rata-rata
1.	Batuan sedimen		
	Dolomit	0-75	10
	Batuan kapur	2-280	25
	Batuan pasir	0-1660	30
			50
2.	Batuan metamorf		
	Ampibolit	-	60
	Schist	25-240	120
	Philit	-	130
	Gneiss	10-2000	-
	Quarsit	-	350
	Serpentin	250-1400	-
	Slate	0-3000	500
3.	Batuan beku		
	Granit	0-4000	200
	Riolit	20-3000	-
	Dolorit	100-3000	1400
	Argit-Synit	2700-3600	-
	Olivin-Diabasin	-	2000
	Diabasin	80-13000	4500
	Porpirin	20-16700	5000
	Gabbro	80-7200	6000
	Basalt	20-14500	6000
	Diorit	50-10000	7000
	Pirosin	-	10500
	Piridotit	7600-15600	13000
	Andesit	-	13500

LAMPIRAN B

Tabel konversi satuan magnetik
(Blakely,1995)

No.	Kuantitas	ElektromagnetikUnits (emu)		Standard International (SI)		Konversi
		Satuan	Dimensi	Satuan	Dimensi	
1.	Gaya (F)	Dyne	$g.cm.s^{-2}$	Newton	$Kg.m\ s^{-2}$	1dyne=10^{-5}newton
2.	Kuat arus (I)	Abampere	$10\ c.s^{-1}$	Ampere	Cs^{-1}	1abampere=10A
3.	Induksi magnetik/ Rapat fluks magnetik (B)	Gauss (G)	$0,1\ gs^{-1}c^{-1}$	Tesla (T)	$Kgs^{-1}c^{-1}$	1Gauss=10^{-4}Tesla
		Gamma	10^{-5} Gauss	NanoTesla	10^{-9} T	1gamma=1nanoTesla
4.	Kuat medan magnetik (H)	Oersted (Oe)	$0,1\ gs^{-1}c^{-1}$	Am^{-1}	$cs^{-1}m^{-1}$	1 Oersted= $\frac{10^3}{4\pi}$ Am^{-1}
5.	Intensitas magnetisasi (I)	Gauss (G)	$0,1\ gs^{-1}c^{-1}$	Am^{-1}	$cs^{-1}m^{-1}$	1gauss=10^3 Am^{-1}
6.	Momen (m)	Gauss.cm^3	$0,1\ gs^{-1}c^{-1}cm^3$	Am^2	$cs^{-1}m^2$	1gauss.cm^3=10^{3} Am^2
7.	Suseptibilitas (k)	-	-	-		1 (emu)=4π (SI)
8.	Ratio koenigberger(Q)	-	-	-		1 (emu)=1 (SI)

Keterangan:

1. Perbedaan numerik maupun dimensi pada satuan kuat medan (H) untuk sistem satuan elektromagnetik dan standatd international (SI) disebabkan:
$B=H + 4\pi M$ (emu)
$B=\mu_0 + (H+M)$ (SI)
Dimana $\mu_0=4\pi \times 10^{-7}\ NA^{-2}$, begitu juga dengan magnetisasi (M)

2. Harga B dan H bernilai sama dengan harga medan magnetik material luar, didalam satuan SI dipengaruhi oleh faktor μ_0, sehingga berbeda numerik maupun dimensinya pada kedua sistem satuan.

3. Untuk suseptibilitas, terkecuali dimensi dipengaruhi oleh faktor 4π pada kedua sistem satuan.

LAMPIRAN C

Persamaan-persamaan vektor
(Blakely,1995)

Jika u dan v merupakan nilai skalar serta A dan B adalah vektor, hubungan keduanya pada suatu titik memenuhi persamaan-persamaan sebagai berikut:

