ES 104: Laboratory # 8
VOLCANISM AND VOLCANIC LANDFORMS

Introduction

Volcanoes are classified into several major types depending on the size and shape of the landform. A *shield volcano* forms a gently sloping dome built of numerous highly fluid lava flows of basaltic composition. A *composite volcano* or *stratovolcano* forms a conical shaped mountain with steep sides composed of interbedded layers of viscous lava and pyroclastic material. The lavas in a composite volcano consist of andesite, dacite, and rhyolite. *Pyroclastic* refers to volcanic ash or any other airborne particles ejected from a volcano. *Cinder cones* are generally steep sided, conical shaped hills primarily composed of pyroclastic material with minor lava flows. The Cascade Range of the western United States contains all three volcanic forms.

During this lab, you will compare two very different volcanic areas – Hawaii and Mount St. Helens. You will make observations, accumulate a database, organize it into tabular form, and make direct comparisons.

Objectives

- Compare the morphology of two different types of volcanoes.
- Determine the tectonic setting of two specific volcanoes.
- Examine volcanic rock types in context of their volcano type.

Useful Websites

- http://hvo.wr.usgs.gov/
- http://www.soest.hawaii.edu/GG/HCV/kilauea.html
- http://www.nps.gov/havo/
- http://vulcan.wr.usgs.gov/Volcanoes/Hawaii/framework.html
- http://www.fs.fed.us/gpnf/mshnvm/
- http://vulcan.wr.usgs.gov/Volcanoes/MSH/
- http://pubs.usgs.gov/gip/msh//

Name________**KEY**______________________

Lab day ______Lab Time______________________

Pre-lab Questions – Complete these questions before coming to lab.

1. What are the differences between cinder cone volcanoes, shield volcanoes, and stratovolcanoes?

Size, slope angle, rock type, tectonic environment, and eruption style

Cinder cones are the smallest, steepest, made of scoria and pumice +/- basalt, formed in continental rifting environments. Their eruptive style is small, shortlived eruptive episodes.

Shield volcanoes are largest, lowest slope angle, composed mostly of basalt flows, and occur in oceanic rifting environments or at mantle hot spots. They are long-lived, with relatively quiet eruptions.

Stratovolcanoes are not as large as shield volcanoes, but significantly larger than cinder cones, their slopes are intermediate in steepness, they contain a variety of rock types including andesite, ash flows, lahars and rhyolite. They occur at convergent continent-ocean and ocean-ocean plate margins. They are characterized by violent eruptions, and may be very long lived.

2. What type of volcano is Mt. Hood? How do you know? What distinguishes it?

Mt. Hood is a stratovolcano. Its size, steepness and character of deposits is distinctive. Its location at a convergent margin also is a distinguishing feature.

3. What is the difference between a pyroclastic volcanic deposit and a lava flow?

Pyroclastic material was blown into the air, in contrast to a flow of molten material over the surface.

4. What is the difference between volcanic ash and lapilli?

Size: ash is extremely fine, lapilli is more walnut sized.

5. Define viscosity and explain how it relates to lava flows?

Viscosity is the resistance to flow. Lavas high in silica are resistant to flow. Lavas low in silica flow much more readily.

6. Do all volcanoes erupt in the same way and have the same shape? Why or why not?

NO!, due to the difference in viscosity of the lava, that depends on the chemistry of the magma.

Part A – Tectonic Environment

Volcanoes occur in a variety of tectonic settings. In this activity, you will examine the tectonic setting of the Hawaiian volcanoes and Mount St. Helens. Study the National Geographic map entitled **"The Earth's Fractured Surface"** to compare the tectonic settings of the volcanic areas. Consider the following information and complete the comparison chart below:

a. Type of crust on which the volcano occurs (oceanic or continental)
b. Name of plate on which the volcano occurs
c. Proximity to plate boundaries (along plate margin or intraplate)
d. Relation to other volcanoes in the area (isolated, in middle of chain, at end of a chain, in center of a wide volcanic area)
e. Summarize the plate tectonic setting

Table 1: Tectonics comparison chart.

