Questions: Magnetics

Quiz Questions

1. The "total field magnetic anomaly" can be best described as:
   a. The amplitude of Earth's magnetic field.
   b. The distribution of magnetic material.
   c. The amplitude of induced magnetic fields projected onto the direction of Earth's magnetic field.
   d. The vertical component of the measured magnetic field.

2. Part of the magnetic anomaly over a buried magnetic feature is negative. This is because
   a. Earth's vector field has a downward component.
   b. Some portions of the induced field are in the opposite direction to Earth's field.
   c. Some portions of the induced field point down.
   d. The regional field has not yet been removed.

3. Induced magnetization…
   a. Is the magnetic behaviour of a material caused by an external magnetic field.
   b. Is a magnetic property that is a permanent part of the material.
   c. Is the measurement a magnetometer records.
   d. Describes the interaction between two independently magnetized bodies.

4. Magnetic susceptibility (κ) of soils is complicated. Which is the following is NOT likely to affect a sample's value of κ?
   a. Source of particles deposited to make up the soil.
   b. Water saturation of the soil.
   c. Capacity to organically produce magnetite.
   d. Amount of magnetite present.

5. A 300 km x 300 km magnetic map is most cost-effectively interpreted for geologic trends and structures using
   a. A forward modelling approach.
   b. Direct interpretation of the map's patterns.
   c. 3D inversion of the data.
   d. Relating anomalies to buried dipoles.

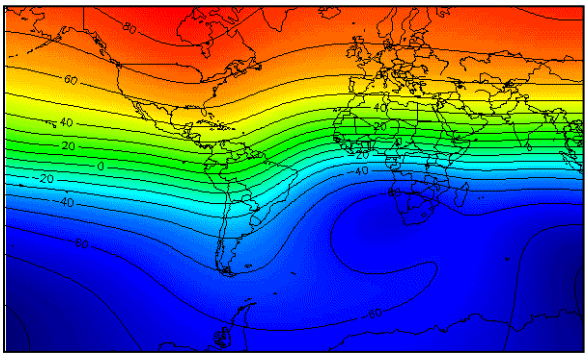
6. Which of the following CAN be corrected using data gathered at a base station?
   a. (i) magnetic storms and (ii) regional trends
   b. (i) diurnal variations and (ii) magnetic storms
   c. (i) regional trends and (ii) geologic features larger than the survey area.
   d. (i) small geologic features and (ii) diurnal variations

7. Remanent magnetization might be important in which of the following circumstances?
   a. Magnetic surveying in volcanic rocks.
   b. Magnetic surveying in archaeological digs.
   c. Magnetic surveying for UXO.
   d. All of the above.

8. Which of the following is LEAST likely to affect a decision about survey measurement spacing?
   a. Expected depth to the target.
   b. Cost per measurement.
   c. Presence of moving vehicles**.**
   d. Target type (object, 2D, or 3D).

9. Magnetic susceptibility describes how easily material can become magnetized. While "magnetization" is the …
   a. Magnetic dipole moment per unit volume.
   b. Magnetic dipole moment.
   c. Strength of oscillating charges within the material.
   d. Number of magnetic dipoles within the material.

10. The following map is a map of:



   a. Total Magnetic field.
   b. Magnetic field declination.
   c. Magnetic field inclination.
   d. None of the above.
   e.

1. Magnetic _____ is the ratio of the total field H and the magnetic flux density B. Magnetic _____ is unitless.
   a) Susceptibility – Permeability
   b) Permeability – Susceptibility
   c) Susceptibility – Susceptibility
   d) Permeability – Permeability

