Lab 2: Magnetics Part I

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Overview

Magnetic surveys are useful when trying to identify a target which has a significant contrast in magnetic susceptibility with the background material. Some examples include unexploded ordinance (UXO) detection, locating steel infrastructure, and mineral exploration. In this lab you will have the chance to go down to the beach and collect magnetic data in order locate and characterize the anomalies due to a number of different steel objects. Fundamentals developed to understand these simple anomalies form a basis for interpreting magnetic data in more complex environments.

Instructions

- For this lab we will be walking down to Wreck Beach to collect magnetic data.
- Bring suitable shoes and be prepared for the weather (ie. water bottle, rain gear: umbrella, poncho)
- Bring a notebook or clipboard for writing
- Form teams of 3 to work with for this lab (Note: Labs are still turned in individually.)

Resources

- GPG: Magnetics

1 Collecting Data with the Magnetometer

In this section, you will be using the proton precession magnetometer to collect a profile of data along a line which passes over buried re-bar. It is your job to identify the horizontal

(along line) location of the re-bar, and later estimate its depth of burial.

There will be three jobs for every data point taken, 1 person will hold the magnetometer (the pole on which the sensor is mounted needs to be held steady and vertical, your data quality will be poor otherwise), 1 person will hold the computer, and 1 person will record your measurements. Be sure to remove all magnetic objects (belts, keys, cell phone and other electronics) from your person before data collection to minimize sources of noise.

To make data collection feasible within a short time span, and also to provide everyone with an opportunity to become familiar with the data acquisition process we will proceed as follows.

(a) Re-bar has been buried in the survey area and a measuring tape has been provided so that the locations at which data have been collected are known. The experiment has been designed so that the survey line is perpendicular to the orientation of the rebar.

(b) The class will be divided into groups of three. Each group can decide who will do which job. Each group has a number.

(c) Three groups will be present at the data collection station at any time: (a) at bat (actively collecting data) (b) on-deck (watching the data collectors) (c) in-the-hole (getting organized)

(d) Group (a) will collect 1 data point at the base station, 3 data points along the line, and then tie back in with the base station.

(e) Data at each location are recorded at least three times to ensure repeatability.

(f) The data location and data values are read out and written down in a log book (provided). These values will also be entered into a computer by the TA's so they can be plotted and viewed in real time.

(g) While group (a) is collecting data groups (b) and (c) are observing to learn proper survey procedures and analyzing the scatter plot of data acquired thus far to determine which 5 additional data points they will collect.

(h) Data collection stops once all groups have cycled through.

(i) Remark: The data collection book also serves a log book on which to write relevant notes.

Q1. Explain how you selected the positions of the 3 data points you collected.

Q2. Name 2 potential sources of noise.

2 Evaluating the potential for using magnetic surveys to find metallic objects

Q3. Now you are going to use a magnetometer app to characterize the magnetic response of different objects.

a. Before we can characterize the magnetic response of other objects we first need to measure the background field so that we have a baseline for comparison. Remove metallic objects and other electronics from your person, orient yourself so that you are facing north and record your measurement of the Earth's inducing field.

Total Field	
B_x	
B_y	
B_z	

Table 1: Background Field Measurements

b. Now characterize the magnetic field of the bar magnet. Provide a labeled sketch showing the orientation of the magnetic field lines. Be sure to keep the magnetometer oriented in the same manner as it was for your measurement of the Earth's inducing field so that all measurements can be compared.

Pole	Total Field	B_x	B_y	B_z

Table 2: Magnetic Field measurements from the bar magnet

c. Using the magnetic field measurements from the bar magnet determine whether the observed field is primary due to induced magnetization or remanent magnetization? Be sure to use the the recorded measurements as evidence to support your assertion.

d. Using Table 3, characterize each object in a given group. You only need to visit ONE of the groups.

- Is the material susceptible enough to produce a measurable anomalous field?
- Is the sample remanently magnetized?
- If the sample is remanently magnetized describe the general orientation of the remanent magnetization using the object labels (top, bottom, sides 1, 2, 3, 4).

Sample	Susceptible	Remanently Magnetized	Remanence Orientation
A (Steel Pipe) (Group 1)			
B (Steel Rod) (Group 1)			
C (Copper Pipe) (Group 1)			
D (4cm Steel Bar) (Group 2)			
E (Angle Iron) (Group 3)			
F (Steel Block) (Group 2)			
G (Steel Cylinder) (Group 3)			
H (Aluminium Block) (Group 3)			
J (Zinc Sheet) (Group 2)			

Table 3: Characterizing the anomalous magnetic field of metallic samples

3 Sketching the anomalous field

The following exercise will help you interpret and understand your recorded data. In your team, sketch out the secondary response and plot the total magnetic field in the sand for a variety of different inducing field orientations specified by the TA's. Be sure to talk through these examples. Everyone needs to understand these sketches and be comfortable making them since they can provide a great deal of incite into the magnetic response of more complex targets. Space is provided below if you would like to make any notes.

4 Shovel Searches

A section of the beach has been marked off containing a buried piece of re-bar which is within the top metre of sand. Each group will be given a shovel and 5 min. A prize will be given to the group which is able to recover the re-bar in the shortest amount of time without the use of any instrumentation. Good luck!