Points of	**Hawaiian Volcanoes**	**Mt. St. Helens**
a) Type of Crust	**Oceanic**	**Continental**
b) Plate	**Pacific**	**North American**
c) Proximity to Plate Boundaries	**Intraplate**	**At convergent margin**
d) Relation to other volcanoes	**At end of linear chain of successively older volcanoes**	**Amidst broad chain of coeval volcanoes**

Part B – Topography

Volcanoes are classified based on their topographic expression. This activity focuses on the topography on Mauna Loa, on the island of Hawaii, and Mount St. Helens. Figure 2 shows topographic maps of each volcano drawn at the same scale. Construct topographic profiles of both volcanoes on Figure 1. (A-A' of Mount St. Helens, and B-B' of Mauna Loa). Place the peaks of the volcanoes near the center of the horizontal axis.

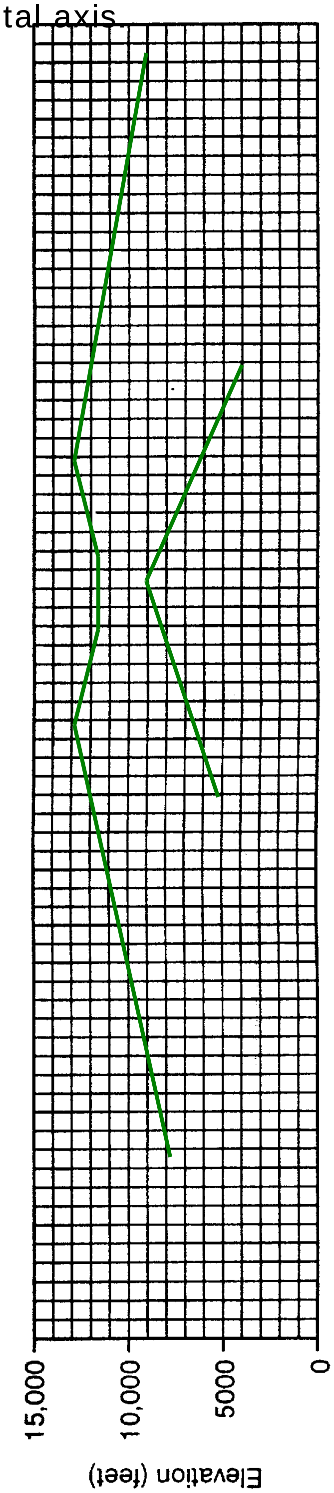

Figure 1: Grid for constructing topographic profiles.

(A)

(B)