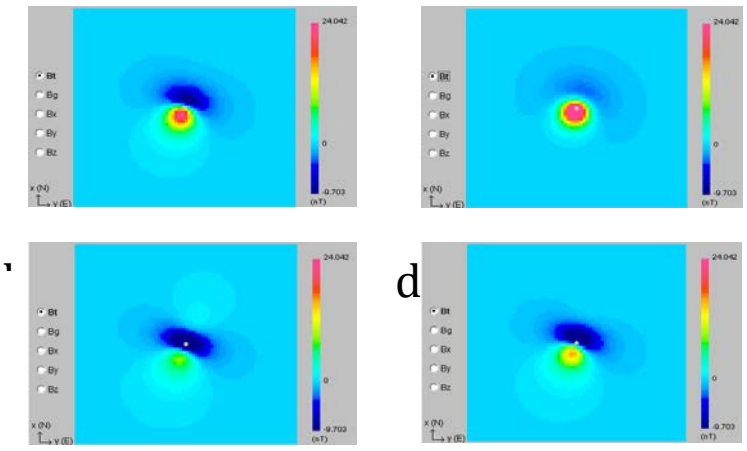
2. How is the magnetization of an object related to the applied magnetic field H_0?
   a) Always linear
   b) Never linear
   c) Quadratic for some minerals
   d) Approximately linear for weak applied fields

3. Which two of the following statements are incorrect regarding magnetics surveys?
   I. The source of this survey is Earth's magnetic fields
   II. As the depth of magnetic material increases (getting deeper), magnetic moment of this material decreases.
   III. Magnetometer measures combination of Earth's inducing fields and anomalous fields.
   IV. Anomalous magnetic field is usually bigger than the earth's magnetic field.

   a) I, II
   b) I, IV
   c) II, III
   d) II, IV

4. Which of the follow statements regarding remanant magnetization are false?
   a) Remanent magnetization is independent of inducing magnetic fields.
   b) Remanent magnetization can complicate interpretation by altering the orientation of total magnetization.
   c) The remanent magnetization is dependent on the susceptibility of the material.
   d) Remanent magnetization can complicate the interpretation by the altering the orientation of induced magnetization.

5. Assuming that you have a buried sphere in a half space in an inducing field with an inclination of 45 degrees and a declination of 20 degrees, which of the following plots show the total field response of the sphere?



6. What is not a reason for using a Base Station in a magnetic survey
   a) To remove effects from near surface rocks that have variable magnetic susceptibility
   b) To correct the data for diurnal variations
   c) To correct for disturbances caused by magnetic storms
   d) To remove the effects of the IGRF

7. Suppose you are trying to locate a buried steel pipe using a magnetic survey. What factor does not need be considered when designing the survey?
   a) Estimated size and depth of the buried pipe
   b) The orientation of the pipe
   c) The resistivity of the ground around the pipe
   d) The susceptibility of the ground around the pipe

8. The magnetic field of a dipole decays as:
   a) 1/r
   b) 1/r^2
   c) 1/r^3
   d) 1/r^4

Q Which choice is required to make the following statement correct?

The strength of the total magnetic field at the pole is _____ of the strength of the total magnetic field at the equator.
   a) Half
   b) Equal
   c) Twice
   d) Same magnitude but opposite in sign

9. Considering magnetic field data, what is the main reason for using a total horizontal derivative
   a) Delineate edges of anomalies
   b) Smooth data in horizontal directions
   c) To identify faults or offsets in a regional magnetic data set
   d) a) and c) are correct

10. Which application is most appropriate for using a magnetic gradient survey?
   a) Identifying regional magnetic features
   b) a UXO survey
   c) Looking for a massive sulphide deposit

d) Mapping ground water contaminants

11. Which region of the earth would have the smallest magnetic total field strength as a background?
    a. Canada
    b. Brazil
    c. Antarctica
    d. Norway

12. The "Total field magnetic anomaly" can be best described as:
    a. A map of the amplitude of Earth's magnetic field.
    b. A map of the distribution of magnetic material.
    c. A map of the vertical component of the measured magnetic field.
    d. A map of the horizontal component of the measured magnetic field.
    e. A map of the component of the measured magnetic field anomaly that is aligned along the direction of Earth's magnetic field.