1. $\nabla(uv) = u\nabla v + v\nabla u$
2. $\nabla(A.B) = (A.\nabla)B + (B.\nabla)A + Ax(\nabla xB) + Bx(\nabla xA)$
3. $\nabla x(\nabla u) = 0$
4. $\nabla.(\nabla xA) = 0$
5. $\nabla x\nabla xA = \nabla(\nabla.A) - \nabla^2 A$
6. $\nabla.(uA) = u\nabla.A + (A.\nabla)u$
7. $\nabla.(AxB) = B.(\nabla xA) - A.(\nabla xB)$
8. $\nabla x(uA) = u(\nabla xA) + (\nabla u)xA$
9. $\nabla x(AxB) = A(\nabla.B) - B(\nabla.A) + (B.\nabla)A - (A.\nabla)B$
10. $\int A.dl = \int_s (\nabla xA).\hat{n}ds$ (Teorema Stokes)
11. $\int_s A.\hat{n}ds = \int_v \nabla.Adv$ (Teorema divergensi)
12. $\int_s u\hat{n}ds = \int_v \nabla udv$
13. $\int_s (\hat{n}xA)ds = \int_v (\nabla xA)dv$
14. $\oint (A.B)dl = \int_s (\nabla(A.B))x\hat{n}ds$