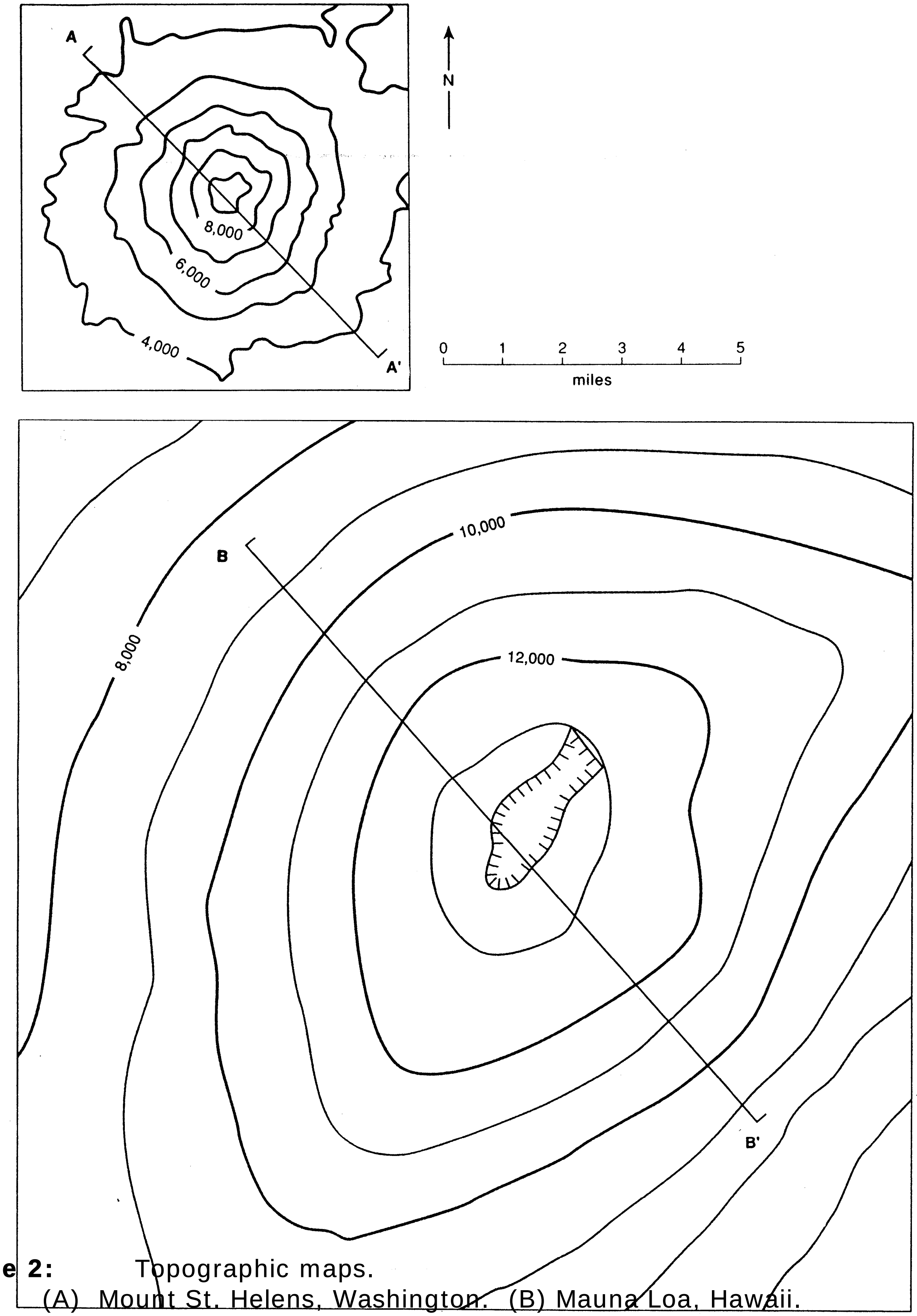

Figure 2: Topographic maps.
(A) Mount St. Helens, Washington. (B) Mauna Loa, Hawaii.

Study the topographic similarities and differences between shield and composite volcanoes. Consider the following information for each volcano and complete the comparison chart below.

a. Describe the morphology of the volcano (shield, composite cone, or cinder cone).
b. Measure the distance across the volcano shown map view (Fig. 2).
c. Determine and record the maximum elevation
d. Relief of volcanic peak above the surrounding topography (the sea floor surrounding Hawaii averages 16,000 ft below sea level)
e. Calculate the slope of the volcano (vertical change in elevation/horizontal map distance). Use profile and map information, not relief determined in part d.
f. Determine the area under each profile (Assume each block on the graph represents approximately 1 million ft^2)

Table 2: Topography comparison chart.

	Points of Comparison	**Hawaiian Volcanoes**	**Mt. St. Helens**
a.	**Morphology of Volcano**	Shield	Composite
b.	**Distance across Volcano**	13 miles	7 ½ miles
c.	**Maximum Elevation**	13,000 feet	9,000 feet
d.	**Relief of Volcano**	4000 feet on profile 13000 ft-9000 ft	5000 feet on profile 9000 ft-4000 ft
e.	**Slope use relief÷ ½ distance acrs.**	615 ft/mi. 4000 ft/6.5 mi	1333 ft/mi. 5000 ft/3.75 mi.
f.	**Area under profile**	By eye	About ¼ of Hawaii on profile drawn

Show calculations (or formulas) with units in chart or below...

Part C –Rock Types and Deposits

The different types of volcanoes produce different rock types and deposits. By studying the rock types and volcanic deposits, one can determine information about the volcano that produced them. Study examples of various samples from each type of volcano. Describe the samples in terms of texture and composition, provide the correct rock name, and interpret the origin of the samples.

Table 3: Sample comparison chart.

