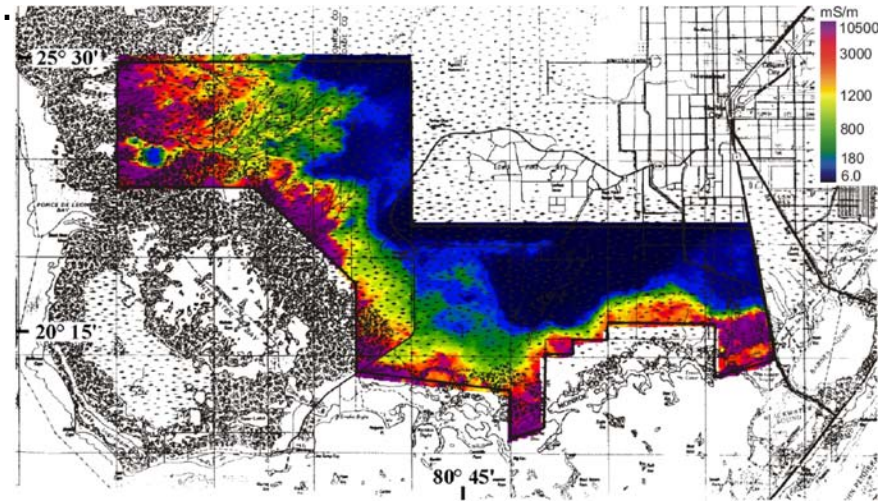
A: Introduction

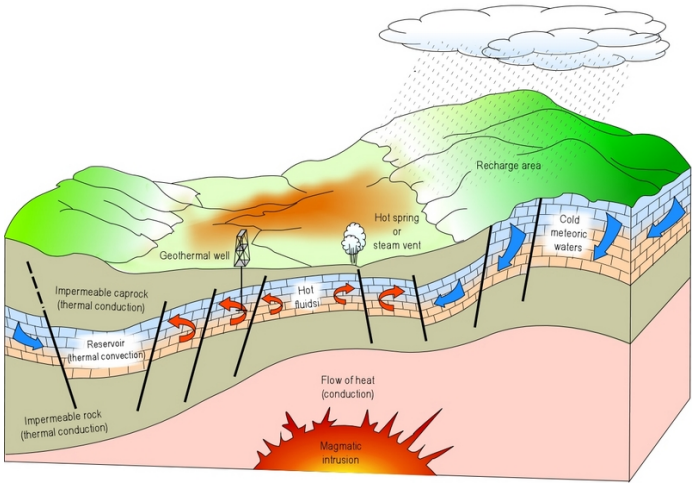
What is geophysical exploration?

imaging underground structures from surface measurements of artificial or natural signals that travel through, or are generated by, the Earth.

Why?

- mineral exploration
- hydrogeology
- geothermal exploration
- monitoring contamination and remediation





A: Introduction

Some basic principles

•All geophysical methods remotely sense a **material property** of the Earth (*e.g.* electrical resistivity, magnetization, seismic velocity, rock density etc)

•Knowledge of these material properties must then be **interpreted** to determine what rock or fluids are present.

•Well log information is very important in this task

•Geophysical methods can be divided into active and passive techniques.

In an **active technique**, **it is necessary to generate a signal** (*e.g.* in electromagnetic surveying surveying, electromagnetic waves are generated by the tramsmitter).

In a **passive technique a naturally occurring signal is detected** (*e.g.* the magnetization of a buried object)

A: Introduction

•Geophysical and geological studies complement one another.

•Geologists are more effective with a basic knowledge of what geophysics can and cannot resolve.

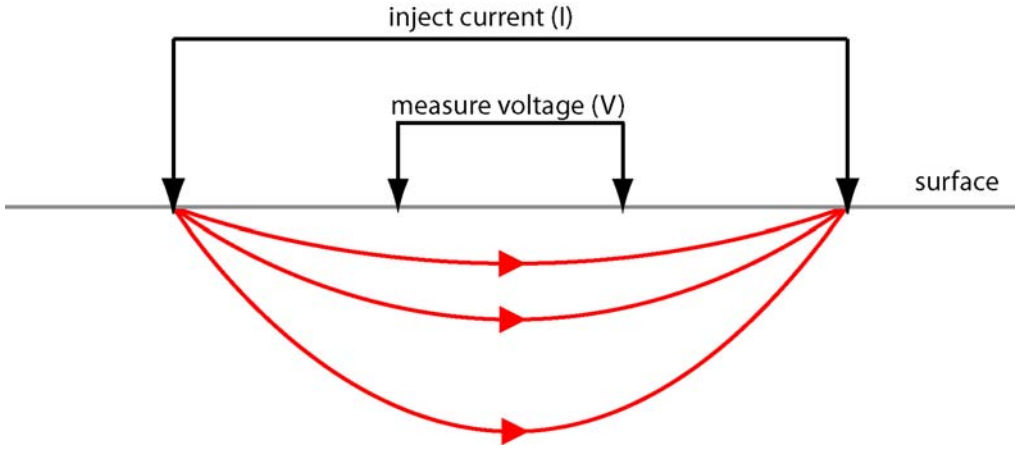
•Many geophysicists would benefit from a basic knowledge of geology.