13. When choosing the station spacing for a magnetic survey which of the following items is the most important
    a. The inclination and declination of the earth's magnetic field
    b. The expected size and depth of the target
    c. The type of magnetometer used (that is, a total field magnetometer or a magnetometer that measures the individual components)
    d. The distance between your survey area and the base station

14. A magnetic survey using a total field magnetometer is carried out over an object at the equator. The total field magnetic anomaly is compared to the anomaly obtained when using a magnetometer that measures all three components of the field. (Bx, By, Bz). (with x, y, z respectively denoting northing, easting and vertical). The total field anomaly is
    a. the same as the Bx component
    b. the same as the By component
    c. the same as the Bz component
    d. None of the above

15. In rocks, susceptibility depends mainly on

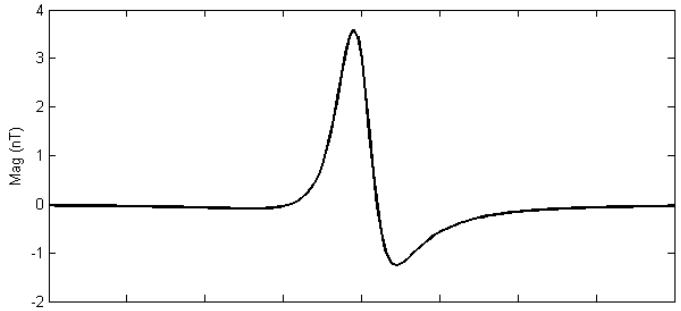
a. The volume percent of magnetite.
b. The clustering of magnetite.
c. The orientation of magnetite.
d. All of the above.

17. The benefit of carrying out a gradient magnetic survey is that it
    a. Provides high spatial resolution of near surface material.
    b. Eliminates temporal variations.
    c. Does not require the use of a base station.
    d. All of the above.

18. A magnetic survey is carried out at the equator to find a buried unexploded ordnance. A total field magnetometer has been used. The simplest way to obtain the total field anomaly is by
    a. Subtracting the total field of the earth at the equatorial location from the measured data
    b. Subtracting the magnetic field of a base station from the measured data
    c. (a) and (b)
    d. Using a magnetic gradiometer

19. The total field anomaly measured in the previous question would look like which component of the anomalous magnetic field
    a. x-component (northing direction)
    b. y-component (easting direction)
    c. z-component
    d. Vertical gradient

20. An elongated target is oriented in the east-west direction and you collected data along a north-south line. The anomaly looks as following. In which hemisphere did you conduct your survey?



North South

a. Northern hemisphere
b. Southern hemisphere
c. At the equator
d. Cannot be determined from the plot.

21. Suppose you are collecting magnetic data in Vancouver over a known target that is a long piece of rebar. Instead of a distinct anomaly however, your data is a flat line. What is a possible explanation?
    a. The regional field needs to be removed.
    b. The profile data are acquired parallel to the rebar
    c. The rebar has remanent magnetization perpendicular to the earth's field
    d. (a) and (b)
    e. (b) and (c)
    f. (a) and (c)

22. Which two of the following statements are INCORRECT when referring to magnetic surveys?
    I. The source for the magnetic survey is the Earth's magnetic field
    II. As the depth of the magnetic material gets deeper, the magnetic moment decreases.
    III. A magnetometer measures a combination of the Earth's inducing fields and anomalous fields.
    IV. The anomalous field is usually larger than the Earth's magnetic field

    a. I, II
    b. I, IV
    c. II, III
    d. II, IV

Short Answer Questions

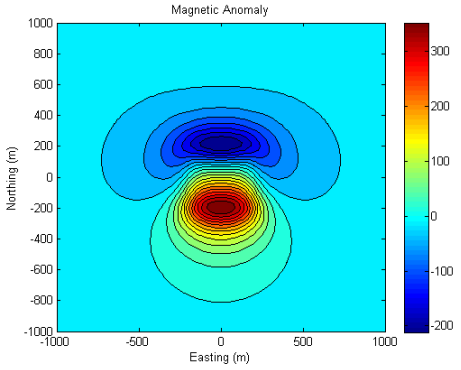
1.) 4 pts) A sphere has a radius of 10 meters and a magnetic susceptibility K=0.1. The center of the sphere is 20 meters beneath the earth's surface. If the strength of the earth's field is B=60,000 nT, what is:
    1. (2 pts) The magnetization of the sphere

