GL01243

END CORRECTIONS IN MAGNETIC INTERPRETATION

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ABSTRACT

The Talwani-Heirtzler algorithm for rapid digital computation of the magnetic effect of bodies with arbitrary polygonal cross section is modified to allow for finite strike extent of the body. The new algorithm requires only one transcendental function for each polygon side at each profile point, whereas the original algorithm requires two transcendental functions. Use of finite strike length in modeling magnetic profiles gives an inferred body with greater susceptibility, greater depth, and different shape. This is illustrated with theoretical and field examples.

INTRODUCTION

Quantitative interpretation of magnetic surveys currently relies heavily on the technique of matching an observed profile with a theoretical profile computed with formulas due to Talwani and Heirtzler (1964). These allow a source body of arbitrary cross section but assume infinite strike extent. In collaboration with A. S. Pasquale I have generalized the Talwani-Heirtzler formulas to allow for finite strike length. The derivation is scheduled for publication in the June, 1973 issue of Geophysics. In this paper I will discuss the application.

EQUATIONS

Figure 1 defines the coordinate system. The body strikes parallel to the y axis and is terminated by planes $y = \pm Y$. The magnetic profile is along the x axis. For arbitrary magnetization $\underset{\sim}{M}$ the components of magnetic field due to the body are

$$H_x = 2M_x P_x + 2M_z Q$$

$$H_y = 2M_y \, (P_z - P_x)$$

$$H_z = 2M_x Q - 2M_z P_z$$

The theoretical profile is a linear combination of the three profiles P_x, P_z, and Q. For example, if the body is supposed to have susceptibility k and no remanent magnetism, the total field anomaly T is given by

$$\frac{T}{2kF} = P_x \cos^2 I \cos 2A \qquad = (1 - \cos^2 I)$$

$$+ P_z \, (\cos^2 I \sin^2 A - \sin^2 I)$$

$$+ Q \cos A \sin 2I$$

where F is the main field strength and A is the angle between x axis and magnetic north.

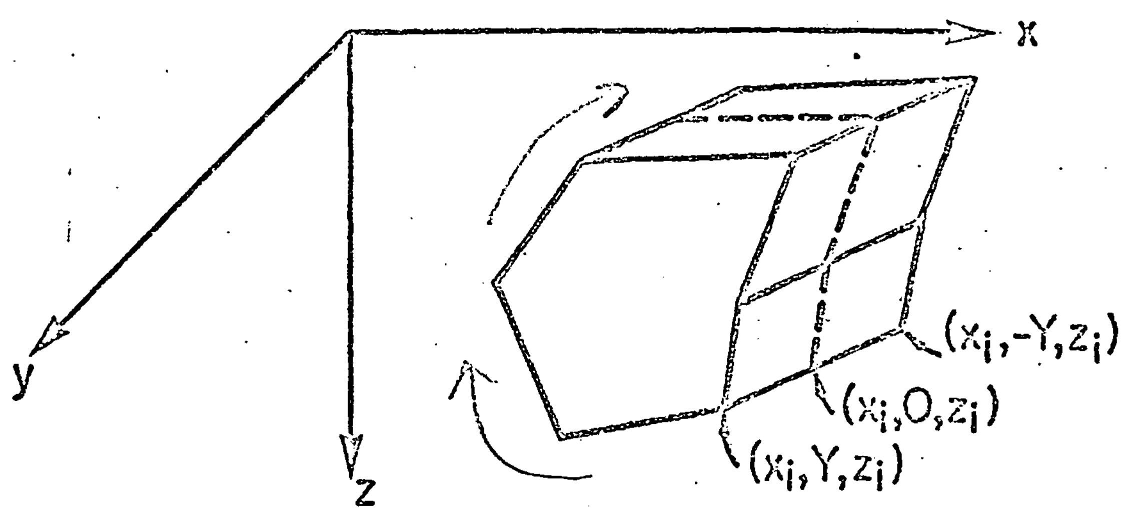

Figure 1. Geometry of " 2½-D dimensional" body. z axis is down, y axis is along strike, and traverse is along x axis.

COMPUTATION

The first step is to place the origin at the point where P_x, P_z and Q are to be evaluated. The basic relations are

$$Q + iP_z = \oint \frac{Y}{r} \frac{dx}{x+iz}$$

$$Q + iP_x = -\oint \frac{Y}{r} \frac{dz}{x+iz}$$

in which the line integral goes clockwise around the cross-sectional figure and

$$r^2 = x^2 + Y^2 + z^2$$

If the body cross-section is a polyon of N sides, the integration is a sum of N term, each term being the integral along the edge from (x_1,z_1) to (x_2,z_2). The final formulas are

$$Q + iP_z = \Sigma \frac{-\Delta x}{\Delta x+i\Delta z} \ln (F_2/F_1)$$

$$Q + iP_x = \Sigma \frac{i\Delta z}{\Delta x+i\Delta z} \ln (F_2/F_1)$$

where the sum is over N sides and

$$\Delta z = z_2 - z_1$$

$$\Delta x = x_2 - x_1$$

$$F_n = \frac{\Delta x+i\Delta z}{x_n+iz_n} (1 + \frac{r_n}{Y}) + \frac{i}{Y^2} (x_n\Delta z - z_n\Delta x)$$

with n taking the values 1, 2.

Below is a FORTRAN V listing of subroutine MAG2H, which finds PX, Q, and PZ according to the above equations. NV is the number of vertices of the polygonal cross section. The X, Z coordinates of these vertices are given in the arrays VX, VZ. These arrays must contain an $(NV+1)^{th}$ value which repeats the first. Complex variables are used within this subroutine but not the main program. Of the two expressions shown for Q, statements 21 and 22, only one is needed and either one may be used. For each point of the profile the main program must place the coordinate origin at this point and call again the subroutine. In our experience computation of theoretical profiles for finite strike length Y is faster and cheaper than computation for infinite strike length using the Talwani-Heirtzler algorithm.

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 1*            SUBROUTINE MAG2H(PX,Q,PZ,VX,VZ,Y,NV)
 2*            COMPLEX I,F(2),FLN,DXIZ
 3*            DIMENSION VX(10),VZ(10),VR(10)
 4*            PX=0.0
 5*            Q=0.0
 6*            PZ=0.0
 7*            YSQ=Y*Y
 8*            NVP=NV +1
 9*            DO 1 I1=1,NVP
10*         1  VR(I1)=SQRT(VX(I1)*VX(I1) +YSQ +VZ(I1)*VZ(I1))
11*            I=CMPLX(0.0,1.0)
12*            DO 5 I5=1,NV
13*            DX=VX(I5+1)-VX(I5)
14*            DZ=VZ(I5+1)-VZ(I5)
15*            DXIZ=DX +I*DZ
16*            DO 3 I3=1,2
17*            IV=I5 +I3 -1
18*         3  F(I3)=(DXIZ*(1. +VR(IV)/Y))/(VX(IV) +I*VZ(IV))
19*           * +(I/YSQ)*(VX(IV)*DZ-VZ(IV)*DX)
20*            FLN=(CLOG(F(2)/F(1)))/DXIZ
21*            Q1=-DX*REAL(FLN)
22*            Q1=-DZ*AIMAG(FLN)
23*            PZ1=-DX*AIMAG(FLN)
24*            PX1=DZ*REAL(FLN)
25*            PX=PX +PX1
26*            PZ=PZ +PZ1
27*            Q=Q +Q1
28*         5  CONTINUE
29*            RETURN
```