Geophysics 223 Assignment 3 : Electromagnetic methods

This assignment will be due in class on **Wednesday April 1st 2009**

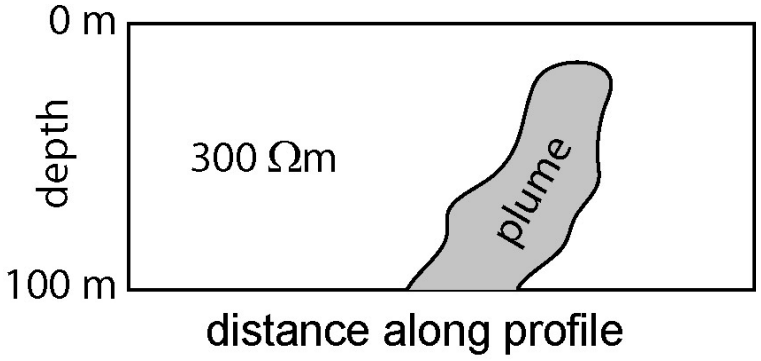
Question 1 - VLF

A VLF survey is being used to locate a **low resistivity plume** of contaminated groundwater. The figure below shows the layout of the survey and the plume.

The TX frequency is 20 KHz.

(a) Sketch the variation of **tilt angle** across the plume. Note that it dips to the left.

(b) What is the **maximum depth** at which the sulphide can be detected?



Question 2 – EM38

At a contaminated site, the ground is saturated with salt water with bulk conductivity 0.3 S/m. At the surface there is a fresh water layer with bulk conductivity 0.008 S/m.

(a) The surface layer is 0.75 m thick. Calculate the apparent conductivity that will be measured with an EM38 with the TX and RX in the **vertical configuration**.

(b) Repeat (a) for the **horizontal configuration**.

(c) The EM38 instrument gives an apparent conductivity reading of 0.1 S/m with TX and RX in the **vertical configuration**. What is the thickness of the surface layer?

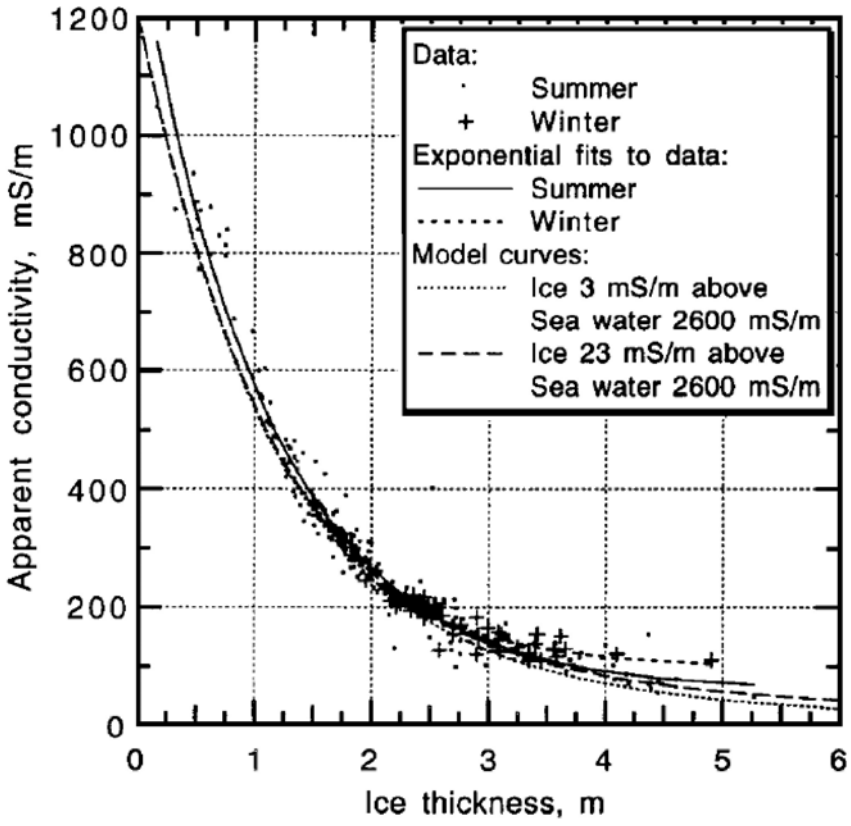
Question 3 – Sea-ice thickness studies with EM31

An EM31 survey is being used to measure sea-ice thickness during the Arctic summer.

The transmitter and receiver are oriented **horizontally**.

The EM31 was 0.14 m above the ice surface.

(a) The instrument gives an apparent conductivity reading of 600 mS/m.
Use the figure below from Haas et al., (1997) to estimate the ice thickness.



(b) Assume values for ice and seawater conductivity of 23 and 2600 mS/m respectively. Use the equations in D2 to compute the variation of apparent conductivity with ice thickness. Recommended to use EXCEL or the spreadsheet of your choice. Should use 3 layers.

