Simulating the field due to prisms

Define a 3D prism

Our model is a rectangular prism. Parameters to define this prism are given below:

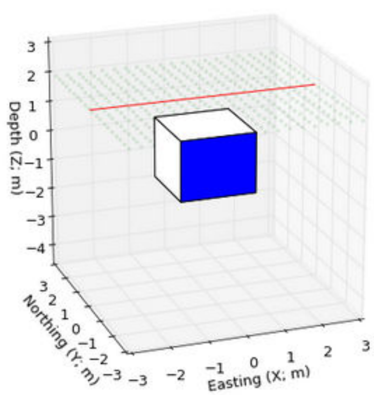
- dx: length in Easting (x) direction (meter)
- dy: length in Northing (y) direction (meter)
- dz: length in Depth (z) direction (meter) below the receiver
- depth: top boundary of the prism (meter)
- pinc: inclination of the prism (reference is a unit northing vector; degree)
- pdec: declination of the prism (reference is a unit northing vector; degree)

You can also change the height of the survey grid above the ground

- rx_h: height of the grid (meter)

Green dots show a plane where we measure data.

dx 2
dy 2
dz 2
depth 0
pinc 0
pdec 0
npts2D 20
xylim 3
rx_h 1.9
View_elev 20
View_azim 250



Magnetic applet

Based on the prism that you made above, below Magnetic applet computes magnetic field at receiver locations, and provide both 2D map (left) and profile line (right).

For the prism, you can alter:

- sus: susceptibility of the prism

Parameters for the earth field are:

- Einc: inclination of the earth field (degree)
- Edec: declination of the earth field (degree)
- Bigrf: intensity of the earth field (nT)

For data, you can view:

susc 0.1
Einc 90
Edec 0
Bigrf 54500
comp tf bx by bz
irt induced remanent total
Q 0
rinc 0
rdec 0

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Computing G
Computing G
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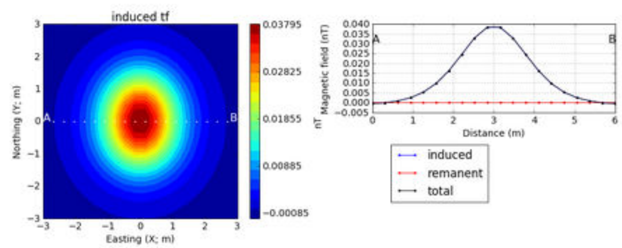


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True
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- [Interactive and live … click here]

Learning from the applet

- Locating the prism at the pole and equator
  - Plotting Bx,By,Bz fields (sign convention)
  - Map data
  - Profile
  - Profile over a magnetic dipole.

