I. Objective

1. Investigate relationships between temperature and the melting point of common rocks at various depths within the Earth.

II. Introduction

The *rate* of temperature increase with depth (how fast the temp. goes up as you go deeper in the earth) can be calculated using the following formula:

$$R = \frac{change in temp (°C)}{change in depth (km)}$$

For example, from the surface (0 km) to 25 km depth, the rate of temperature increase is:

$$R = \frac{change\ in\ temp\ (°C)}{change\ in\ depth\ (km)} = \frac{600°C - 20°C}{25km - 0km} = \frac{580°C}{25km} = 23.2°C / km,$$

which means that between 0-25 km, the temperature increases 23.2°C for every kilometer of depth. If this rate of temperature increase continued down to the core, the mantle would be so hot that all rocks would completely melt. We know, however, that the mantle is solid and therefore the temperature must not increase as fast as it does near the surface.

III. Materials

Calculator, colored pencils

IV. Prelab Definitions

1. geothermal gradient

2. magma

3. granite

4. basalt

V. Lab Procedure

Part A: Geothermal Gradient

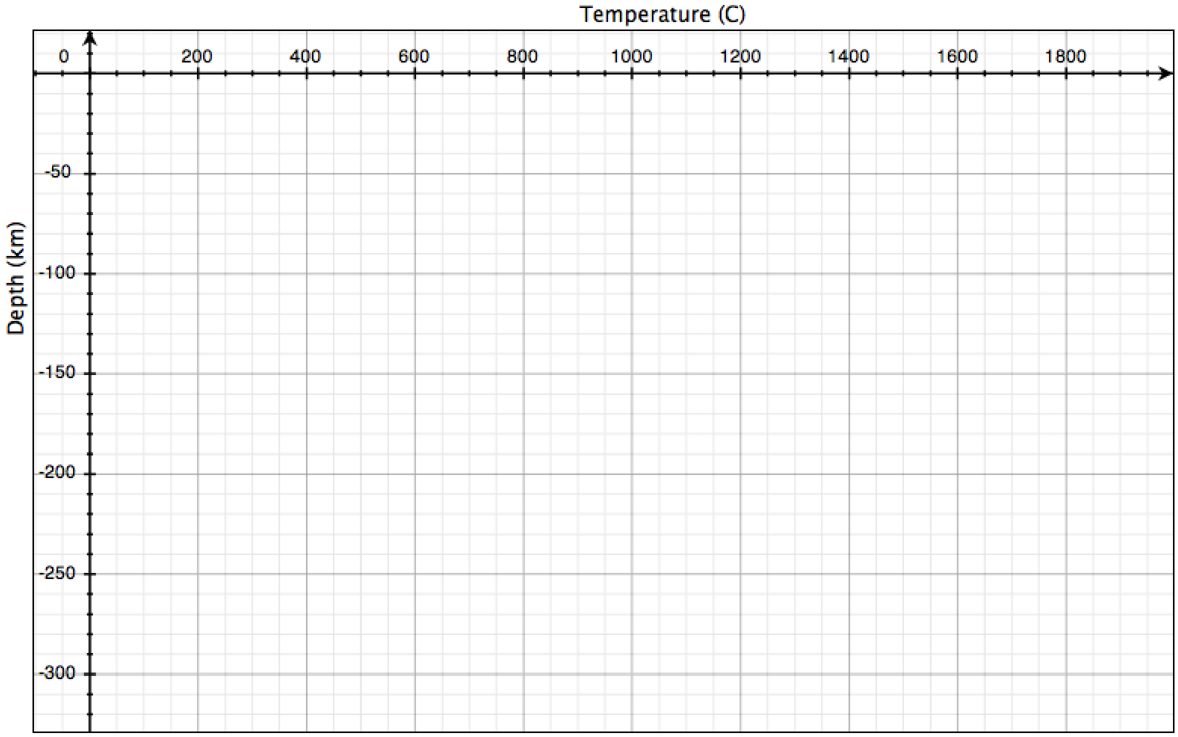
Table 1 provides the temperatures within the Earth at various depths.

1. Graph the temperature values on the graph below with a single color and connect the dots with line segments. Label this line “geothermal gradient”. This curve represents the temperature within the earth as you descend into the crust and upper mantle of either continental or oceanic lithosphere.

Table 1: Geothermal Gradient	
depth in km	temperature in ^{0}C
0	20
25	600
50	1000
75	1250
100	1400
150	1700
200	1800

2. Using the graph, estimate the temperature at the base of the lithosphere if it is 125 km thick. Be sure to include units. Explain how you determined your answer.

3. Using your graph and the table above, determine the rate of temperature increase between 75-100 km, and between 150 km - 200 km. Your answers should be positive and include units in °C/km. Show your work below.



Graph 1: Geothermal Gradient & Melting Temperature

Part B: Melting Temperature of Rocks

The melting temperature of rocks (the temp. required to melt a rock) changes as the pressure increases with depth in the Earth. Table 2 below provides the melting temperatures of granite and basalt.

4. Graph the points, connect the dots, and label each curve (use a different color for each).

Table 2: Melting Temperatures and Depths for Two Common Rock Types			
Granite		Basalt	
depth in km	melting temperature in °C	depth in km	melting temperature in °C
0	950	0	1100
5	700	25	1160
10	660	50	1250
20	625	100	1400
40	600	150	1600

VI. Lab Discussion

1. Based on the melting temperatures above, which type of magma, granitic or basaltic, would you expect to be hotter when it is erupted? Explain your reasoning.

2. Based on your graph, at what depth does granite reach its melting point and form granitic magma? At what depth does basaltic magma reach it's melting point?

3. Will basalt at 50 km depth and 1000°C be solid or partially molten? Explain your reasoning.

4. A piece of basalt at 60 km depth and 1200°C is not melted, but is kept at the same temperature and brought towards the surface to 25 km depth. What happens?

5. Of the three ways to melt a rock discussed in class, which one is occurring here?

6. At what type of plate tectonic setting does this process occur? Explain your reasoning.

7. A piece of granite at 10 km and 600°C is not melted, but is heated to 800°C and kept at the same depth. What happens?

8. Of the three ways to melt a rock discussed in class, which one is occurring here?

9. At what type of plate tectonic setting does this process occur? Explain your reasoning below.

10. The rocks in the asthenosphere (similar to basalt) at 150 km and 1700°C are not molten (because their melting temperature is ~1800°C). If water is added to the asthenosphere, the melting temperature of the asthenosphere rocks is lowered. How much will it have to be lowered to have the same melting temperature of basalt at the same depth?

11. At what type of plate tectonic setting does this process occur? Explain your reasoning below.

Lab courtesy of Dr. Jim Washburne