Core Lab 5 - Igneous, Sedimentary and Metamorphic Rocks

Part I: Igneous Rocks

Introduction

There are two major bases of distinction that you can apply to igneous rocks:

1. Colour: light coloured, medium coloured or dark-coloured.
2. Texture: coarse grained (crystals are large enough to see with the unaided eye), fine grained (crystals cannot be seen with the unaided eye), and glassy.

Purpose and Outcomes

The students will

- identify some igneous rocks and classify them according to the above criteria.
- see how the densities of light-coloured rocks tend to differ from that of dark-coloured rocks.

Materials Required

- igneous rock specimens, including basalt, gabbro, granite, obsidian, pumice, rhyolite and scoria
- graduated cylinder and protective ring, 100 mL.
- laboratory balance
- magnifying glass

Method

1. First sort the rock samples into 2 groups by colour. Use your judgement on the medium coloured rocks!
2. Within each "colour-group," sort the rocks by texture.
3. Look at the summary table for common igneous rocks. Copy the table below on your own paper, but larger. Place the correct rock specimen in the correct location. Note that you will not use the medium coloured category.

	light	dark
coarse		
fine		
glassy		

4. Recall that density, D, is given by $D = \frac{m}{v}$. Recall also that in core lab 4, you calculated the density of a rock sample. Use a similar procedure to determine the density of the granite sample. Record your date in a table and use the same procedure to find the density of the gabbro sample. What differences do you notice?
5. Use your answer to part D to help predict how the density of rhyolite compares with the density of basalt.
6. Recall that the percent of error is given by the following expression.

$$\% \text{ error} = \frac{\text{Actual Value - Calculated Value}}{\text{Actual Value}} \times 100\% = \_\_\_\_\%$$

   The average density of granite is about 2.6 g/mL. Calculate the percent error for your density.

7. Recall that the samples are composed of one or more distinct minerals. What minerals would you find in each sample?

   (1) granite (use a hand lens)

   (2) rhyolite (give an explanation.)

   (3) gabbro

   (4) basalt (give an explanation.)

8. Examine your sample of obsidian. Explain how it can fit in two places on your chart based on colour and texture. Use the information in the summary table to locate the correct position.
9. Contrast the physical appearance of scoria and pumice. How are they different? Use the properties of the lava from which each was formed to explain this difference.

Summary Table: Common Igneous Rocks

Texture and Origin	Felsic or Light-Coloured Rocks		Medium-Coloured Rocks	Mafic or Dark-Coloured Rocks	
	Colours: white, tan, grey, pink, red *Minerals:* feldspar (mostly orthoclase), quartz; also some mica and hornblende		*Colours:* grey, green *Minerals:* feldspar (mostly plagioclase), hornblende, augite, biotite	*Colours:* dark green, dark grey, black *Minerals:* plagioclase feldspar, augite, also olivine, horblende, biotite	
	With Quartz	*Almost No Quartz*	*Without Quartz*		
Glassy: cooled quickly at surface of Earth	Obsidian Purmice		Obsidian	Basalt glass Scoria	
Fine-grained: cooled slowly at or near surface	Rhyolite	Trachyte	Andesite	Basalt Diabase	
	Felsite				
Course-grained: cooled very slowly, usually at great depths	Granite pegmatite	Syenite	Diorite	Gabbro	*No Feldspar*
		Granodiorite			Periodite Pyroxenite Dunite

Part II: Sedimentary Rocks

Introduction

There are three major types of sedimentary rocks:

1. Clastic (sometimes called detrital): formed from pieces of other rocks.
2. Chemical: formed by chemical activity such as precipitation-generally in the sea.
3. Organic: formed from the remains of living creatures. Coal is a good example.

Purpose and Outcomes

The students will

- identify some sedimentary rocks and classify them according to the above criteria.

Materials Required

- sedimentary rock specimens, including conglomerate, sandstone, shale, limestone (shell and compact), coal, rock salt
- sandpaper (coarse)
- magnifying glass

Method

1. Copy the chart below and make it larger. Use the summary table which follows to write the correct name in the proper location.
2. Place your rock specimens at the correct location on the chart.

Clastic (detrital)	Chemical	Organic
larger grains stuck together	grains too small to see, light brown or grey, high specific gravity	made from the remains of plants
smaller grains stuck together	salty taste	made from the remains of animals (shells and bones)
muddy look, easily broken		

3. Contrast:

   (1) conglomerate with sandstone and shale,

   (2) shale with conglomerate and sandstone.

