PRRE1003 Resources, Processes & Materials

Workshop P1: Exploration of Resources

LEARNING OUTCOMES

- Understand how critical resources are discovered and characterized using geophysical techniques
  - Use acoustic impedance and reflection coefficient in geothermal energy exploration
  - Use surface geology, magnetic susceptibility and electrical conductivity in mineral exploration

ACTIVITIES

Activity 1: Geophysical exploration of major resources (15 minutes)

Video 1; www.youtube.com/watch?v=CeQ7p2NdkPc

Video 2 ; www.youtube.com/watch?v=T1yzHW5x1HE&t=2s

As a group, watch the following videos and discuss which of the below items mentioned:

- Resources
- Physical properties
- Geophysical Techniques

Activity 2: Geophysical Resources and Methods of Exploration (20 minutes)

Working as a group, use the lecture notes, video and credible web resources to complete the table below:

Resources	Geological Setting/ Mineralogical Parameter	Geophysical Methods	Rock Property
Crude Oil Reservoir			
Gas Reservoir			
Water			
Porphyry Deposit			
Iron Deposit			

Activity 3: Exploration for Geothermal Energy Resources: Reflection of Soundwaves (30 minutes)

Your group has been asked to use seismic exploration find a geothermal energy resource. You send out a sound wave and measure its reflection coefficient. This enables you to understand what is beneath the surface.

Please note that **Acoustic Impedance** ($Z = V_p \rho$) is the product of seismic velocity and density. The differences in acoustic impedances between rock layers determine the **Reflection Coefficient,** which is defined by $R = \frac{(Z_2 - Z_1)}{(Z_2 + Z_1)}$, where Z_1 is the acoustic impedance of the upper layer and Z_2 is the acoustic impedance of the lower layer. For each Figure, the one-way distance travelled by the sound wave is 500 m.

In your groups, fill in the following Table, based on calculations from Figures 1 and 2:

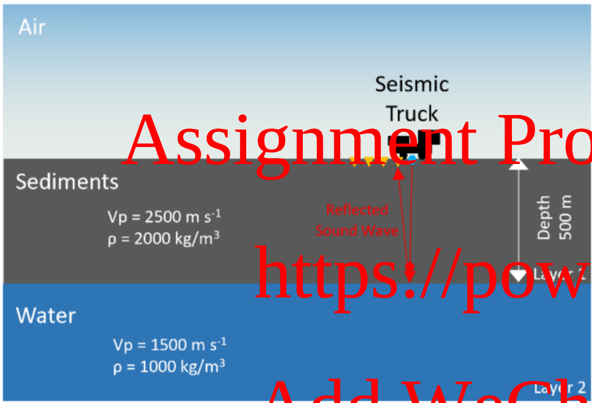

Figure 1: Seismic exploration through sediment. Response from Water

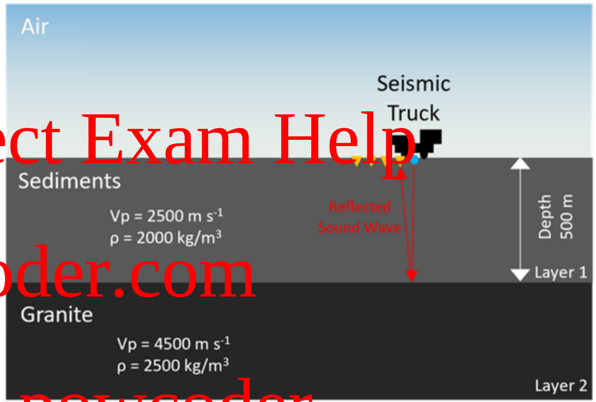

Figure 2: Seismic exploration through sediments. Response from Granite

Activity 4: Exploration for Mineral Resources: Find the Porphyry Deposit (25 minutes)

Porphyry copper deposits are ore bodies rich in valuable minerals such as gold, silver and copper and can present in a 'donut' or circular shape. These are formed via the deposition of mineral rich hydrothermal fluids within igneous rock. These can be associated with volcanic intrusions such as dikes and with major faulting and fracturing. Porphyrys have distinct signatures:

- **High magnetic anomaly** due to higher ferromagnetic mineral concentrations (e.g., pyrrhotite and magnetite). This can be detected using ***airborne magnetics***.
- **High electrical conductivity anomaly** over the deposit due to high concentrations of electrically conductive minerals (e.g., chalcopyrite and pyrite). This can be detected using ***airborne electromagnetics***.

Note: Clays can also complicate the inversion and may have a higher electrical conductivity (>100 mS/m) than the surrounding host rock.

Working in your groups:

(a) Use the rock property charts to identify the minimum and maximum values of electrical conductivity (Figure 3) and magnetic susceptibility (Figure 4) of a mineralized porphyry.

	Mineralized Porphyry	
Rock Property	**Minimum**	**Maximum**
Electrical Conductivity (mS/m)		
Magnetic Susceptibility (SI)		

Time taken to hear first reflected sound wave from layer boundary (s)		
$Z_{layer\ 1}$ ($kg.m^{-2}.s^{-1}$)		
	Figure 1 - Calculations	**Figure 2 - Calculations**
$Z_{layer\ 2}$ ($kg.m^{-2}.s^{-1}$)		
Reflection coefficient, R		
What does the reflection coefficient tell us about the properties of the layers?		