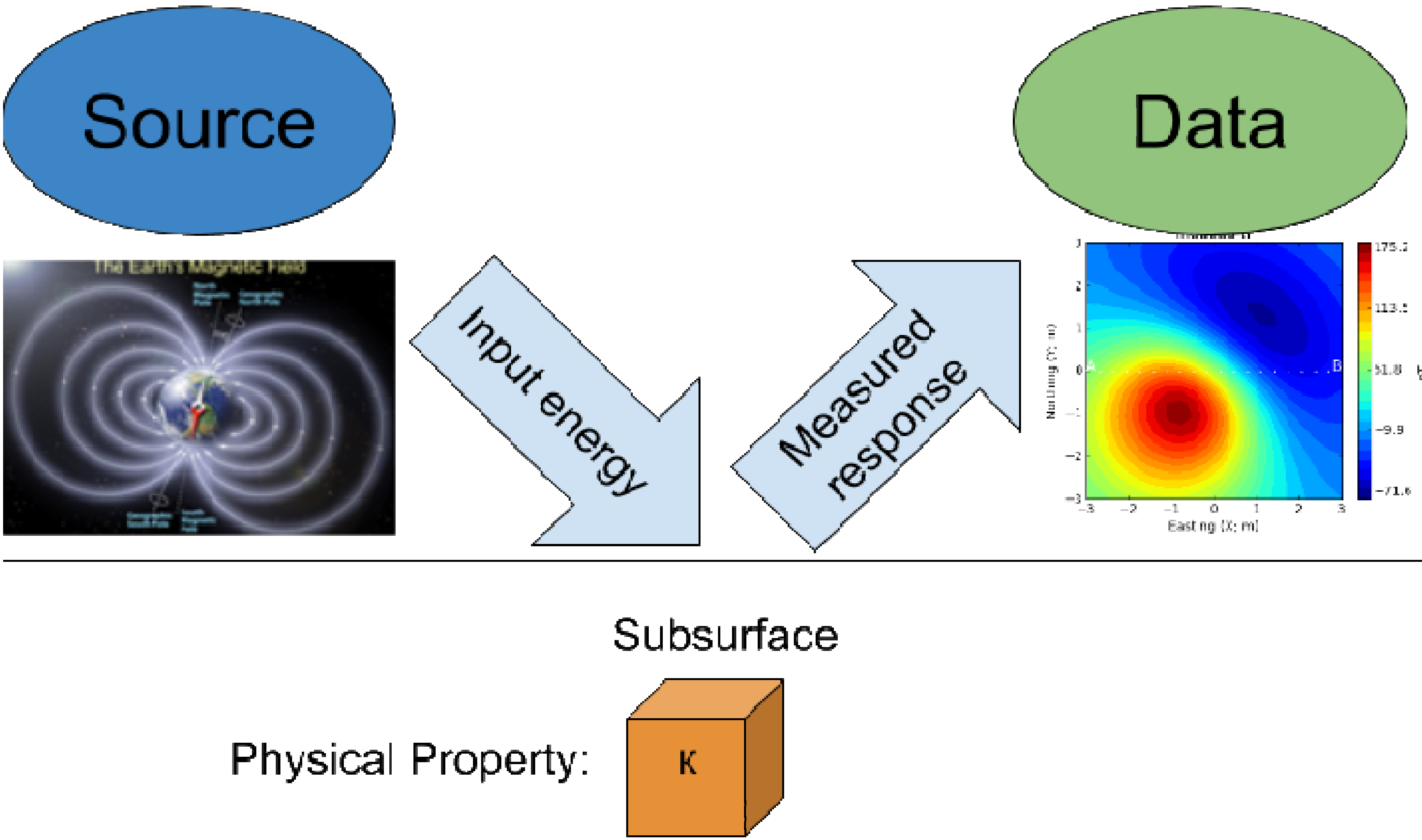
- Effects of depth of burial (half width)

- Data sampling

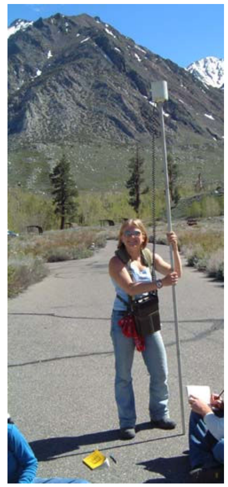
Survey Acquisition (with applet)

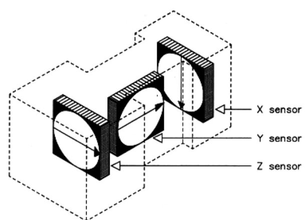
- Must sample data sufficiently often to capture the anomaly.
- Want 3-5 points in a halfwidth
- Width of the signal increases with depth of burial.
- Ground surveys generally choose line spacing and station spacing to be equal.

Magnetic Survey



Magnetic Sensors to acquire data





In-class magnetic surveying: Detection

- Magnetic material underneath the table tops.
- NO PEEKING!!!!
- Use magnetic compass on smartphones (download apps if not already done)
- Carry out a survey to detect the magnetic bodies.
- Flag them with tape.

If the magnet was a UXO

- Magnet:
- diameter: 6mm;

- UXO
- 20cm in diameter…

- If our table: ~ 1m X 3m

how large would a survey area equivalent to the table be?