LAMPIRAN D

LISTING PROGRAM PEMODELAN ANOMALI MAGNETIK TOTAL

```
**********************************************************
*    Program: Menghitung Anomali Magnetik 3 Dimensi       *
*             Untuk Benda Berbentuk Prisma                *
*    NAMA  : FERY ARIYANTO                                *
*    NIM   : J2D096167                                    *
*             JURUSAN FISIKA FAK. MIPA UNDIP              *
**********************************************************


      PROGRAM Anomali
      Real z0(99),z1(99),x1(99),y1(99),x2(99),y2(99)
      real mi(99),md(99),fi(99),fd(99),theta(99),k(99),H(99),m(99)
      real t(99), ttot(99,99),xxtot(99),yy0tot(99)
      real  yy0 (99)
      real  xx (99)
      integer i,j,bendake,jumsta
      character*1 YT
      CHARACTER*20 IIFILE
      CHARACTER*20 KOMFILE
      bendake=0
      ttot=0.0
      write (*,'(24(/))')
      write (*,'(1x,A)')'Program  Menghitung Nilai Anomali Magnetik '
      write (*,'(1x,A)')'     Akibat Benda Berbentuk Prisma '
      write (*,'(1x,A,\)') ' Masukkan jumlah Titik Stasiun = '
      read (*,'(i3)') jumsta
      write (*,*)
  111 bendake=bendake + 1
      write (*,'(24(/))')
      write (*,'(A)')' Input Data HARUS dengan Bilangan RIIL '
      write (*,'(A)')'       Masukan posisi stasiun :'
c Posisi acuan
      do i=0, jumsta
         write (*,'(a,i3,a,\)')' Posisi line  tambahan y0(',i,') = '
         read  (*,'(F10.2)')  yy0(i+1)
         xx(i+1) = i
      end do
      pause 'Tekan enter, untuk melanjutkan '

c Posisi benda anomali
      write (*,*)
      write (*,'(24(/))')
```

```
write (*,'(A)')' Masukan Posisi Benda Anomali '
write (*,'(A)')' ---------------------------- '
write (*,'(a,i3)') ' Posisi benda ke-',bendake
write (*,*)
write (*,'(A,\)')' Posisi x1 : '
   read  (*,'(F10.2)') x1(bendake)
write (*,'(A,\)')' Posisi y1 : '
   read  (*,'(F10.2)') y1(bendake)
write (*,'(A,\)')' Posisi z0(kedalaman): '
   read  (*,'(F10.2)') z0(bendake)
write (*,'(A,\)')' Posisi z1(kedalaman): '
   read  (*,'(F10.2)') z1(bendake)
write (*,*)
write (*,'(A,\)')' Posisi x2 : '
   read  (*,'(F10.2)') x2(bendake)
write (*,'(A,\)')' Posisi y2 : '
   read  (*,'(F10.2)') y2(bendake)
write (*,*)

c     Masukan Parameter
write (*,'(A)')' Masukan Input Parameter '
write (*,'(A)')' ------------------------ '
write (*,'(A,i3)') ' Benda ke-',bendake
write (*,'(A,\)')' inklinasi mi: '
   read  (*,'(F10.2)') mi(bendake)
write (*,'(A,\)')' Deklinasi md : '
   read  (*,'(F10.2)') md(bendake)
write (*,'(A,\)')' Field Inklinasi : '
   read  (*,'(F10.2)') fi(bendake)
write (*,'(A,\)')' Field Deklinasi: '
   read  (*,'(F10.2)') fd(bendake)
write (*,'(A,\)')' Azimuth : '
   read  (*,'(F10.2)') theta(bendake)
write (*,'(A,\)')' Suseptibilitas magnetik(k-SI): '
   read  (*,'(E10.2)') k(bendake)
write (*,'(A,\)')' Kuat medan magnetik (H-SI): '
   read  (*,'(E10.2)') H(bendake)
m(bendake)=k(bendake)*H(bendake)
write (*,*)
pause 'Tekan enter, untuk melanjutkan '
write (*,*)

c Tampilan data input ( Posisi dan Parameter )
write(*,*)
write(*,'(24(/))')
write(*,*)
```

```
      write(*,'(A,i3)')' Posisi Benda Anomali      Benda ke-',bendake
      write(*,'(A)')' ============================================='
      write(*,'(A,F8.3,A,F8.3)')'  x1: ',x1(bendake) , '       x2 :',
     -x2(bendake)
      write(*,'(A,F8.3,A,F8.3)')'  y1: ',y1(bendake) , '       y2 :',
     -y2(bendake)
      write(*,'(A,F8.3)')'  z0: ',z0(bendake)
      write(*,'(A,F8.3)')'  z1: ',z1(bendake)
      write(*,'(A)')' ============================================='
      write(*,*)
      write(*,'(A,i3)')' Input Parameter          Benda ke-',bendake
      write(*,'(A)')' ============================================='
      write(*,'(A,F10.2)')' Inklinasi mi              : ',mi(bendake)
      write(*,'(A,F10.2)')' Deklinasi md              : ',md(bendake)
      write(*,'(A,F10.2)')' Field Inklinasi           : ',fi(bendake)
      write(*,'(A,F10.2)')' Field Deklinasi           : ',fd(bendake)
      write(*,'(A,F10.2)')' Azimuth                   : ',theta(benda
     -ke)
      write(*,'(A,E10.2)')' Suseptibilitas magnetik(k-SI): ',k(bendake)
      write(*,'(A,E10.2)')' Kuat medan magnetik (H-SI)   : ',H(bendake)
      write(*,'(A,E10.2)')' Magnetisasi(SI)           : ',m(bendake)
      write(*,'(A)')' ============================================='
      write(*,*)
      pause'Tekan enter, untuk melanjutkan '
      write(*,*)

C MENYIMPAN DATA KE FILE

      WRITE(*,'(A,\)')'Ketikkan Nama File Output (max 8 character) : '
      READ(*,'(A20)')IIFILE
      OPEN(5,FILE=IIFILE,STATUS='New')

c     write
(5,'(A)')'================================================='
      write (5,'(A)')'    x      y          anomali t   '
c     write
(5,'(A)')'================================================='
c      do bendake=1,jumbenda
       do i=0,jumsta
         do j=0,jumsta
          call Mbox(xx(i+1),yy0(j+1),z0,x1(bendake),y1(bendake),
     *     z1(bendake),x2(bendake),y2(bendake),mi(bendake),md(bendake),
     +     fi(bendake),fd(bendake),m(bendake),theta(bendake),t(bendake))
          ttot(i+1,j+1)=ttot(i+1,j+1) + t(bendake)
          xxtot(i+1)=xx(i+1)
          yy0tot(j+1)=yy0(j+1)
```

```
        write (5,'(2x,F8.2,8x,F8.2,10x,E12.6)')xx(i+1),
     -  yy0(j+1),t(bendake)
       end do
      end do
c     end do
c    write
(5,'(A)')'========================================================'

      ENDFILE 5
      CLOSE(5)

      write(*,*)
      write(*,*)

      write(*,'(a,\)')'Ingin menginput data lagi (Y/T) ? '
      read(*,'(a)')YT
      if (YT.eq.'Y'.or.YT.eq.'y') then
      goto 111
      endif
      WRITE(*,*)
      WRITE(*,*)
      WRITE(*,'(A,\)')'Ketikkan Nama File KOMULATIF (max 8 character):'
      READ(*,'(A20)')KOMFILE
      OPEN(6,FILE=KOMFILE,STATUS='New')
c    write
(6,'(A)')'========================================================'
      write (6,'(A)')'    x       y            anomali t   '
c    write
(6,'(A)')'========================================================'

       do i=0,jumsta
         do j=0,jumsta
          write (6,'(2x,F8.2,8x,F8.2,10x,E12.6)')xxtot(i+1),
     -    yy0tot(j+1),ttot(i+1,j+1)
         end do
       end do

c    write
(6,'(A)')'========================================================'

      ENDFILE 6
      CLOSE(6)

      stop
      end
```

```
c Program Sub-Rutin Dircos
      Subroutine Dircos (incl,decl,azim,a,b,c)
      real incl
      PI=4*ATAN(1.0)
      xincl= incl*PI/180.0
      xdecl= decl*PI/180.0
      xazim= azim*PI/180.0
      a = cos(xincl)* cos(xdecl-xazim)
      b = cos(xincl)* sin(xdecl-xazim)
      c = sin(xincl)
      return
      end

c Progran Sub-Rutin Mbox
      Subroutine Mbox(x0,y0,z0,x1,y1,z1,x2,y2,mi,md,fi,fd,m,
     -theta,t)
      real alpha(2),beta(2),mi,md,m,ma,mb,mc,fa,fb,fc
      data cm/1.e-7/,t2nt/1.e9/
      call dircos(mi,md,theta,ma,mb,mc)
      call dircos(fi,fd,theta,fa,fb,fc)
      fm1=ma*fb+mb*fa
      fm2=ma*fc+mc*fa
      fm3=mb*fc+mc*fb
      fm4=ma*fa
      fm5=mb*fb
      fm6=mc*fc
      alpha(1)=x1-x0
      alpha(2)=x2-x0
      beta(1)=y1-y0
      beta(2)=y2-y0
      h=z1-z0
      t=0.
      hsq=h**2
      do 1 i=1,2
         alphasq=alpha(i)**2
         do 1 j=1,2
            sign=1.
            if(i.ne.j)sign=-1.
            r0sq=alphasq+beta(j)**2+hsq
            r0 =sqrt(r0sq)
            r0h=r0*h
            alphabeta=alpha(i)*beta(j)
            arg1=(r0-alpha(i))/(r0+alpha(i))
            arg2=(r0-beta(j))/(r0+beta(j))
            arg3=alphasq+r0h+hsq
            arg4=r0sq+r0h-alphasq
```

```
          tlog=fm3*alog(arg1)/2.+fm2*alog(arg2)/2.-fm1*alog(r0+h)
          tatan=-fm4*atan2(alphabeta,arg3)-fm5*atan2(alphabeta,arg4)
     &      +fm6*atan2(alphabeta,r0h)
    1      t=t+sign*(tlog+tatan)
          t=t*m*cm*t2nt
      return
      end
```