    2. (1pt) The magnetic moment of the sphere

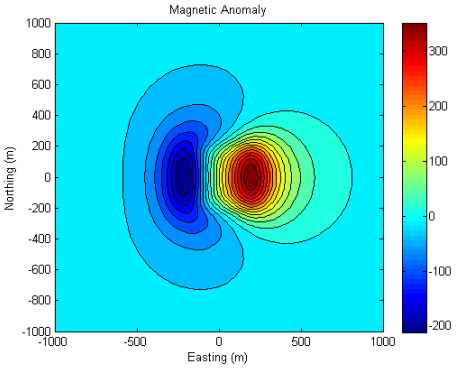
    3. (1 pt) How is the magnetic moment affected if the center of the sphere is moved to 40 meters below the surface?

2.) (10 pts) Suppose a sphere is buried below the surface of the Earth in a location where the inclination is -45 degrees and the declination is 0 degrees. The instrument used is a total field magnetometer.

a) (4 pts) Which of the following images shows the responses that would be measured? In arriving at your answer please provide a series of diagrams that demonstrate your thought process.



i.



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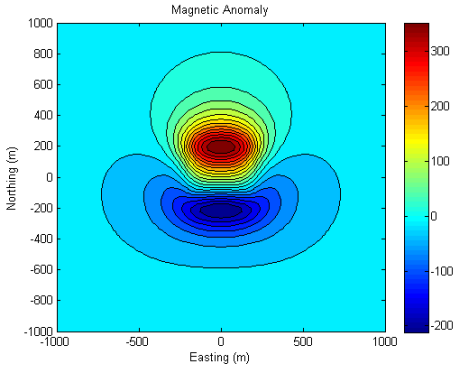

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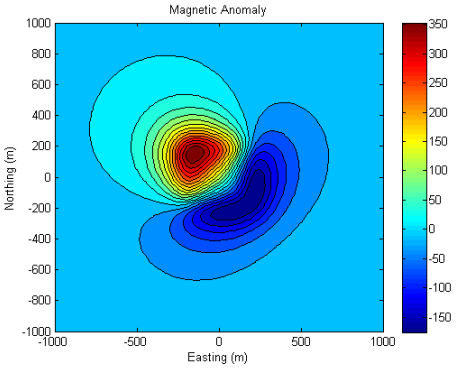


iv.

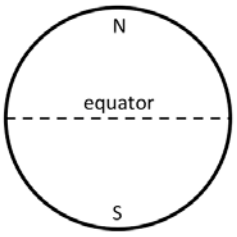
b) (3 pts) Use your chosen magnetic field data and consider the data that would be collected along a line that goes through the maximum and minimum of the anomaly. In the space below provide a rough sketch of the data. Use this information to estimate the depth of burial of the object and also estimate its location in (Easting, Northing) coordinates.

c) (3 pts) If you were designing a field survey to find this object what survey design would you choose? That is, station spacing, line spacing etc. Show how you arrived at your answer.

- M 1: (2 pts) Suppose you have a rock sample and its magnetization is in the direction of the earth's magnetic field. What can you conclude about the existence, or non-existence, of remnant magnetization in the sample?

- M 2: (4 pts) Suppose you are provided with a total field magnetometer and asked to carry out a magnetic survey at the equator to find a compact magnetic object buried at depth. Your survey line passes in a north-south direction directly over the item. On the first plot below, show the direction of the induced magnetization in the body and show the secondary fields. In the second plot, sketch the total field anomaly.