4. Identify the mineral in the largest grains of the conglomerate.
5. Suggest reasons why you rarely find fossils in conglomerate.
6. Use the hand lens. Identify the material from which the sandstone is formed. Explain why the sandstone feels like the sandpaper.
7. Describe the chemical test that can be used to identify limestone.
8. Examine the shell limestone. Can you identify any of its component parts? Explain how the appearance of the shell limestone differs from that of the compact limestone.
9. Describe the appearance of the coal sample. Can you identify any fossils in the sample?
10. Explain whether halite differs from rock salt.

Summary Table: Common Sedimentary Rocks			
Name	Colour	Distinguishing Features	Origin
breccia	variable	contains angular fragments surrounded by finer grains	clastic
coal	shiny to dull black	found in beds located between other sedimentary rocks	organic
conglomerate	variable	contains rounded pebbles held together by cement	clastic
rock salt	colourless to white	cubic crystals	chemical
gypsum	white, grey, brown, red or green	grains range in size from very fine to very large, can have a very crumbly texture	chemical
limestone	variable - white, grey, yellow, red, brown	found in thick layers on cliffs, may contain fossils	organic
sandstone	white, grey, yellow, red	fine or coarse grains held together by cement	clastic
shale	yellow, red, grey, green, black	dense but soft, breaks easily	clastic

Part III: Metamorphic Rocks

Introduction

There are three major classes of distinction for the appearance of metamorphic rocks:

1. Foliated: rocks have bands which give a layered appearance.
2. Nonfoiliated: rocks have no apparent bands or layers.

Purpose and Outcomes

The students will

- identify some metamorphic rocks and classify them according to the above criteria.

Materials Required

- metamorphic rock specimens, including gneiss, schist, slate, quartzite and marble
- magnifying glass

Method

1. Examine the rocks and separate them into two groups-foliated and nonfoliated.
2. Copy the chart below, but larger. Write the name of each metamorphic rock in the correct location and

Foliated	Nonfoliated
light and dark bands, coarse-grained	fused quartz grains, dense, hard, cyrstalline
wavy surfaces, thin, parallel bands	white or grey, crystals of calcite, crystalline
flat layers, fine grained, may be green, grey, purple or red	

place the appropriate specimen next to the name.

3. Examine the gneiss with the magnifying glass. Note the coloured bands. Identify the minerals.

4. Explain why it is reasonable to assume that gneiss can be formed from granite.
5. Explain how the appearance of granite differs from that of gneiss.

6. Contrast schist with gneiss. Explain how the mineral bands differ in appearance.

7. Explain why it is reasonable to assume that slate may have been formed from shale.

8. Contrast the texture of marble with that of quartzite.

9. Explain how you can distinguish quartzite from marble using the following tests:

   (1) hardness test,

   (2) acid test.

Core Lab 6 - Particle Size and Settling Rate

Introduction

This is intended to be a student-designed activity. Appropriate time should be allocated for the planning, execution and analysis stages.

Purpose and Outcomes

The students will

- experimentally determine the relationship between particle size and settling rate for sediments.
- design an experiment identifying and controlling major variables.
- use instruments effectively and accurately for collecting data.
- communicate the findings.

Materials Required

- various, depending upon the experimental design

Method

The activity should consist of the following components:

1. A clear statement of the relationship that is sought. The students can begin from the first statement under "purpose and outcomes" above.
2. A general description of the expected relationship.
3. A description of the experimental procedure. The description should also include the materials used.
4. A record of all findings.
5. An appropriate analysis-numerical or graphical or both.
6. A clear statement of findings.

Core Lab 7 - Locating an Earthquake Epicentre

Introduction

Earthquakes occur when blocks of the earth's crust suddenly slip along a fault break and release the strain energy built up over time by the pressure of oppositely moving pieces. The point where the earthquake occurs is its focus and earthquake waves of several types spread out in all directions from there.

P-waves and S-waves travel through the earth and are detected by seismograph stations at many locations around the world. The arrival times of the P-waves and S-waves from a minimum of three seismic stations can be used to determine the location of the epicentre of the earthquake, i.e., the point on the earth's surface directly above the focus of the earthquake.

Purpose and Outcomes

The students will

- locate the epicentre of an earthquake given approximate seismographic data.
- idenify patterns in data.

In this activity you will first plot a travel-time graph for P- and S- waves from the data given in Part A. Then, in Part B, you will use seismic records from three stations to calculate the distance of each station from the epicentre. In Part C, you will use these distances on a scale map to actually pinpoint the epicentre's location.

