<u>Potential Applications of Gravity and Magnetic Methods</u>
<u>in Engineering and Environmental Studies</u>
(from Hinze, 1990, Geotechnical and Environmental Geophysics, v.1, p.73-126)

Target	Gravity*	Magnetics*
Mapping subsurface voids	X	x
Mapping bedrock topography	X	x
Mapping steeply dipping geologic contacts	x	X
Mapping regions of potential stress amplification (e.g. plutons and fault zone irregularities)	X	X
Mapping potential zones of weakness (e.g. paleorifts, sutures, and faults)	X	X
Mapping landfills	X	X
Mapping archeological sites	---	X
Locating buried well casings	---	X
Locating buried drums, pipelines, and other ferromagnetic objects	---	X
Locating coal burns	---	X
Determining density	X	---
Mapping groundwater cones of depression	x	---
Determining volume of organic fill in lakes	x	---
Determining groundwater volume in basins	x	---
Locating underwater ferromagnetic objects	---	X
Locating sand and gravel deposits that contain heavy minerals (including magnetite)	---	X

*X = major method; x = minor method.

<u>Gravity: Wavelengths and Amplitude Resolution for Typical Geologic Targets</u>
(from Yale et al., 1998, *The Leading Edge*, v.17, p.73-76)

Target	Wavelength	Amplitude
Buried cavities, tunnels, tanks	1-10 m	5-100 μGal
Pediment and seismic weathering layer thickness, shallow gas pockets, karst	10-200 m	0.05-0.2 mGal
Shallow salt domes and cap rock	200-1000 m	0.1-0.3 mGal
Anticlines, faults, deep salt dome flanks and overhangs	0.5-4 km	0.2-2.0 mGal
Deep sedimentary basin structure	2-20 km	5 mGal
Sedimentary basin outlines and boundaries, plate tectonic structures	10-100 km	10 mGal

Useful Equations for Gravity and Magnetic Fields
(from Hinze, 1990, Geotechnical and Environmental Geophysics, v.1, p.73-126)

Source	Gravity	Magnetics
Susceptibility	---	k (SI units) = 4πk (cgs units)
magnetic units	---	1 nanoTesla (nT) = 10^{-5} Oersted
Basic	$g = \frac{G\rho V d}{r^3}$	$T = \frac{kHV}{r^n}, k = k_m \text{ x } \%\text{magnetite}$
Sphere	$g = \frac{4\pi G\rho R^3}{3d^2} \frac{1}{\left[1+\left(x^2/d^2\right)\right]^{3/2}}$	$T = \frac{8\pi kHR^3}{3d^3} \frac{\left[1-\left(x^2/2d^2\right)\right]}{\left[1+\left(x^2/d^2\right)\right]^{5/2}}$
Vertical Cylinder (infinite)	$g = \frac{\pi G\rho R^2}{\left(x^2+d^2\right)^{1/2}}$	$T = \frac{\pi dkHR^2}{\left(x^2+d^2\right)^{3/2}}, E >> d$
Horizontal Cylinder (infinite)	$g = \frac{2\pi G\rho dR^2}{\left(x^2+d^2\right)}$	$T = \frac{2\pi kHR^2\left(d^2-x^2\right)}{\left(x^2+d^2\right)^2}$
Narrow Vertical Sheet	$g = \frac{2G\rho t \ln\left(x^2+d_2^2\right)^{1/2}}{\ln\left(x^2+d_1^2\right)^{1.2}}$	$T = 2kHt\left[\frac{d_1}{\left(x^2+d_1^2\right)} - \frac{d_2}{\left(x^2+d_2^2\right)}\right]$
Vertical Fault	$g = 2G\rho t\theta$	$T = \frac{2kht x}{\left(x^2+d^2\right)}$
Finite Slab	$g = 2G\rho t\left(\theta_1-\theta_2\right)$	$T = 2kH\left(\theta_1-\theta_2\right), E >> d$

Notes: g is the gravity anomaly in Gals due to a density contrast (ρ) in g/cm^3 (kg/m^3); T is the magnetic anomaly in Oersteds (Teslas) in a vertical polarizing magnetic field caused by a magnetic susceptibility contrast (k) in cgs units; k_m is the volume susceptibility of magnetite, 0.25 cgs units (3.14 SI); H is the vertical magnetic field in Oersteds (Teslas); G in the gravitational constant, 6.672 x 10^{-8} dyne-cm^2/g^2 (6.672 x 10^{-11} N-m^2/kg^2); V is volume; r is the distance between the observation point and the center (sphere) or axis (cylinder) or centerline; x is the horizontal distance from the observation point to the center (sphere) or axis (cylinder) or centerline (sheet) or edge (fault); d is the depth to the center (sphere) or axis (cylinder) or top (d_1) or bottom (d_2) of sheet or centerline (fault); R is radius; E is depth extent; θ is the angle from the horizontal (θ_1 to top; θ_2 to bottom). All distances in centimeters (meters). Units in parentheses are SI.