Plot 1:

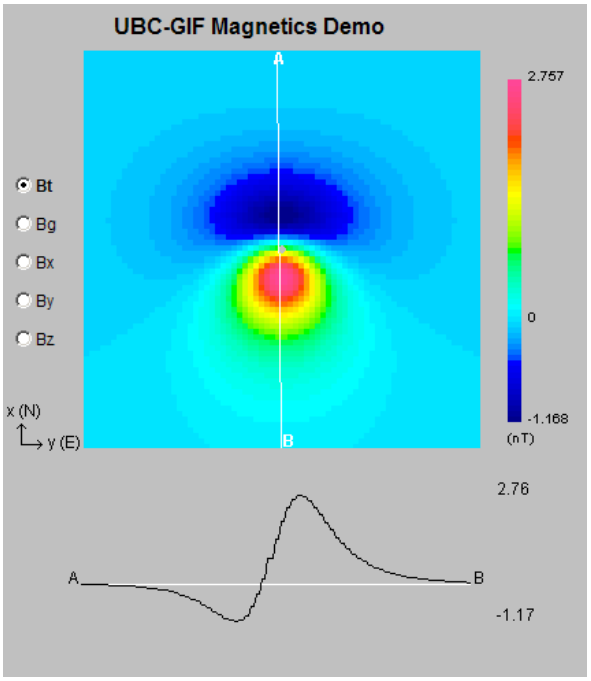


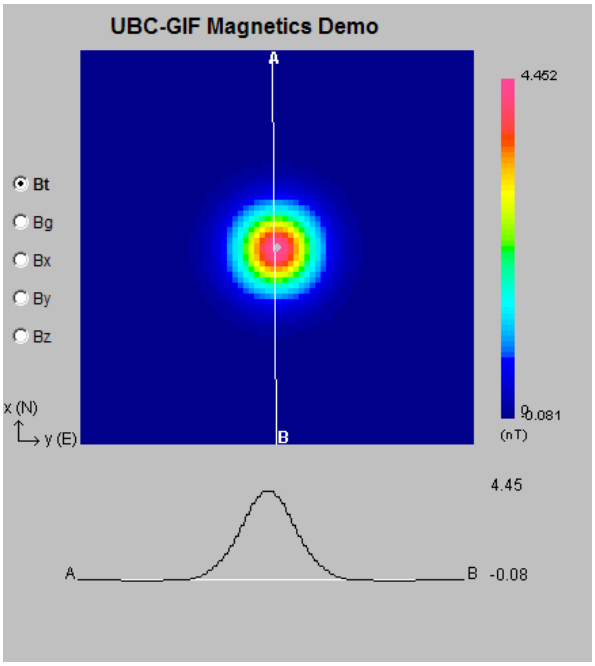
Plot 2:

1.) (3pts) Suppose you want find a ferrous object such as a buried drum or UXO. Which quantity is more important and why? Your explanation might be aided by using a formula or two.

- Magnetization
- Magnetic moment

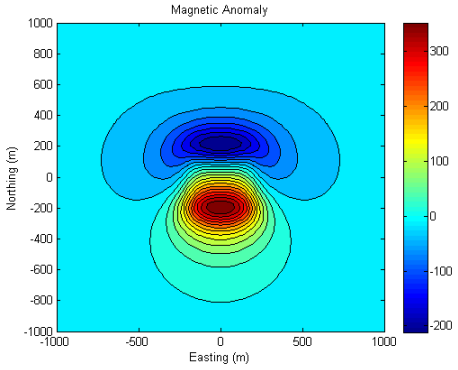
2.) (3 pts) The first picture below was processed to produce the second. What is the name of the processing step applied, what does it do, and why is it beneficial?