(b) Use the contour maps (Figure 5) and **circle the following**:
- ☐ Areas of corresponding to the **electrical conductivity** of a mineralized porphyry
- ☐ Areas of corresponding to the **magnetic susceptibility** of a mineralized porphyry

(c) What grid square do you expect has the highest probability of containing a porphyry copper deposit? Explain briefly.

(d) Why isn't it good practice to rely *only* on the electrical conductivity plot in Figure 5ii to explore a mineralized Porphyry deposit?

<u>Rock Property Charts</u>

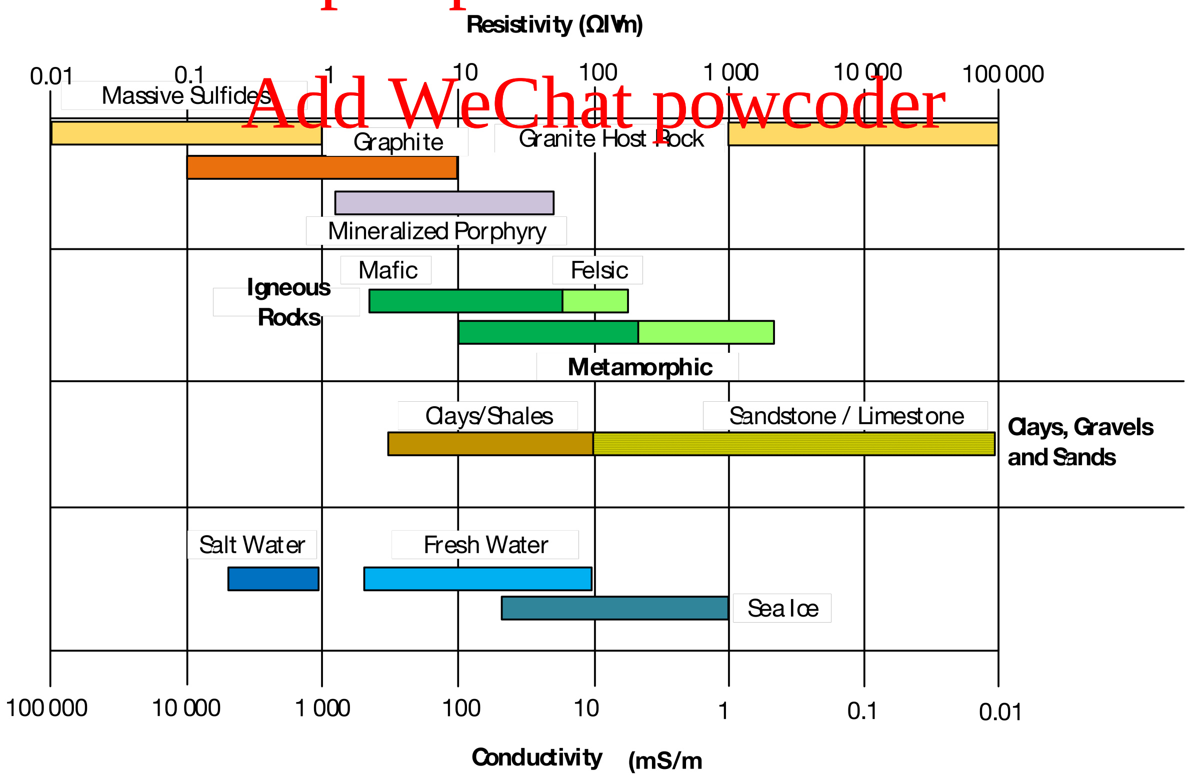

Figure 3: Electrical conductivity/resistivity properties of rocks and water.