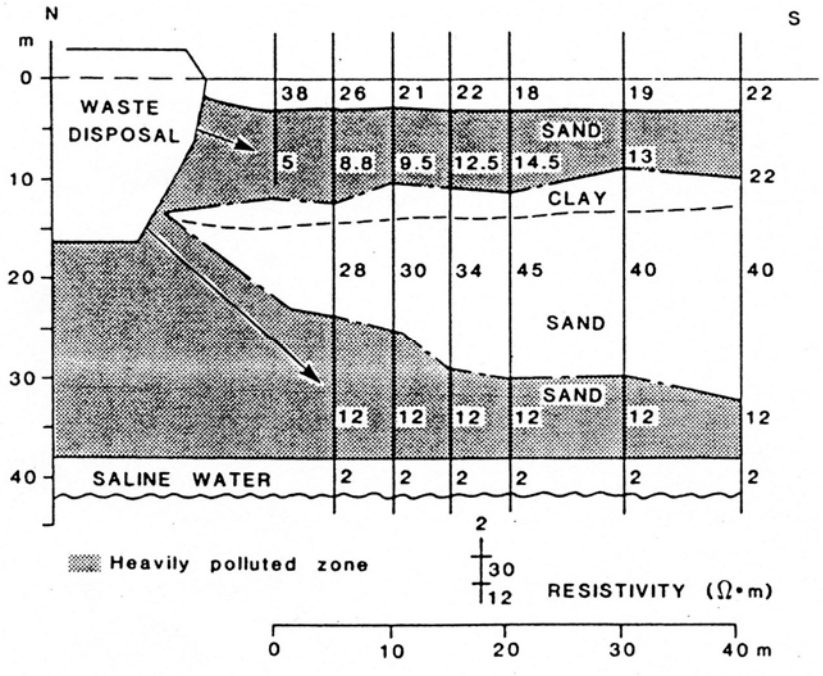
•Geophysical imaging does not always give a unique answer! Additional information is often needed to discriminate between possible solutions (*e.g.* other geophysical surveys, knowledge of local geology, well log information in the study area).

•Please do not be intimidated by equations! Mathematics will be used in this class where needed, and I hope that this will provide a review of math classes you have taken in the recent past. I do not expect students to memorize equations. My expectation is that students will be able to perform simple rearrangement of equations, and use a calculator to evaluate an equation for a given set of values.

•I will appreciate feedback to keep the mathematics at an appropriate level.

B : Direct current methods (DC resistivity)





Survey measures

Voltage between electrodes caused by Injected electric current

Property computed by data analysis

Electrical conductivity (resistivity)
(IP : Polarizability/chargeability)