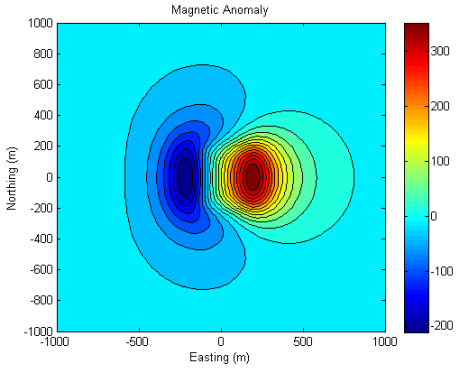


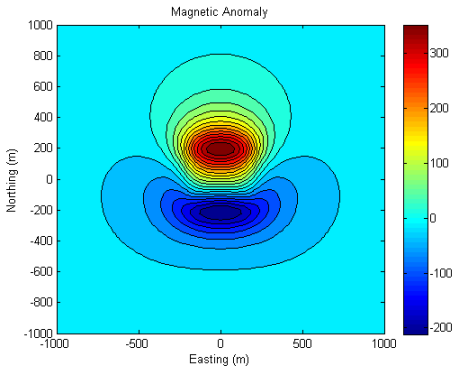


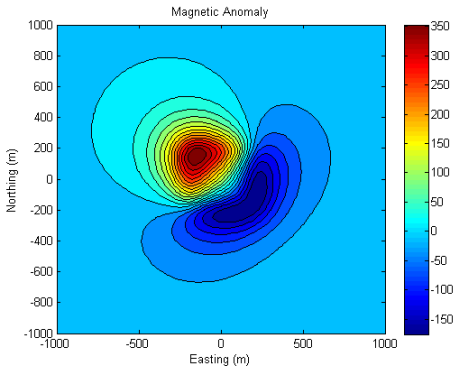
3.) (2pt.) Is magnetic surveying a good choice for finding buried voids within limestone? Why or why not?

4.) (5 pt) Suppose a sphere is buried below the surface of the Earth in a location where the inclination is -45 degrees and the declination is 0 degrees. The instrument used is a total field magnetometer. Which of the following images shows the responses that would be measured? In arriving at your answer please provide a series of diagrams that demonstrate your thought process.









(3pts) : Use your chosen magnetic field data consider the data that would be collected along a line that goes through the maximum and minimum of the anomaly. In the space below provide a rough sketch of the data. Use this information to estimate the depth of burial of the object and also estimate its location in (x,y) coordinates.

(3 pts) If you were designing a field survey to find this object what survey design would you choose? That is, station spacing, line spacing etc. Show how you arrived at your answer.

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Q: Which of the following objects could you potentially identify using a magnetic survey?

a. Steel rod
b. Copper wire
c. Pop can
d. All of the above

Q: What are the units of magnetic susceptibility?

a. Tesla (T) or nano-Tesla (nT)
b. Gauss (G)
c. Gammas (γ)
d. unitless

Q: A Canadian Geologist is interpreting two total field magnetic data sets both over identical magnetite deposits. Data set A is from the Canadian Arctic (latitude +59) and data set B is from Antarctica (latitude -59). Consider only the main feature on the anomaly. What should we expect?

a. Deposit A will show as a positive anomaly and deposit B will show as a negative anomaly
b. Deposit A will show as a negative anomaly and deposit B will show as a positive anomaly
c. Data sets A & B will be almost identical:
d. Data set A will have a larger anomaly because it is closer to the north pole

Q: When doing a total field magnetic survey in, you observe a monopole anomaly. What does that tell you about the geometry of the target?

a. you should win a nobel prize for finding magnetic monopoles
b. it is a confined body
c. it has a very long horizontal dimension
d. it has a very long vertical dimension
e. it doesn't say anything about the target. The inducing field must be vertical

