GLY3160 / PHY3160
Introduction to Geophysics

• **What is geophysics?**
  - Comes in two* basic flavors *(your text says three)*
    - **Pure (academic) geophysics** – Studying various Earth processes from a physics approach.
      - Purpose: To understand Earth processes.
    - **Applied (geological) geophysics** – Using physical properties of the Earth to provide information about the subsurface.
      - Purpose: To better characterize the geology of the subsurface.

  - **A giant natural physics lab** – Used to test physics hypotheses / theories about general physical processes. Not really concerned about the Earth.
    - Purpose: To better understand physics laws.
Example: Gravity

• Pure Geophysics:
  ▪ Measure accel due to gravity → mass of the Earth.
  ▪ Then use size of Earth → avg. density

• Applied Geophysics
  ▪ Measure small changes in g → detect subsurface void

• Applied geophysics requires knowledge and understanding of pure geophysics!
Why Study Geophysics?

• **Who hires geophysicists?**
  - Energy Companies $$$
  - Mining Companies $$$
  - Government Jobs
  - Engineering Consultants
  - Environmental Consultants

• **Bottom line…geophysics is highly employable**
Why is Geophysics Useful?

Some sweeping generalizations…

• Geology:
  ▪ Limited to the surface of the Earth
    • Geologists must infer the 3rd dimension
    • Boreholes are an exception, but are expensive and only give limited information (<13 km depth).
  ▪ Gives extremely detailed data about small areas.
  ▪ Provides information about the past.

• Geophysics
  ▪ Adds information about the 3rd dimension.
  ▪ Can truly “look into the Earth”
  ▪ Gives less detailed information about much larger areas.
  ▪ Results are often “non-unique”
  ▪ Usually cannot give information about the past
    • Exceptions are radiometric dating and paleomagnetism.
  ▪ Can study non-tangible things…e.g. forces
How Do Geophysicists “Look at” Rocks?

• Geologists mainly look at rocks visually
  ▪ Map rock occurrence
  ▪ Visually identify mineral content
    • Optical microscopes
    • SEM
  ▪ “Direct” approach.

• Geophysicists “look at” rocks differently
  ▪ Measure properties such as density, resistivity, magnetic properties, elastic moduli, radioactivity, etc…
  ▪ Use these properties to infer rock type / composition
  ▪ “Indirect” approach, but offers information that is not possible to visually obtain.
Geology vs. Geophysics

- At the end of the day geology and geophysics are both useful when studying the Earth.

- Geophysics does not replace traditional geologic study; it compliments it.

- The best geologists understand and appreciate geophysics.

- The best geophysicists understand and appreciate geology.
The Scientific Method

- Science is not subjective
- Results are **statements** based on **observations**
- Results must be **reproducible** and **thoroughly tested**
- Scientific discovery is the results of human efforts... people just like you!
- Science is not involved with “proving” things; science just test ideas!
The Basic Steps of the Scientific Method

• 1- Identifying the problem or question
  What are we trying to figure out?

• 2- Collecting data
  Collect data that addresses the problem

• 3- Propose hypothesis
  An idea that is consistent with your collected data

• 4- Test hypothesis
  If your idea is correct, then maybe other things should be true too. Test ‘em! Get ‘er done!

Over time, others will test your hypothesis

- Does the hypothesis agree with other data?
- Does the hypothesis predict behaviors?
  - If yes, then the hypothesis may become a theory
  - If no, then the hypothesis must be modified or rejected
Hypotheses, Theories, and Laws, Oh My!

- **Hypothesis**
  - proposed by a person or several people
  - consistent with your data
  - other researchers test it

- **Theory**
  - proposed by the scientific community
  - consistent with all verified data
  - may be modified if new data is presented.

- **Scientific Model**
  - Combines many theories and hypotheses
  - to explain a complex system

- **Law**
  - considered absolutely correct throughout the natural universe (e.g. gravity, superposition)
  - usually based on logic or mathematics

The Moral…

*It's not easy to become a theory.*
Scientific Method Modern Example: Upheaval Dome, UT

• Step 1 – Identify the problem/question
  ▪ What formed this bizarre geologic structure?
Collect Data

- Circular shape
- Dome structure
- Lots of Faults
Make A Hypothesis

- Meteor Impact!
  - Consistent with dome structure and lots of faults
Great Hypothesis?

Boom!
Hypothesis Testing

- After you submit your findings, someone else reviews your work and points out that
- Salt deposits can also make circular domes!!
- Uh Oh! 😞
This Hypothesis is not Theory-bound!

Science?...or Something Else?

- A friend tells you that he read that sandstone is made of tiny diamonds.
  - So small that they are not detectable by any means.
- Is this science? Is it correct?
- String Theory...
  - Is it science or philosophy?
The Moral of the Story

• Most hypotheses don’t become theories

• *It takes a LOT of data for a hypothesis to become a theory*

• *Ideas that are not testable are not science*