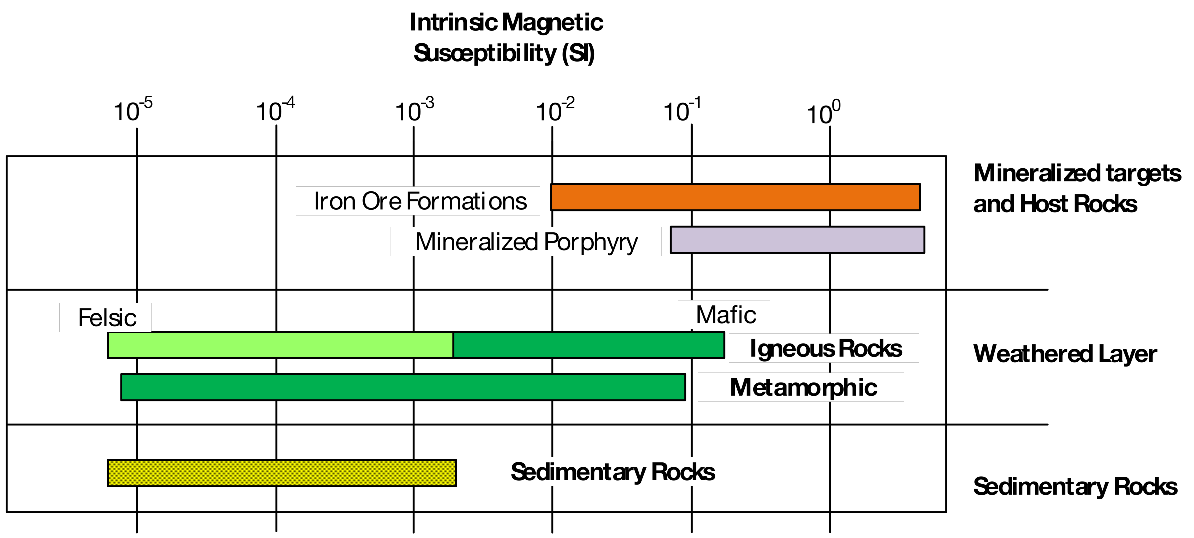

Figure 4: Magnetic susceptibility properties of rocks.

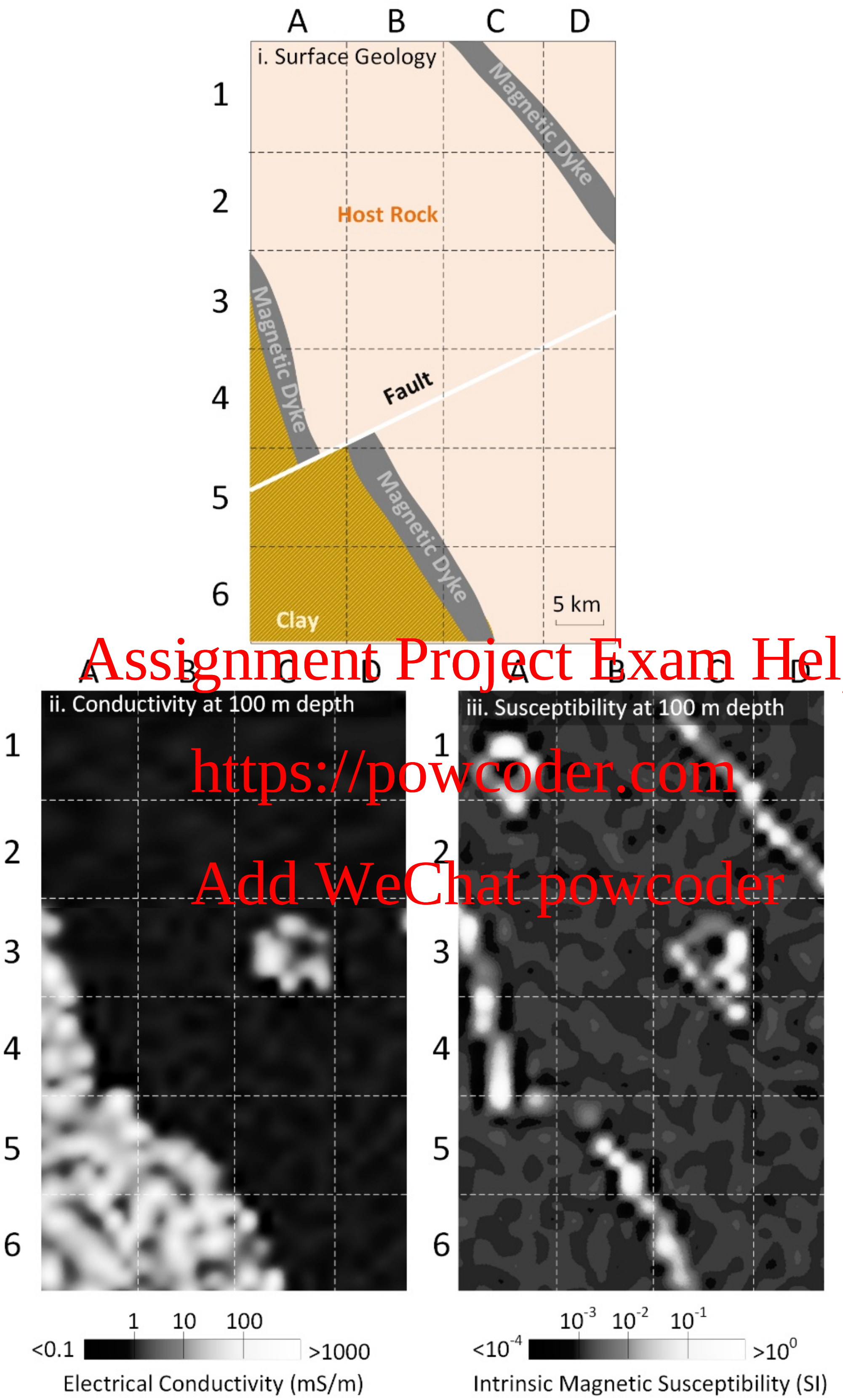

Figure 5. Maps showing (i) surface geology, (ii) electrical conductivity at 100 m depth and (iii) magnetic susceptibility at 100 m depth.