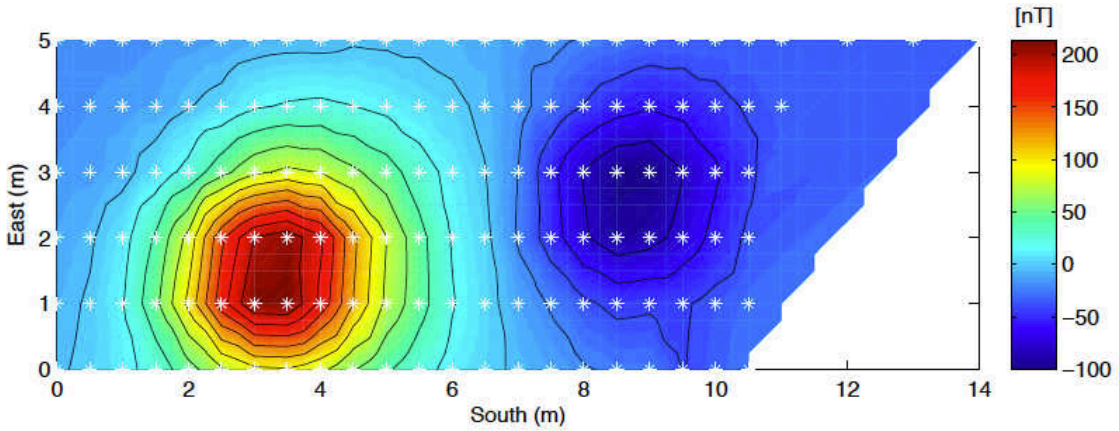
Q: Define the total magnetization vector.

a. vector sum of the induced and remanent components
b. projection of the remnant magnetization vector onto the inducing field
c. sum of the squares of the components
d. projection of the sum of the induced and remnant magnetization onto the inducing field

Q: In which of the following situations may diurnal corrections, using base station measurements, be required?

a. when the magnitude of the measured anomaly is small
b. when the standard deviation of the data is larger than the variation observed in the base station
c. if the measurements were acquired over a short period of time
d. during periods of intense solar activity
e. a & d are correct
f. b & c are correct

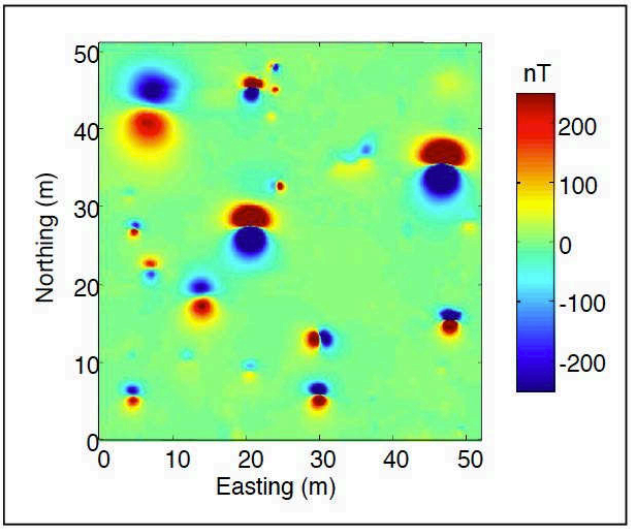
Q: The data shown in the figure below were collected over two vertical pieces of rebar (that no one found!). Both pieces of rebar are similar in length. Which of the following best explains the observed data?



a. Both pieces of rebar are buried near 7m south, 2m east, resulting in a single dipolar anomaly
b. The two pieces of rebar are buried at different depths, resulting in the opposite polarity of the anomalies
c. The two pieces of rebar have a strong remanent magnetization in opposite directions
d. Both pieces of rebar have remanent magnetization in the same direction, but one is stronger than the other

Q: The following data were collected over a UXO site. What accounts for the multiple orientations of the dipolar anomalies?

a. The shape of the UXO varies
b. The orientation of magnetometer varied as the data were collected
c. The background geology is interfering with the signal
d. The UXO are remanently magnetized in various directions



Short Answer Questions

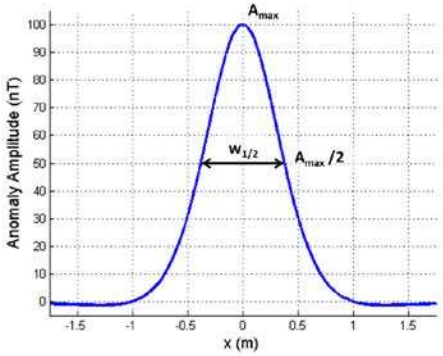
Q: Your task is to find buried magnetized objects buried in 10m X 10 m area. You assume the field from the object can be represented by a magnetic dipole. For the sake of this problem assume that your magnetometer is right on the surface of the earth.

a) The figure below shows the results of your modelling. What is the depth of the object associated with this figure?

b) If you are going to find the object, what line and station spacing would select? What is your thought process for choosing these numbers? How many observations would you make in total?

c) Suppose that the sought item is 25 cm beneath the surface. How does this change your strategy? How many observations are now required?

