Exercise 3 – magnetometry

1) A steel drum is approximately located at 1 m depth (*d*), as depicted in Figure 2. Please, use matlab to plot the Vertical (Hx) and Horizontal (Hz) components of the magnetic field, if measurements are performed in Vienna. Please assume perfect magnetization. The shape of the drum, for simplicity can be approximated to the one of a sphere with a radius (*r*) of 0.2 m. Measurements were performed with a proton precession magnetometer at a height (*h*) of 2 m over the surface every 30 centimeter.

Hint: the Vertical and Horizontal components of the magnetic field measured at the surface along profile direction (x) can be computed, for a sphere, as:

$$H_x(x) = \frac{m}{4\pi}\frac{(2x^2 - z^2)(cosI) - 3xz\,(\sin I)}{(z^2 + x^2)^{\frac{5}{2}}}$$

$$H_z(x) = \frac{m}{4\pi}\frac{(2z^2 - x^2)(sinI) - 3xz\,(\cos I)}{(z^2 + x^2)^{\frac{5}{2}}}$$

Where *I* is the magnetic inclination, *m* is the dipole moment given by

$$m = k_{eff}|B_{ext}|\frac{V}{\mu_o}$$

Where B_{ext} is the magnitude of the external field (~ **48589.9 nT for Vienna**), k_{eff} is the effective permeability of an object with a demagnetization, which can be written in terms of the magnetic permeability (μ) and the demagnetization factor (N_{geom}) as:

$$k_{eff} = \frac{\mu}{1 + \mu N_{geom}}$$

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The magnetic permeability of iron (100% pure) is ~$5x10^3$ (Wb/A). The demagnetization factor may be consider with a value of 1 for perfect magnetization.

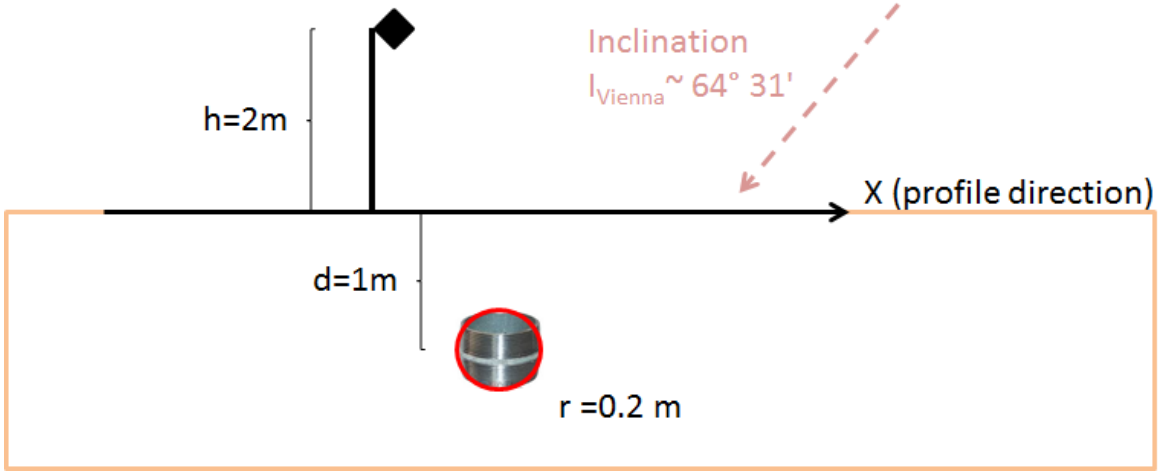

Figure 1

2) Please compute the curves for the Vertical, Horizontal and Total response from the same steel drum as question 1, but assuming a desmagnetization factor of 1/3 for a sphere.

3) Plot the Total field measured at the surface for the same steel drum, but buried at a depth of 3m

4) Compare the discrete measured response for the Horizontal component as obtained in Question 1 and for the response obtained for measurements every 2m

5) Plot the vertical, horizontal and total field for the same steel drum from Question 1, if the measurements were performed at the magnetic North pole. Compare the curves for measurements performed at the Equator.

Information about the geomagnetic field (Inclination, magnitude) can be obtained in:
http://magnetic-declination.com/