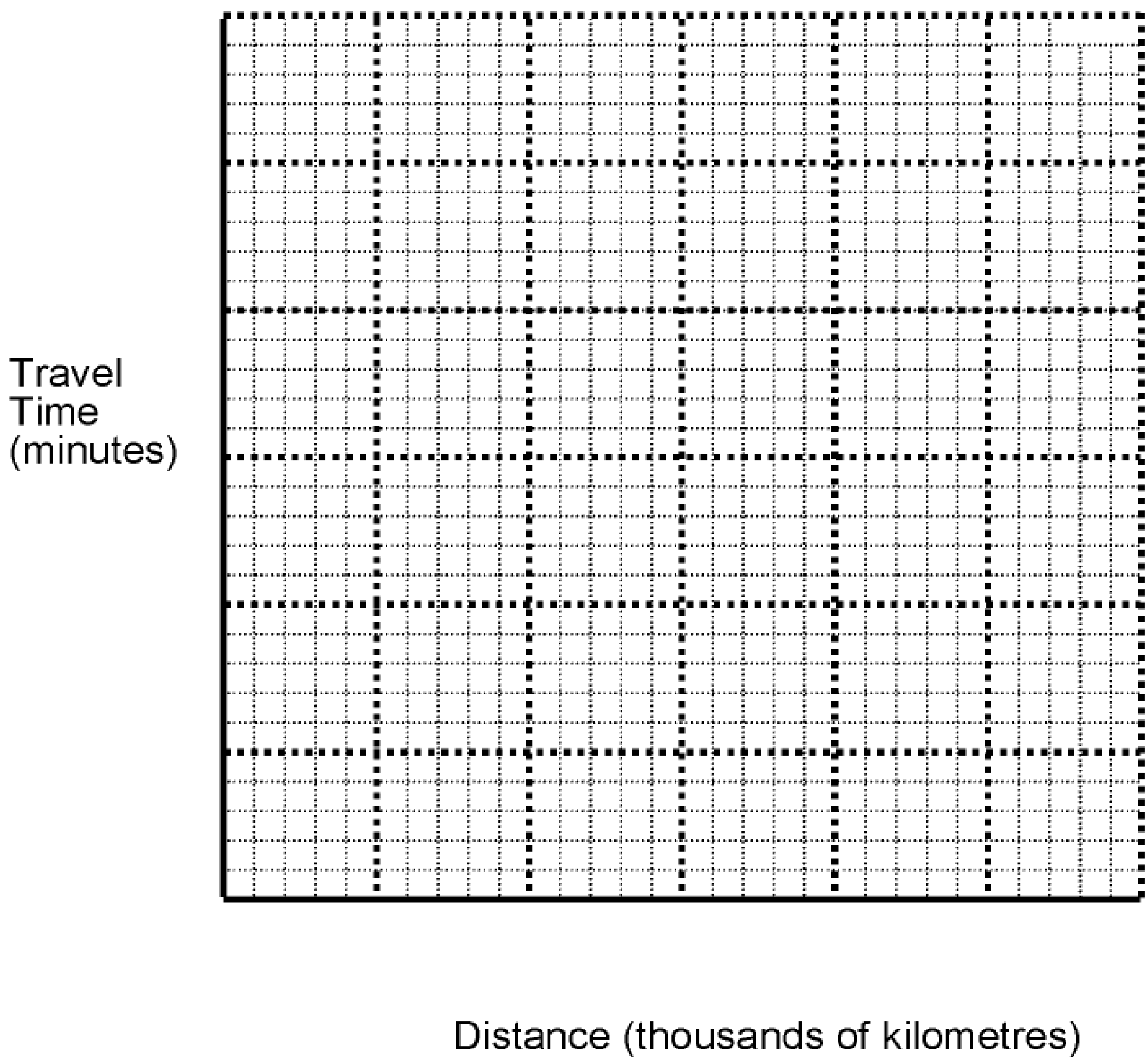
EARTHQUAKE!

At 7:30 a.m. on November 18, 1929, the town of Burin, Newfoundland, was hit by a "tidal wave" (tsunami) created by an earthquake and the town was flooded by a 15m surge which rose up over the town, destroying wharves, boats, stages and houses. Nine people died from this disaster and many homes and properties were destroyed, creating considerable hardship. What was the location of the cause of this tsunami?

Part 1

Use the data below to plot a travel-time graph for seismic waves. Put travel time in minutes on the y-axis and distance in kilometres on the x-axis. Draw one line for the P-wave and another for the S-wave. on the same graph. This data is for an earthquake assumed to have occurred at 7:00:00 a.m. (h-mm-sec).