LAMPIRAN E

CONTOH MASUKAN DAN KELUARAN PROGRAM PEMODELAN ANOMALI MAGNETIK TOTAL

E-1. Contoh Masukan Pada Program Pemodelan

```
Program  Menghitung Nilai Anomali Magnetik
     Akibat Benda Berbentuk Prisma
 Masukkan jumlah Titik Stasiun = 20

Input Data HARUS dengan Bilangan RIIL
      Masukan posisi stasiun :
Posisi line  tambahan y0(  0) = 0.
Posisi line  tambahan y0(  1) = 1.
Posisi line  tambahan y0(  2) = 2.
Posisi line  tambahan y0(  3) = 3.
Posisi line  tambahan y0(  4) = 4.
Posisi line  tambahan y0(  5) = 5.
Posisi line  tambahan y0(  6) = 6.
Posisi line  tambahan y0(  7) = 7.
Posisi line  tambahan y0(  8) = 8.
Posisi line  tambahan y0(  9) = 9.
Posisi line  tambahan y0( 10) = 10.
Posisi line  tambahan y0( 11) = 11.
Posisi line  tambahan y0( 12) = 12.
Posisi line  tambahan y0( 13) = 13.
Posisi line  tambahan y0( 14) = 14.
Posisi line  tambahan y0( 15) = 15.
Posisi line  tambahan y0( 16) = 16.
Posisi line  tambahan y0( 17) = 17.
Posisi line  tambahan y0( 18) = 18.
Posisi line  tambahan y0( 19) = 19.
Posisi line  tambahan y0( 20) = 20.
Tekan enter, untuk melanjutkan

Masukan Posisi Benda Anomali
----------------------------
Posisi benda ke-  1

Posisi x1 : 10.
Posisi y1 : 10.
Posisi z0(kedalaman): 2.
Posisi z1(kedalaman): 4.
```