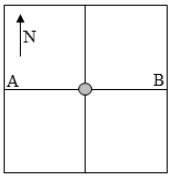
d) Now suppose you raise your magnetometer to a height of 1 meter. How would this affect the number of observations that you collect? What are potential negative consequences of proceeding with this?



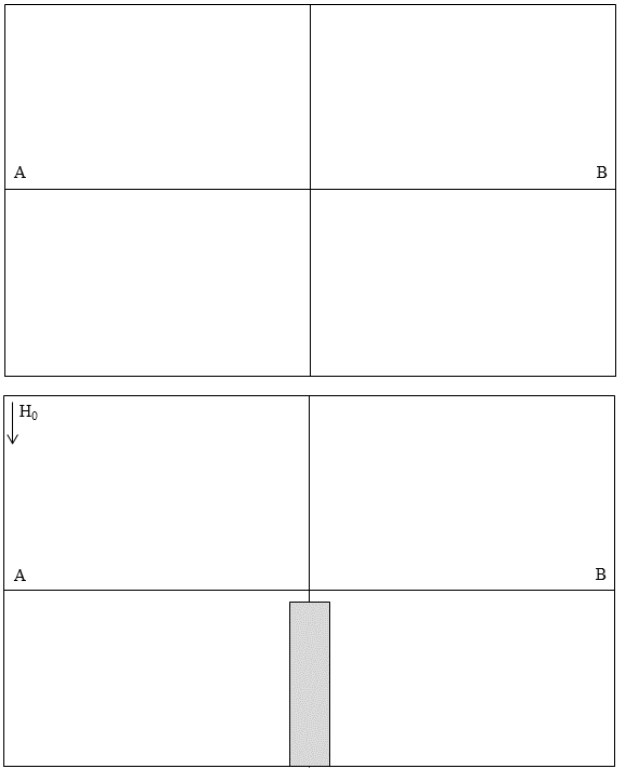
Q: Consider a location on the earth's field is pointing vertically down and B=60,000nT. An ore body in that field has a magnetic susceptibility of kappa=0.1. The body is also remanently magnetized in the easting direction with M_R=0.5 Amp/m. What is the total magnetization in the body?

Q: To locate an abandoned steel-cased well, a total magnetic field survey is conducted. Assume that the inclination of the inducing field is 90°.

a. In the below diagrams, sketch the anomalous magnetic field lines (bottom plot) and a profile of the total field anomaly (top plot) along a profile line over a susceptible well that extends to depth.

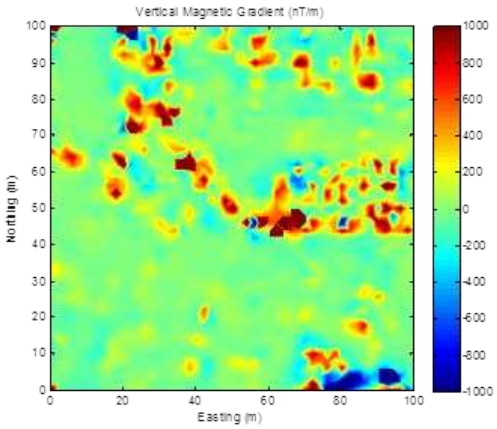


Map with profile line



b. Why might such an anomaly be referred to as a "monopole anomaly"?
c. How would the total field response change if the top of the well were buried deeper?

Q: The following plot show vertical magnetic gradient data collected over the old expo site in Vancouver.



a. How are vertical magnetic gradient data acquired?
b. What is it sensitive to?
c. Name one benefit it provides over a total field survey.
d. How might gradient magnetic data be used in conjunction with EM-31 data to distinguish between iron debris and copper debris?