Magnetized Sphere

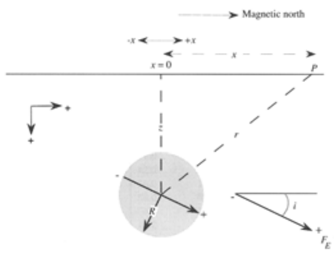


Figure 7-23 Notation used for the derivation of magnetic-field anomalies over a uniformly magnetized sphere.

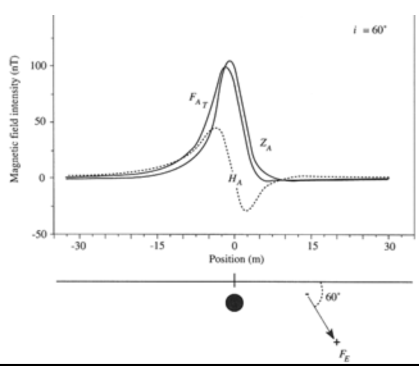
Magnetized Sphere

$$Z_A = \frac{\left(\frac{4}{3}\pi R^3 k F_E\right)\sin i}{\left(x^2+z^2\right)^{3/2}}\left[\frac{3z^2}{\left(x^2+z^2\right)} - \left(\frac{3xz}{\left(x^2+z^2\right)}\cot i\right) - 1\right] \quad (7\text{-}36)$$

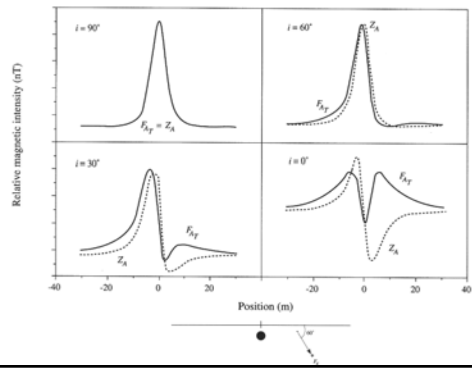
and

$$H_A = \frac{\left(\frac{4}{3}\pi R^3 k F_E\right)\cos i}{\left(x^2+z^2\right)^{3/2}}\left[\left(\frac{3x^2}{\left(x^2+z^2\right)} - 1\right) - \left(\frac{3xz}{\left(x^2+z^2\right)}\tan i\right)\right] \quad (7\text{-}37)$$

Magnetized Sphere



Magnetized Sphere



Horizontal Sheet: Vertical H_E

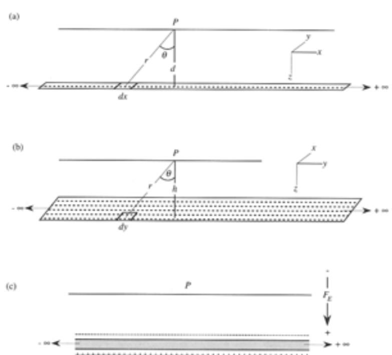
In all considerations of horizontal sheets presented here, we assume the inducing field is vertical. If we consider a uniform strip of negative poles (Fig. 7-26(a)), then, from Eq. 7-2, the magnetic field intensity at point *P* due to a small area of the strip is

$$R_A = \frac{(m/_{area})\,dx\,dy}{r^2} \qquad (7\text{-}38)$$

Following the Bouguer effect derivation, we can say that the vertical field at *P* due to the strip of poles is

$$Z_A = \int_{x=-\infty}^{x=+\infty} \frac{(m/_{area})\,dx\,dy}{r^2} \cos\theta \qquad (7\text{-}39)$$

Horizontal Sheet: Vertical H_e



Thin Plate: Infinite Extent

$$Z_A = \int_{-\pi/2}^{\pi/2} \frac{(m/_{area})dy}{d} \cos\theta d\theta \qquad (7\text{-}40)$$

and

$$Z_A = \frac{2(m/_{area})\, dy}{d} \qquad (7\text{-}41)$$

$$R_{A_{sheet}} = \frac{2(m/_{area})\, dy}{r} \qquad (7\text{-}42)$$

$$Z_{A_{sheet}} = \int_{y=-\infty}^{y=+\infty} \frac{2(m/_{area})dy}{r} \cos\theta \qquad (7\text{-}43)$$

$$Z_{A_{sheet}} = \int_{-\pi/2}^{\pi/2} 2(m/_{area})d\theta \qquad (7\text{-}44)$$

and

$$Z_{A_{sheet}} = 2(m/_{area})\pi = 2\pi I \qquad (7\text{-}45)$$

Thin Plate: Finite Extent

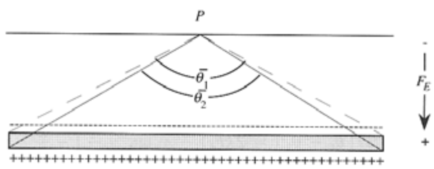


Figure 7-27 Notation used to derive the expression for a thin plate of limited extent.