Posisi x2 : 12.
Posisi y2 : 12.

Masukan Input Parameter

Benda ke- 1
inklinasi mi: 0.
Deklinasi md : 0.
Field Inklinasi : 0.
Field Deklinasi: 0.
Azimuth : 0.
Suseptibilitas magnetik(k-SI): 1.26 E-04
Kuat medan magnetik (H-SI): 3.98E+01

Tekan enter, untuk melanjutkan

Posisi Benda Anomali   Benda ke- 1

=====================================

x1: 10.000   x2 : 12.000
y1: 10.000   y2 : 12.000
z0: 2.000
z1: 4.000

=====================================

Inklinasi mi : 0.00
Deklinasi md : 0.00
Field Inklinasi : 0.00
Field Deklinasi : 0.00
Azimuth : .0.00
Suseptibilitas magnetik(k-SI): 0.13E-05
Kuat medan magnetik (H-SI) : 0.39E+02
Magnetisasi(SI) : .50E-02

=====================================

Tekan enter, untuk melanjutkan

ketikkan Nama File Output (max 8 character) : I0.dat

ingin menginput data lagi (Y/T) ? T

ketikkan Nama File KOMULATIF (max 8 character): HI0.dat

E-1. Contoh Keluaran Pada Program Pemodelan

x	y	anomali	t
0	0	-5.21481E-4	
0	1	9.19401E-5	
0	2	8.70674E-4	
0	3	1.83061E-3	
0	4	0.0029746	
0	5	4.28417E-3	
0	6	5.71015E-3	
0	7	7.16626E-3	
0	8	8.53017E-3	
0	9	9.65649E-3	
0	10	0.0104031	
0	11	0.0106649	
0	12	0.0104031	
0	13	9.65649E-3	
0	14	8.53017E-3	
0	15	7.16626E-3	
0	16	5.71015E-3	
0	17	4.28417E-3	
0	18	0.0029746	
0	19	1.83059E-3	
0	20	8.70674E-4	
1	0	-1.28484E-3	
1	1	-6.91354E-4	
1	2	1.03772E-4	
1	3	1.13314E-3	
1	4	2.41759E-3	
1	5	3.95328E-3	
1	6	5.69541E-3	
1	7	7.54255E-3	
1	8	9.33072E-3	
1	9	0.0108475	
1	10	0.0118723	
1	11	0.0122353	
1	12	0.0118723	
1	13	0.0108475	
1	14	9.33072E-3	
1	15	7.54255E-3	
1	16	5.69541E-3	
1	17	3.95328E-3	
1	18	2.41758E-3	
1	19	1.13314E-3	
1	20	1.03772E-4	
2	0	-2.23321E-3	