Table 1				
Location	Distance (km)	Arrival Time P-Wave	Arrival Time S-Wave	Difference S - P
A	1000	07:02:00	07:03:34	
B	2000	07:03:25	07:06:16	
C	3000	07:04:40	07:08:30	
D	4000	07:05:45	07:10:30	
E	5000	07:06:30	07:12:00	



1. Which travels faster, P or S waves? ___________

2. From the graph, interpolate the arrival times for the P and S-waves at a station 2500 km from the source
   P _____________ S _______________

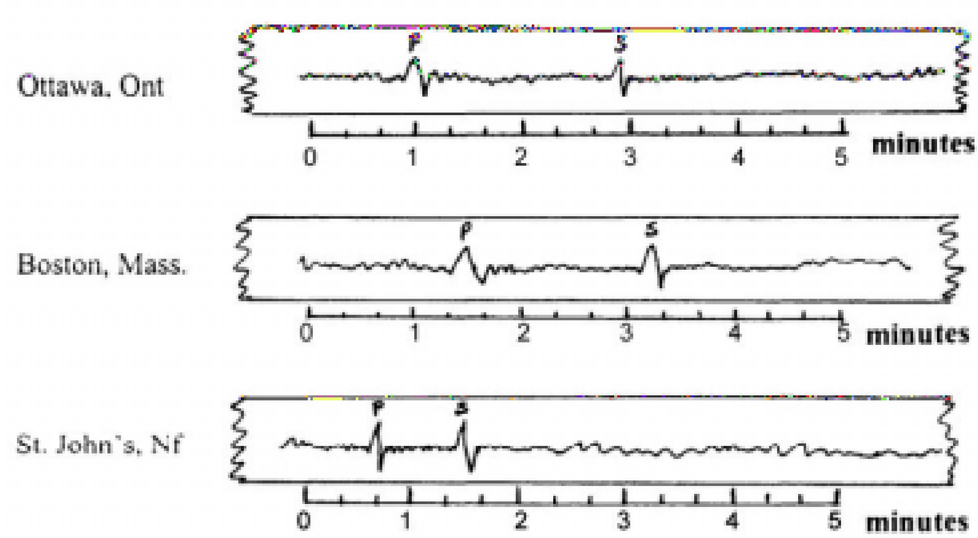
3. Extrapolate the graph to predict the arrival time for a P-wave at a station 5000 km away.

4. Find the difference between the S- and P-wave arrival times in each case and record it in the table. State the relation between this and the distance from the source.

Part 2

Since surface waves travel more slowly than P- or S-waves, and tsunamis, being large sea waves, travel more slowly again, we will assume the earthquake that triggered the Burin tsunami to have occurred four hours earlier, at 3:30:00a.m. on November 18, 1929.

Shown below are sketches of three seismograph records such as might have been generated at the stations shown. Note the time scale markings on each and use them to determine the arrival times for the P- and S-waves at each location and the difference between these. Record the data in Table 2.



For each location, use the travel-time graph produced in Part I to determine the distance of each from the epicentre and record the distance in Table 2. (Hint: Place a piece of paper by the time scale of the travel-time graph and put two marks on the edge at the appropriate time difference. Then bring this piece of paper onto the graph so that the P- and S- graphs just match these marks on the edge of the paper and read off the distance from the scale below as shown.) The time difference between the P- and S- waves will indicate the distance from the source.