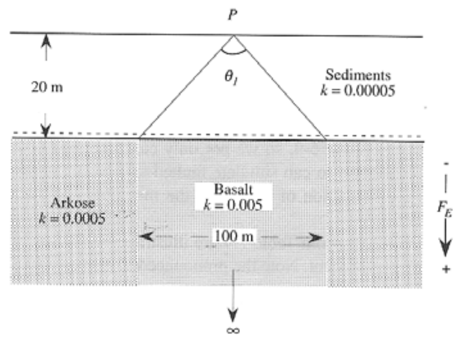
Thin Plate: Finite Extent

$$\overline{\theta}_1 = \frac{\pi}{2} + \tan^{-1}\left(\frac{x}{z}\right), \quad \overline{\theta}_2 = \frac{\pi}{2} + \tan^{-1}\left(\frac{x}{(z+t)}\right)$$

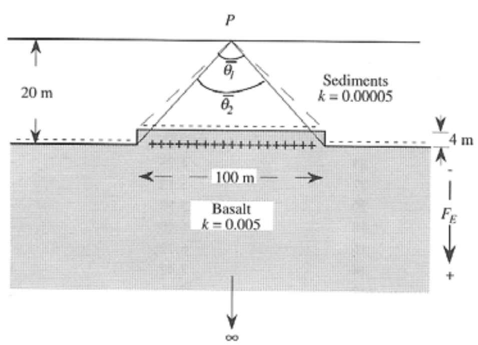
and so

$$Z_A = 2I(\overline{\theta}_1 - \overline{\theta}_2) = 2kF_E\left[\frac{\pi}{2} + \tan^{-1}\left(\frac{x}{z}\right) - \frac{\pi}{2} - \tan^{-1}\left(\frac{x}{z+t}\right)\right]$$

Basalt Dike



Lithology Change



Semi-Infinite Sheet

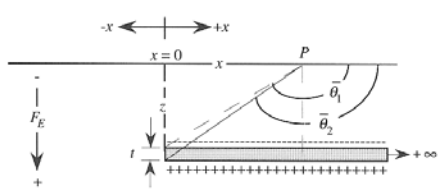
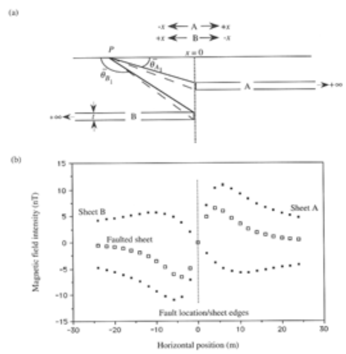


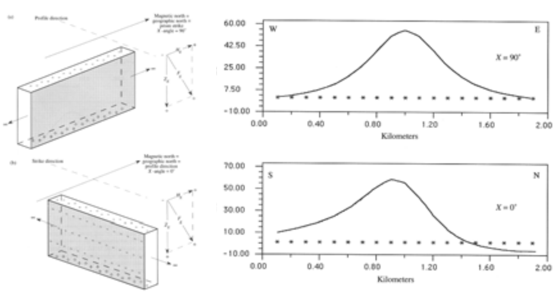
Figure 7-29 Relationships and notation for derivation of semi-infinite sheet equation.

$$Z_A = 2kF_E\left[\tan^{-1}\left(\frac{x}{z}\right) - \tan^{-1}\left(\frac{x}{z+t}\right)\right] \qquad (7\text{-}47)$$