2	1	-1.70603E-3
2	2	-9.43332E-4
2	3	1.10954E-4
2	4	1.50669E-3
2	5	3.26994E-3
2	6	5.37607E-3
2	7	7.71798E-3
2	8	0.0100829
2	9	0.0121598
2	10	0.0135983
2	11	0.0141145
2	12	0.0135983
2	13	0.0121598
2	14	0.0100829
2	15	7.71799E-3
2	16	5.37607E-3
2	17	3.26994E-3
2	18	1.50669E-3
2	19	1.10954E-4
2	20	-9.43332E-4
3	0	-3.38197E-3
3	1	-2.98601E-3
3	2	-2.33164E-3
3	3	-1.33327E-3
3	4	1.01477E-4
3	5	2.05073E-3
3	6	4.54011E-3
3	7	7.48421E-3
3	8	0.0106256
3	9	0.0135137
3	10	0.0155817
3	11	0.0163369
3	12	0.0155817
3	13	0.0135137
3	14	0.0106256
3	15	7.48421E-3
3	16	4.54011E-3
3	17	2.05074E-3
3	18	1.01462E-4
3	19	-1.33327E-3
3	20	-2.33164E-3
4	0	-4.73192E-3
4	1	-4.55123E-3
4	2	-4.11326E-3
4	3	-3.30108E-3
4	4	-1.96874E-3

4	5	4.23789E-5
4	6	2.85669E-3
4	7	6.47156E-3
4	8	0.0106241
4	9	0.0146865
4	10	0.017731
4	11	0.0188701
4	12	0.017731
4	13	0.0146865
4	14	0.0106241
4	15	6.47156E-3
4	16	2.85667E-3
4	17	4.23789E-5
4	18	-1.96873E-3
4	19	-3.30108E-3
4	20	-4.11326E-3
5	0	-6.25989E-3
5	1	-6.39298E-3
5	2	-0.006311
5	3	-5.87409E-3
5	4	-4.88245E-3
5	5	-0.0030745
5	6	-1.63317E-4
5	7	4.04382E-3
5	8	9.40142E-3
5	9	0.0151187
5	10	0.019689
5	11	0.0214595
5	12	0.019689
5	13	0.0151187
5	14	9.40142E-3
5	15	4.04382E-3
5	16	-1.63317E-4
5	17	-3.07451E-3
5	18	-4.88245E-3
5	19	-5.87409E-3
5	20	-0.006311
6	0	-7.90849E-3
6	1	-8.45599E-3
6	2	-0.0088883
6	3	-9.06822E-3
6	4	-8.76793E-3
6	5	-7.63258E-3
6	6	-5.16739E-3
6	7	-8.28355E-4
6	8	5.63113E-3

6	9	0.0134658
6	10	0.0203533
6	11	0.0231619
6	12	0.0203533
6	13	0.0134658
6	14	5.63114E-3
6	15	-8.28355E-4
6	16	-5.16741E-3
6	17	-7.63256E-3
6	18	-8.76793E-3
6	19	-9.06822E-3
6	20	-0.0088883
7	0	-9.57977E-3
7	1	-0.0106218
7	2	-0.0117141
7	3	-0.0127668
7	4	-0.0135908
7	5	-0.0138213
7	6	-0.0128144
7	7	-9.58973E-3
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8	20	-0.0145377
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17	13	0.0151187
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20	11	0.0141145
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20	17	3.26994E-3
20	18	0.0015067
20	19	1.10954E-4
20	20	-9.43332E-4

LAMPIRAN F

HASIL UJI PROGRAM DENGAN PROGRAM INVERSI MAGNETIK 3D

(Yulianto,2000)

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*****DATA MODEL AWAL********

JUMLAH PARAMETER YANG TIDAK DIKETAHUI (NP) =   10
JUMLAH PRISMA (NB)                          =    1
TOTAL ITERASI   (ITERI)                     =   30
JUMLAH OBSERVASI ARAH-X (NX)                =   16
JUMLAH OBSERVASI ARAH-Y (NY)                =   16
INTERVAL STASIUN ARAH-X   (DX)              =1.000
INTERVAL STASIUN ARAH-Y   (DY)              =1.000
INKLINASI MEDAN GEOMAGNET   (AI)            =      .00
DEKLINASI MEDAN GEOMAGNET   (DI)            =      .00
KONSTANTA MEDAN REGIONAL                    =        .00
-----------------------------------------------------------------------------
NO    a1     a2     b1     b2     h1     h2    AI0   AD0    THI      EI
-----------------------------------------------------------------------------
1.   8.00  10.00   8.00  10.00   1.00   1.50   .00   .00    .00    .0200

