Exercise 2 – magnetometry

1) A steel drum is located at 1 m depth (*d*), as depicted in Figure 1. Please, use matlab to plot the Vertical (H_x) and Horizontal (H_z) components of the magnetic anomaly associated to such structure, considering that the anomaly is located at Vienna, at a region with only sand materials (negligible magnetic susceptibility, *k*=0) assuming a perfect magnetization. The shape of the drum, for simplicity, can be described to the one of a sphere with a radius (*r*) of 0.2 m. Measurements were performed along a 40 m profile with the center of the sphere located at the middle of the profile and using a proton precession magnetometer at a height (*h*) of 2 m over the surface, with readings collected every 30 centimeter.

Hint: following the analytical model described by Heiland (1951)[1], the Vertical (H_z) and Horizontal (H_x) components of the magnetic field due to a spherecan be computed following the equations:

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

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

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

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

Where B_{ext} is the magnitude of the external field (~ **48589.9 nT for Vienna**), *k* is the magnetic susceptibility of the anomalous object and μ_o the magnetic permeability of vacuum.

The magnetic permeability of iron (100% pure) is ~5x10^3 (H/m).

2) Please compute the curves for the Vertical, Horizontal and Total response from the same steel drum as question 1, but assuming a

[1] Heiland, C. A., 1951, Geophysical exploration. New York, Prentice-Hall, p 392

radius for 3, 10 and 50 m for the sphere and a depth of 100 m – if needed increase the profile length.

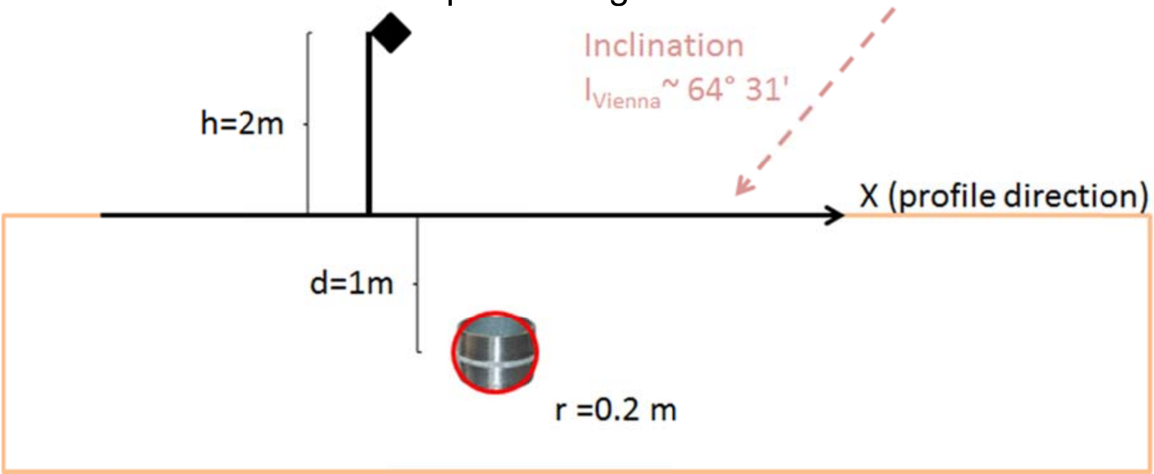

Figure 1

3) Plot the Total field measured at the surface for the same steel drum, but buried at a depth of 3m and with the magnetometer placed at a height of 5m and 1m

4) Compare the discrete measured response for the Horizontal and Vertical components for measurements performed with a separation of 2m. Is there any difference? Which? Why?

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.

6) The file "magnetic_measurements.txt" contains data collected on top of a metallic structure which can also be defined by an iron sphere. Please find a model (depth and radius of the sphere) which can describe the data. Measurements were collected at a location with an inclination of 45 degrees and a magnetic flux density of 30 microTesla [μT]. The height of the magnetometer is 2m. Please plot the curve from the measurements and the modeled curve for the sphere defined.

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

Delivery date: October 28, 2016 at latest 10:00 am (tugeophysics@outlook.com)