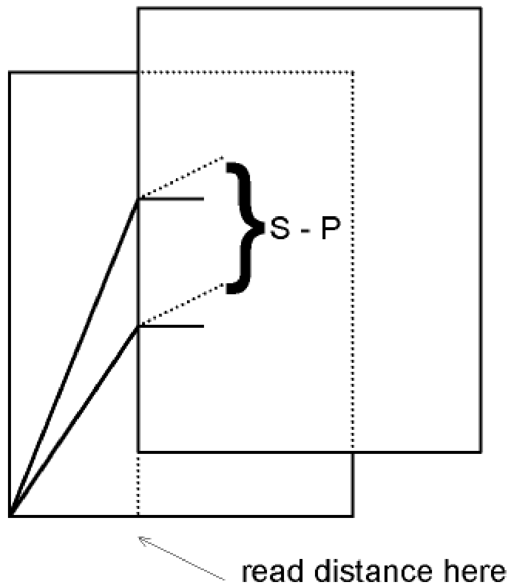
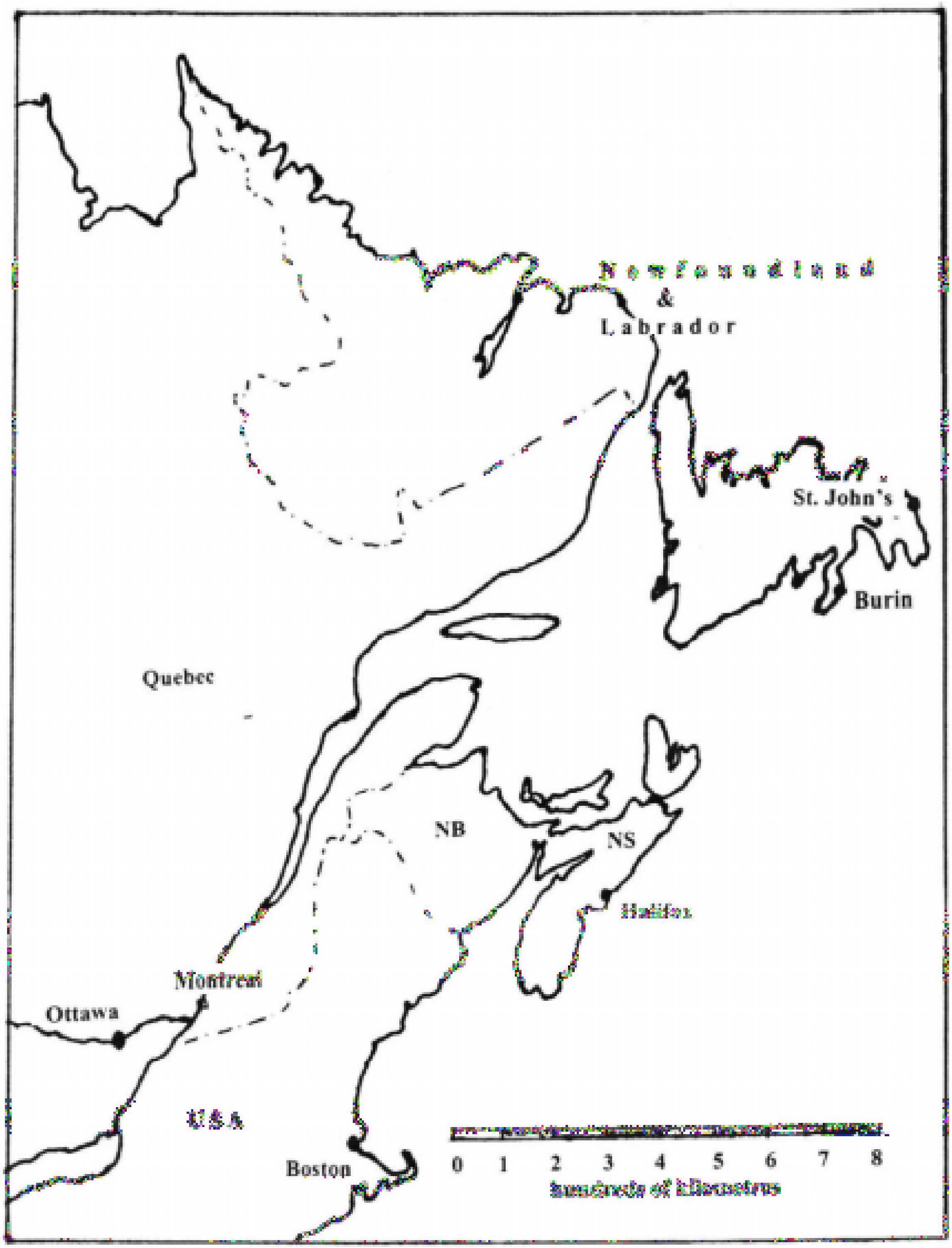


Table 2				
Location	P - Wave	S - Wave	Difference	Distance (km)
Ottawa				
Boston				
St. John's				

Part 3

On the map attached, make arcs from each station at the appropriate distance using the map scale. Use a compass for this. The point where all three intersect is the epicentre of the earthquake.

5. Why are the arcs from two stations alone (e.g. Ottawa and Boston) not sufficient to be sure of the location of the epicentre?
6. Does plotting the data on a flat map introduce some error? Explain.


Newfoundland
&
Labrador
St. John's
Burin
Quebec
NB
NS
Halifax
Montreal
Ottawa
USA
Boston
0 1 2 3 4 5 6 7 8
hundreds of kilometres