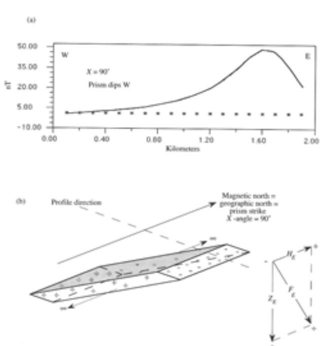
Faulted Horizontal Bed



Orientation Relative to Earth's Field: GRAVMAG



Inclined Prism: GRAVMAG



Depth of Anomaly

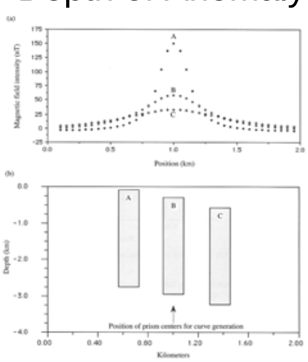
As a straightforward example consider the case of the slender vertical rod with bottom far removed from the observer. Recall that this shape can be represented by a monopole. If we assume our traverse is directly over the rod, Eq. 7-22 simplifies to

$$Z_A = \frac{z\left(kF_E A\right)}{\left(x^2 + z^2\right)^{3/2}} \qquad (7\text{-}48)$$

Because the maximum is directly over the center of the rod, one-half this maximum value is

$$Z_{A_{(1/2)\max}} = \frac{\left(kF_E A\right)}{2z^2} \qquad (7\text{-}49)$$

Depth of Anomaly



Slope Method

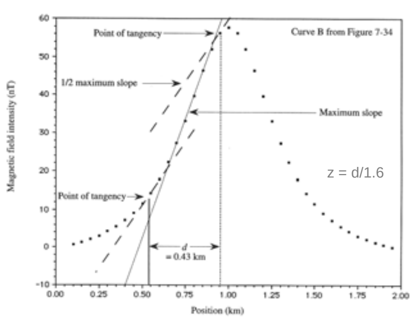


Figure 7-35 Illustration of the Peters slope method as used to analyze curve B in Figure 7-34.

Depth of Anomaly (Half-Max)

At a position where the maximum is one-half its value, we have

$$Z_{A_{(1/2)\max}} = \frac{(kF_E A)\left(z^2 + x^2_{(1/2)\max}\right)^{1/2} \cos\theta}{\left(z^2 + x^2_{(1/2)\max}\right)^{3/2}} \qquad (7\text{-}50)$$

since $\cos\theta = \frac{z}{r}$ and $r = \left(z^2 + x^2_{(1/2)\max}\right)^{1/2}$ (see Fig. 7–16).

As before, we equate Eqs. 7-49 and 7-50 such that

$$\frac{\left(z^2 + x^2_{(1/2)\max}\right)^{1/2} \cos\theta}{\left(z^2 + x^2_{(1/2)\max}\right)^{3/2}} = \frac{1}{2z^2} \qquad (7\text{-}51)$$

This reduces to

$$2z^3 = \left(z^2 + x^2_{(1/2)\max}\right)^{3/2} \qquad (7\text{-}52)$$

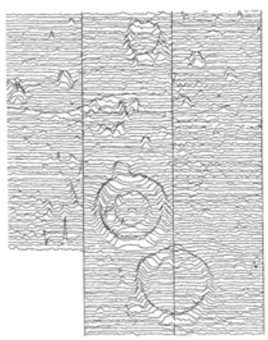
and, finally,

$$0.766z = x_{(1/2)\max} \quad \text{or} \quad z = \frac{x_{(1/2)\max}}{0.766} \qquad (7\text{-}53)$$

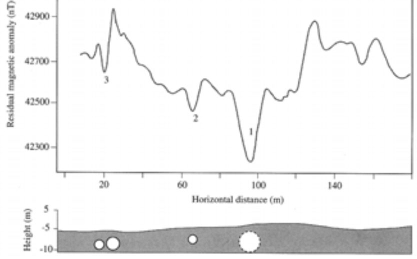
Relationships for several other shapes include (Telford et al., 1990, p. 85–102):

Sphere—total width of anomaly curve at $Z_{A_{max}}/2$ roughly equals depth to sphere center.
Cylinder—total width of anomaly curve at $Z_{A_{max}}/2$ roughly equals depth to cylinder center.
Semi-infinite sheet—depth roughly equals one-half the distance from $Z_{A_{max}}$ to $Z_{A_{min}}$.

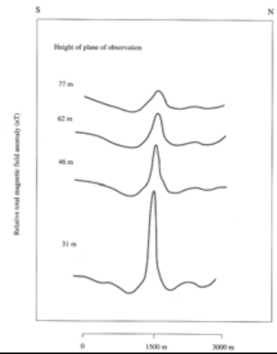
Bronze Age Burial Mounds, UK



Magnetic Lows Associated with Tunnels



Upward Continuation



Landfill: Upward Continuation