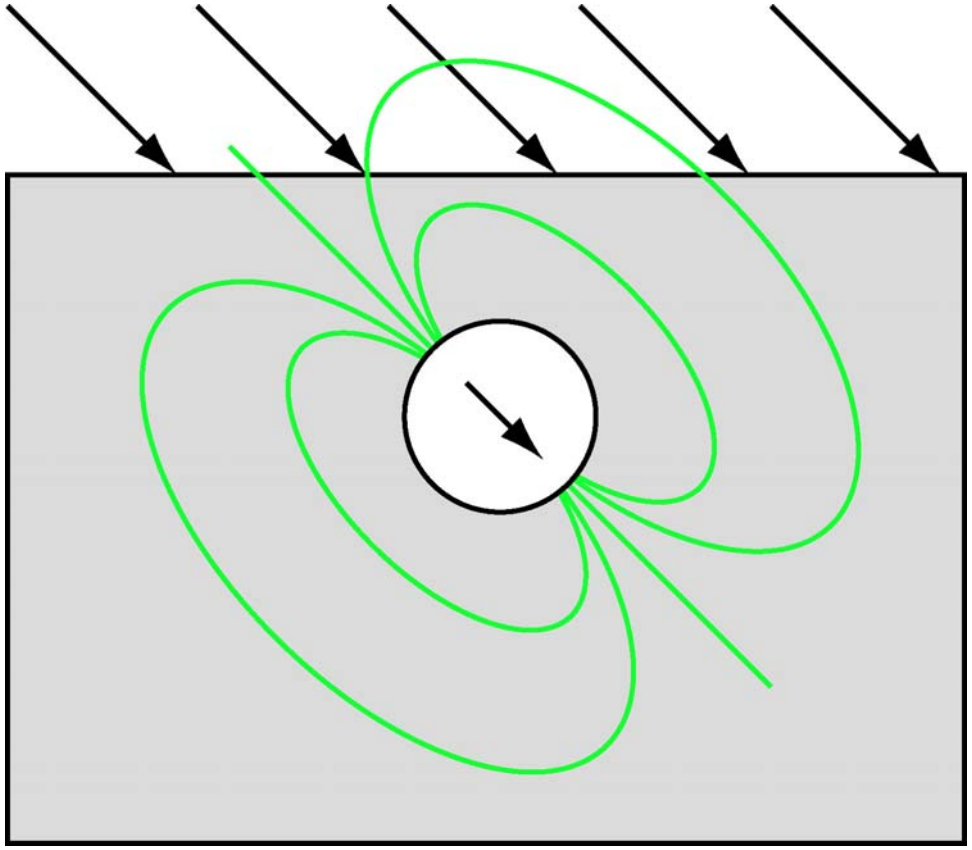
Applications

- Hydrogeology
- Geotechnical studies
- Shallow geological studies
- Mineral exploration

Limitations

Deep exploration requires long wires and a power source of current

C : Magnetic exploration



Survey measures

Magnetic field at surface (**B**)
Ground based and airborne surveys

Property computed by data analysis

Magnetic susceptibility (k)
magnetization (**M**)