- Length scale ratio ~1:33
- Survey area ~ 10m x 30m

If the magnet was a UXO

If the magnet was a UXO

Team Exercise: Searching for $1B Cu deposit

- Magnet: diameter: 6mm; height=2mm vol 5.65e-8 m^3
- For table size: ~ 1m X 3m

- Price: $310 USD/lb; $684 /kg
- $1 billion. I need: ??? Kg
- Density of copper 8960 kg/m^3
- Need ??? m^3 of copper
- Assume 0.3% Cu by volume: ??? m^3
- Scale length of deposit: 1 ~ ????
- Survey area: ?? km x ?? km

Student exercise

- Magnet: diameter: 6mm; height=2mm vol 5.65e-8 m^3
- Table: 1m x 3m

- Find a copper resource worth $1B
- Price: $3.10 USD/lb; $6.84 /kg (Note decimal)
- $1 billion 1,461,305 kg
- Density of copper 8960 kg/m^3
- Need 163 m^3 of copper
- Assume 0.3% Cu by volume: 54,330 m^3 (cube: 38 m on side)

- Scale length: $$\left(\frac{V_c}{V_m}\right)^{\frac{1}{3}} \simeq 10000 \qquad (1)$$

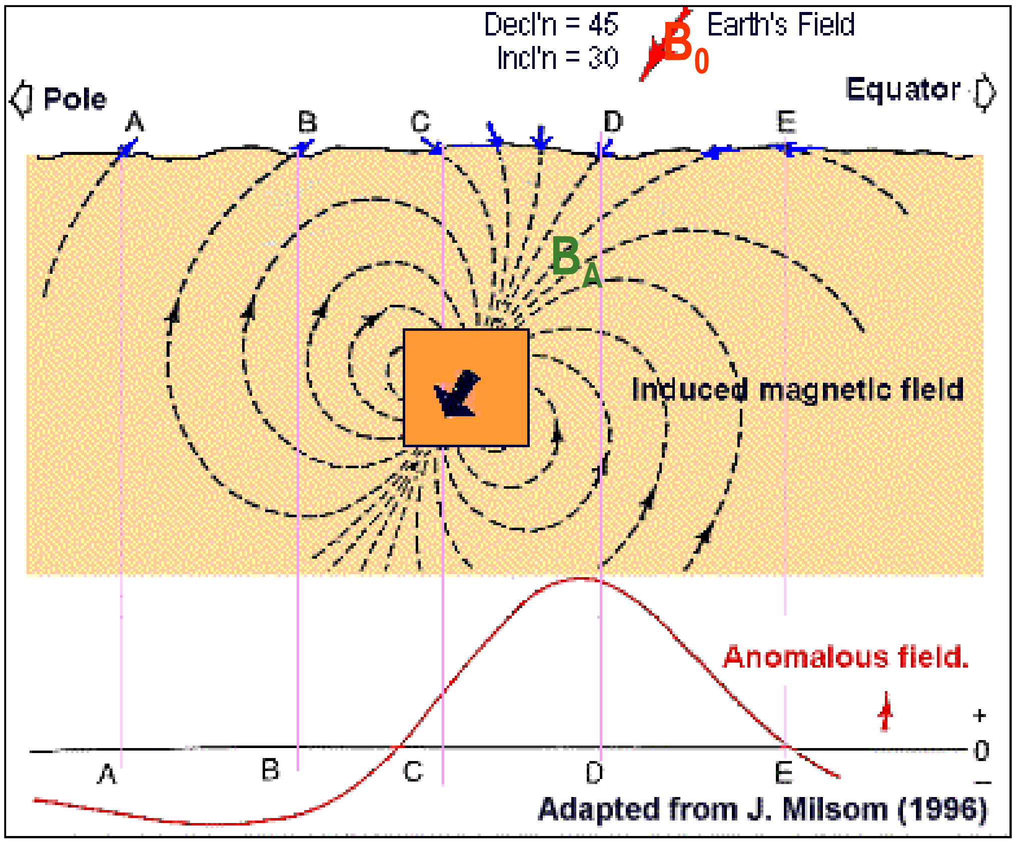
- Survey area: 10 km x 30 km

If the magnet was a billion dollar copper deposit

Readings

- GPG Magnetics
- Lab #2 (see course website)