ITERASI KE      =   6
LAMDA           =   .1563E-01
FUNGSI OBYEKTIF=          103.7567

KONSTANTA REGIONAL =       -.00127
HASIL INTERPTRETASI MODEL PRISMA
-----------------------------------------------------------------------------
NO.   a1     a2     b1     b2     h1     h2    AI0    AD0    THI      EI
-----------------------------------------------------------------------------
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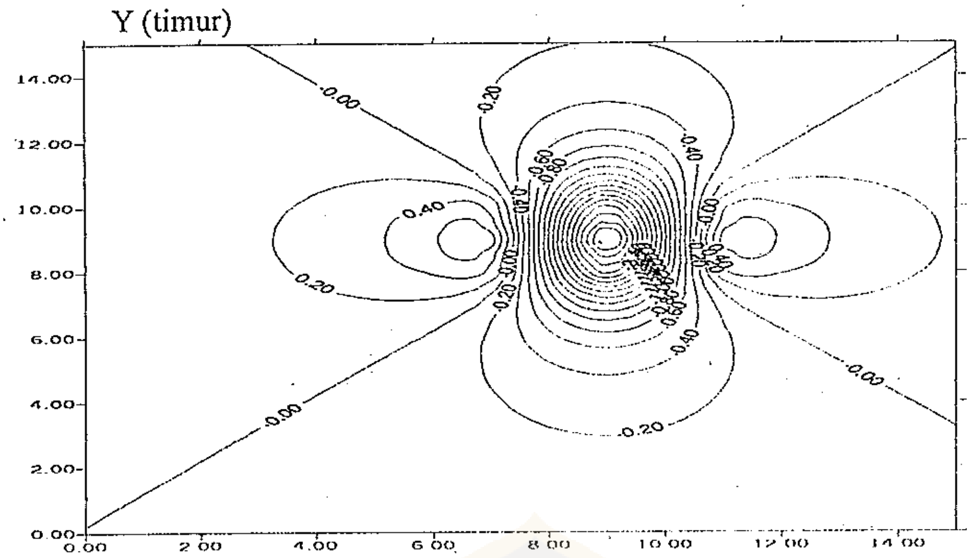
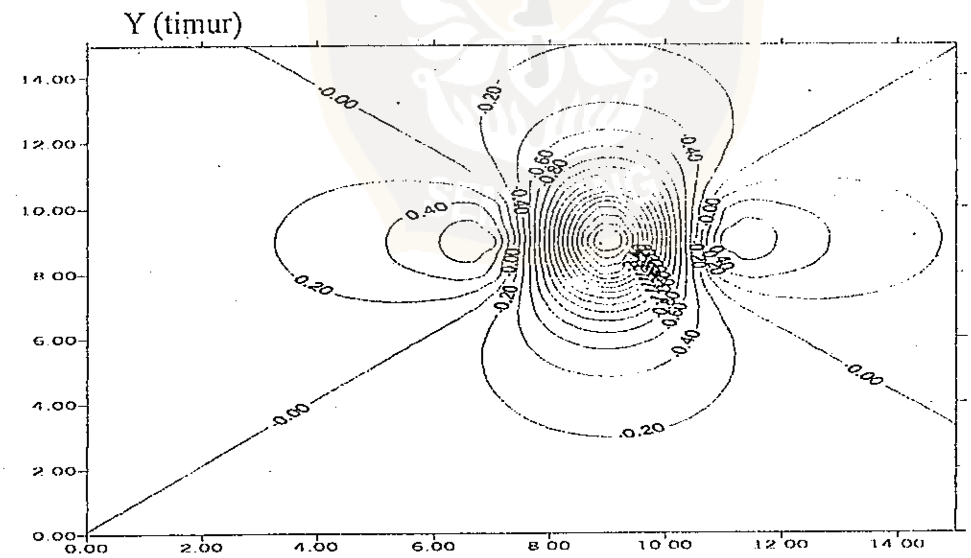
KONTUR HASIL PROGRAM PEMODELAN



Interval 0.2 nT X (Utara)

KONTUR HASIL PROGRAM INVERSI MAGNETIK 3D



Interval 0.2 nT X (Utara)