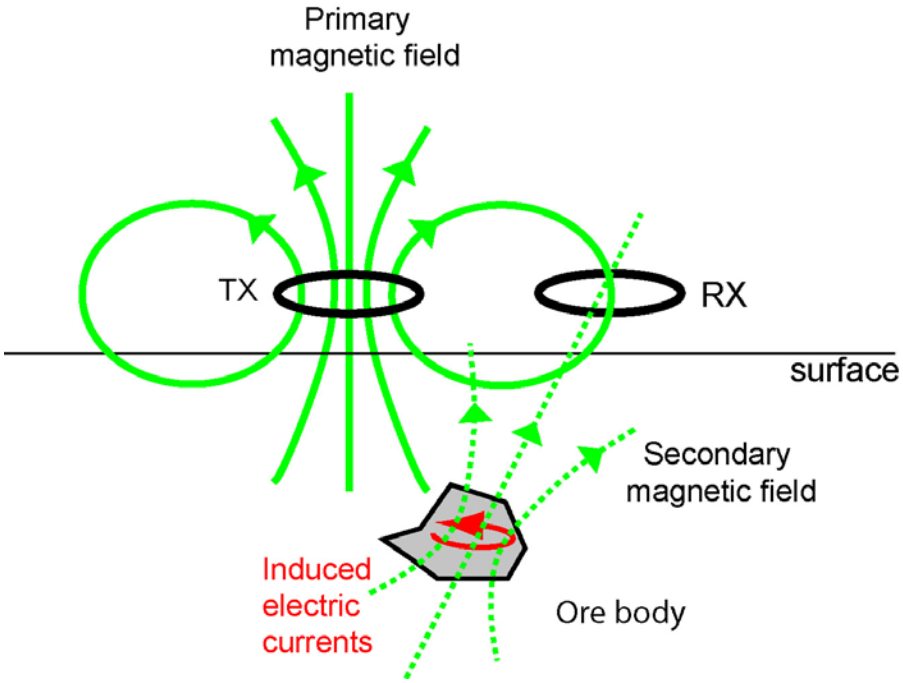
Applications

- Locating 55 gallon drums, UXO etc
- Mapping ore deposits
- Archaeology

Limitations

Need to understand if magnetization
Is induced or remnant

D : Electromagnetic methods



Survey measures

Amplitude and phase of low frequency radio waves

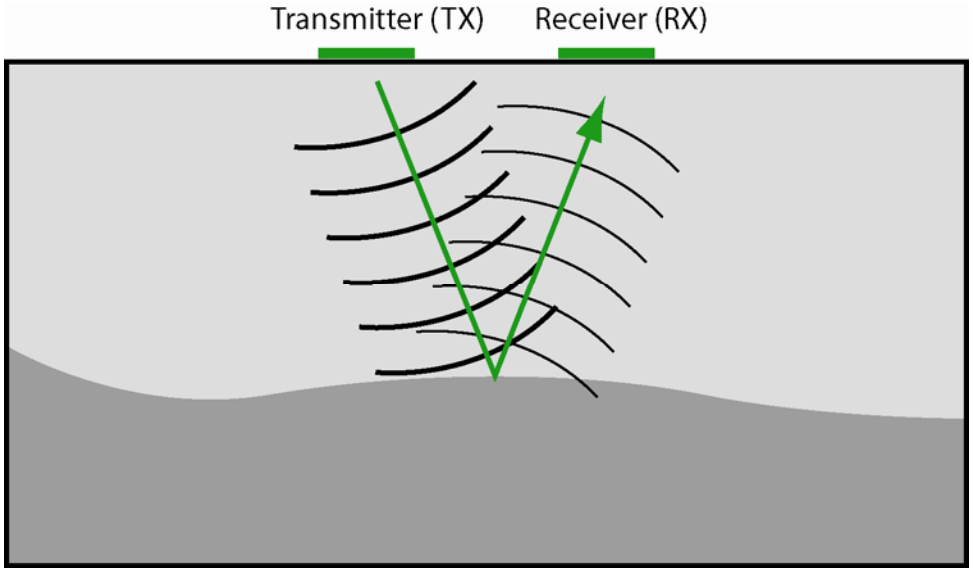
Property computed by data analysis

Electrical conductivity (resistivity)

Applications

- Hydrogeology
- Geotechnical studies
- Shallow geological studies
- Mineral exploration

E : Ground-penetrating radar (GPR)



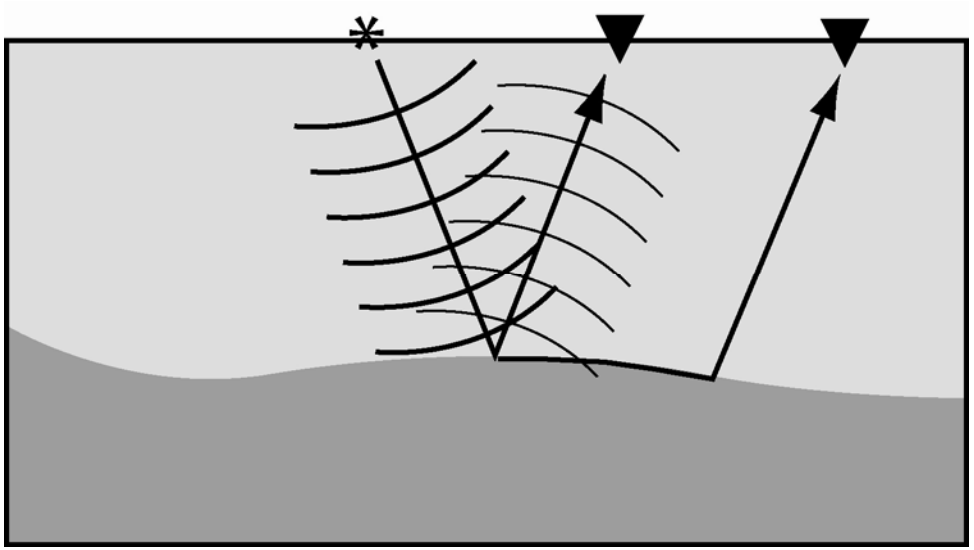
Survey measures
Travel time and amplitude of high frequency radio waves

Property computed by data analysis
Velocity of radio waves in Earth
Dielectric permittivity

Applications
- Snow and ice mapping
- Geotechnical studies
- Shallow geological studies
- Mineral exploration

Limitations
Signals attenuated in low resistivity soils

F : Shallow seismic exploration



Survey measures
Travel time and amplitude of seismic waves
Reflection and refraction

Property computed by data analysis
Velocity of seismic waves in Earth

Applications
- Geotechnical studies
- Shallow geological studies
- Mineral exploration