Using this curve, estimate the thickness of ice required to produce an apparent conductivity of 600 mS/m

(c) Comment on the agreement between your answers to (a) and (b).

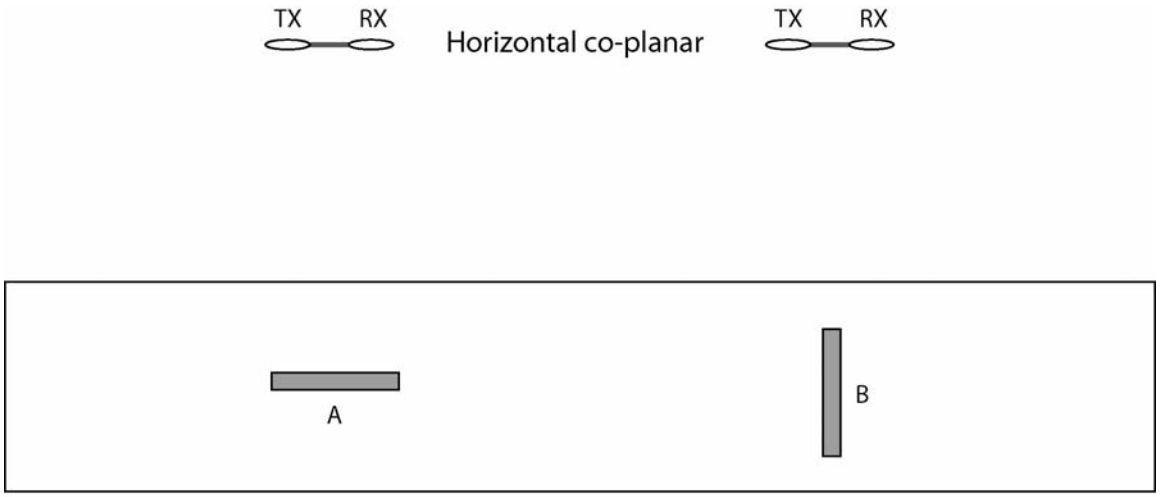
Question 4 - DIGHEM

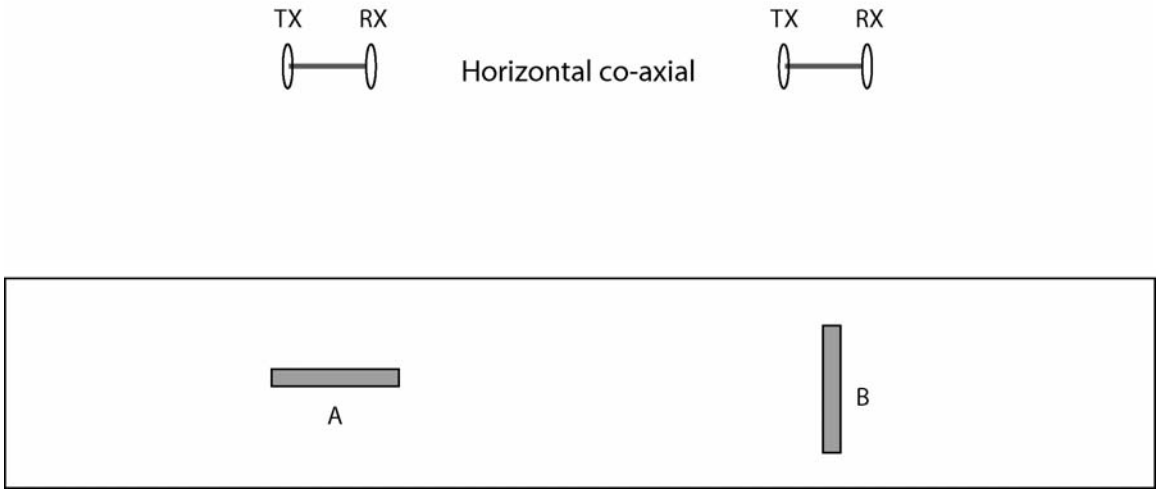
A DIGHEM survey is flown over two buried conductors ‘A’ and ‘B’.

TX and RX are oriented in horizontal coplanar and horizontal coaxial configurations.

Draw a diagram of the primary and secondary magnetic fields for each.

For each conductor, which configuration will give the largest response?





Question 5 - GEOTEM

In a GEOTEM survey motion of the RX bird in the Earth's magnetic field causes magnetic noise with an amplitude = 137 nT/s in $\frac{dB_z}{dt}$

At late time the magnetic field decays as

$$\frac{dB_z(t)}{dt} = \frac{\mu_0 IA}{20}\left(\frac{\mu_0\sigma}{\pi}\right)^{\frac{3}{2}} t^{-\frac{5}{2}}$$ and the symbols are defined in the notes.

(a) The transmitter has a current I = 1000 amps and area A = 100 m^2.

The Earth has a resistivity of 100 ohm-m.

Use the noise level stated above to calculate the **latest time** at which the decaying magnetic field can be observed?

(b) What **depth of exploration** does this represent?