Sample	Texture	Composition	Rock Name	Origin
#5	Fine grained Porphyritic	Intermediate	Andesite	Composite: Mt. St. Helens
#6	Vesicular, fine grained porph	Mafic	Basalt	Mantle source: Hawaii
#7	Glassy, frothy	Felsic	Pumice	Mt. St Helens
#9	Vesicular, fine grained	Mafic	Scoria	Hawaii

Study the geologic maps of Kilauea and Mount St. Helens on the next page (8-8). Compare the following attributes of the volcanic deposits of Kilauea and Mount St. Helens and complete the comparison table (Table 4) on page 8-8.

a. Observed composition or compositional range for each volcano.
b. Type and range of deposits produced.
c. Apparent lava viscosity.
d. Relative volume of deposits produced.
e. Surface area affected by primary volcanic deposits.
f. Inferred plumbing system (single conduit, fissures, or both)

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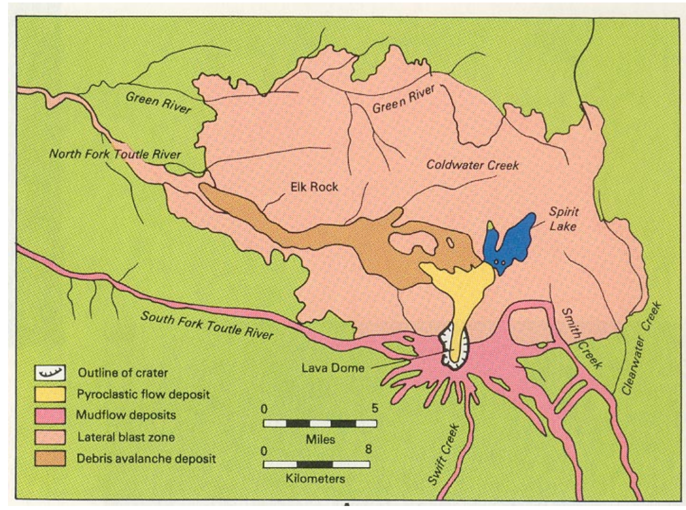

Geologic map of Kilauea: Brown areas are lava flows formed since 1900. Black areas are pyroclastic deposits.

Geologic map of Mt. St Helens Deposits formed from 1980 eruption.

Figure 3: Simplified geologic maps showing volcanic deposits formed around Kilauea and Mount St. Helens since 1900.

Table 4: Volcanic rock types and deposits comparison chart.

Points of	**Hawaiian Volcanoes**	**Mt. St. Helens**
Observed Compositions	Basalt	Andesite
Type and Range of Deposits	Lava and pyroclastics	Pyroclastics, mudflows, debris avalanche
Apparent Lava Viscosity	Fluid, low viscosity	Explosive, high viscosity
Relative volume of deposits	Much more lava than pyroclastics	Mostly debris avalanche as shown on map

Surface area affected	Small area	Larger area
Plumbing system	Magma plume from mantle hot spot	Rising magma bodies from convergent margin

Name______Key______________________

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POST LAB ASSESSMENT

1. Using differences in lava viscosity, explain why the diameter of Mauna Loa is much larger than the diameter of Mount Saint Helens.

The fluid (low viscosity) basalt lava at Hawaii can flow for long distances, resulting in a much wider volcano than Mt St Helens, which has very viscous lava that is highly resistant to flow.

2. Explain the relationships of lava viscosity, lava composition, and volcano morphology relative to one another.

See above, and consider that the silica content is roughly proportional to the viscosity: high silica—high viscosity, low silica—low viscosity

3. Suppose 200 million years in the future, that the solidified magma chambers beneath Mauna Loa and Mount Saint Helens became exposed at the surface. What rock(s) would most likely make up the Mauna Loa magma chamber? What rocks would the Mount Saint Helens magma chamber contain?

Deep solidified magma chambers are composed of intrusive rocks. Hawaii is composed of basalt. Its magma is mafic. The intrusive equivalent of basalt is gabbro. Hawaii's magma chamber would probably be gabbro.
Mt St Helens has intermediate composition of lava. Its magma chamber would probably be diorite or granodiorite.