The composite field



Composite field:

$$\mathbf{B} = \mathbf{B_0} + \mathbf{B_A}$$

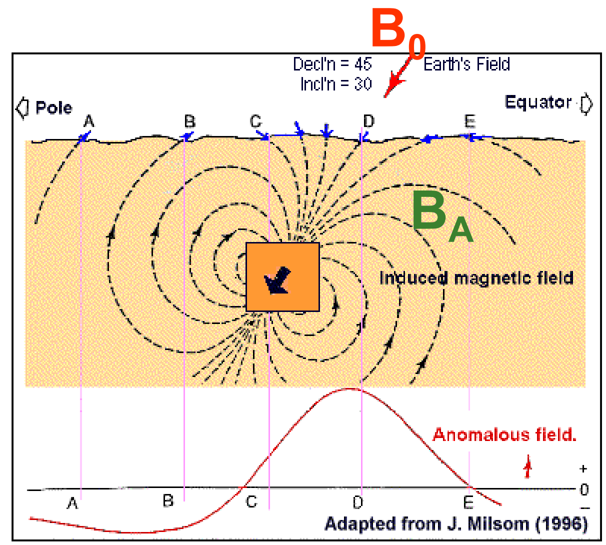
B is a vector:

$$\mathbf{B} = \{B_x, B_y, B_z\}$$

Total field:

$$|\mathbf{B}| = |\mathbf{B_0} + \mathbf{B_A}|$$

The Anomalous field



Measured field B = B_0 + B_A

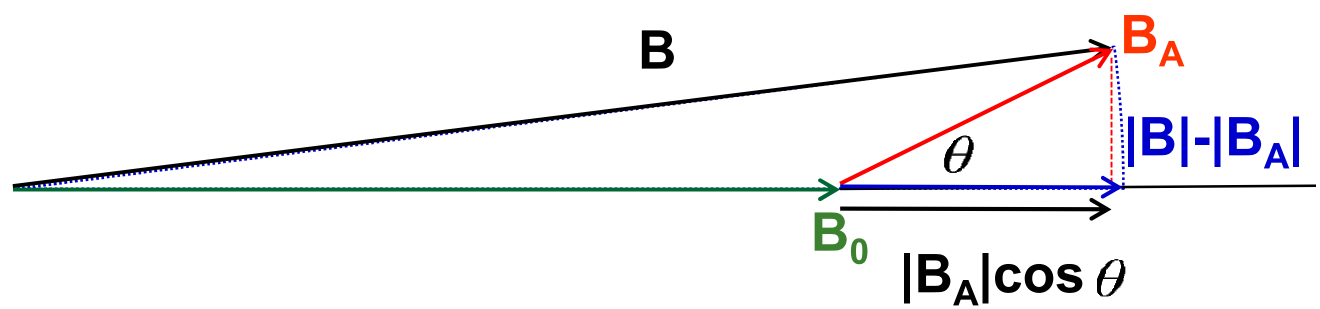
Link to GPG

- The *total* field *anomaly*: **ΔB = |B| - |B_0|**
- If **|B_A| << |B_0|** then
- That is, total field anomaly **ΔB** is the projection of the anomalous field onto the *direction* of the inducing field.

$$\Delta\vec{B} \simeq \vec{B}_A \cdot \hat{B}_0$$

Why is the total field anomaly: $\triangle\vec{B} \simeq \vec{B}_A \cdot \hat{B}_0$

- Vector Diagram



$$
\begin{aligned}
|\triangle\vec{B}| &= |\vec{B}_0 + \vec{B}_A| - |\vec{B}_0| \\
&\simeq \vec{B}_A \cdot \hat{B}_0 \\
&= |\vec{B}_A| cos\theta
\end{aligned}
$$

Data Processing

- Removing time variations of the Earth’s field (necessity for a base station)

- Removing a regional trend

Magnetics – Earth’s field