Lab 8: Volcanic Hazards

Many kinds of volcanic activity can endanger the lives of people and property both close to and far away from a volcano. Most of the activity involves the explosive ejection or flowage of rock fragments and molten rock in various combinations of hot or cold, wet or dry, and fast or slow. Some hazards are more severe than others depending on the size and extent of the event taking place and whether people or property are in the way. And although most volcano hazards are triggered directly by an eruption, some occur when a volcano is quiet.

As a result of the devastating (and unexpected) effects from the catastrophic eruption of Mount St. Helens in 1980, a series of research studies were initiated to focus on the potential hazards associated to Cascade volcanoes.

One of the areas identified as high risk is that of Mount Rainier, the highest peak in the Cascade Range (14,410 feet). One of the reasons for the detailed studies prepared for this area is its high population and, therefore, increased hazard risk.

Because of its height, it holds more glacier ice than any other Cascade volcano, which poses an added hazard as a source of water for volcanic mudflows, known as lahars. These, together with tephra (ash), constitute the greatest volcanic hazard in the area.

Other volcanic hazards are: ballistic projectiles, pyroclastic flows, lava flows, volcanic gases, debris avalanches, and lateral blasts. These, however, are mainly restricted to the area immediately surrounding the volcano (area in gray on map), and would not extend to the areas that are heavily populated. Lateral blasts, however, can affect an area beyond the volcanic cone, but only in the direction of the blast (such as in the 1980 eruption of Mt. St. Helens, when it was directed only towards the north).

Because of the potential hazard of lateral blasts, we will consider them first before dwelling on the two main hazards, lahars and tephra.

Lateral blasts

As the magma moves its way to the surface, it will move in the path of least resistance. Usually this is upwards, but, occasionally, the pressure can be reduced on one of the sides of the volcanic cone, and the magma will expand in that given direction. In the case of the 1980 eruption of Mt. St. Helens, the northern slope was weaker than the others, and a sequence of landslides removed enough rock to allow the magma to burst out in that direction, leveling the landscape for over ten miles in that direction.

These explosions are known as lateral blasts. They are, fortunately, relatively predictable because the flank of the volcano that is going to explode will start swelling and this can be monitored and measured. As the tilt of the surface begins to increase at a rate much higher than usual, the eruption is imminent.
Analyze the hazards map for Mt. Rainier. In which direction would a lateral blast affect the most people?

Tephra

Volcanoes in the Cascades typically produce vertical plumes of hot gases mixed with pyroclastic material, known as tephra. With time, the tephra will be carried downwind and fall to produce a deposit that covers a broad area. Tephra deposit thicknesses and particle sizes usually decrease with increasing distance to the volcano. Clouds of fine tephra (ash) can block sunlight and are a hazard to breathing. Residents from communities affected by ash from the 1980 Mt. St. Helens eruption found accumulations of ash of over \( \frac{1}{4} \) inch to be a major inconvenience. (See Figure 1).

Mt. Rainier is a moderate tephra producer relative to other Cascade volcanoes. The following figure shows its tephra-producing eruptions for the last 10,000 years.

What is the average (mean) time interval between eruptions for the last 10,000 years?

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\text{Mean Time} = \frac{\text{# of years}}{\text{# of eruptions}}
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How representative of reality is this value?

By analyzing the distribution of tephra deposits from these previous eruptions, it would appear that about 1 inch of tephra cover can be expected as far as 40 km from the summit in the downwind direction.

Draw an ellipse on the handout map showing the expected 1-inch thick tephra distribution for a future eruption during a day of usual (most common) wind direction. Use Map #2.

Does this seem to pose a threat to the populated areas?

Certain days, however, the wind could actually blow in the direction of the closest highly-populated area, Tacoma.

Would you expect to have more or less than an inch of tephra in Tacoma?
For what percent of the year could this happen?

LAHARS – Use Figure 3 (colored map)

These mudflows look and behave much like flowing concrete. They can travel at speeds of up to 60 mph, especially on steeper slopes. They damage or destroy most structures in their path by impact or burial. Their paths are strongly controlled by topography, therefore, areas of low topography (river valleys, plains) close to the volcano are at the highest risk of being affected by these flows. They may or may not be generated by an eruption. Simple ground failure (landslides) may initiate one, such as the Electron mudflow 600 years ago that deposited over 100 feet of sediment in the Puget Sound lowlands.

Circumstances conducive to the occurrence of future lahars (including substantial volumes of rock, substantial topographic relief, great volumes of ice, and the potential of renewed volcanism) are all present at Mount Rainier. Thus, lahars are a greater threat to communities down valley from Mt. Rainier than any other volcanic phenomenon.

For the purposes of lahar hazard assessment, past lahars were studied and classified into 3 categories (Cases): 1, 2, and 3 (in order of decreasing size and increasing frequency).

The largest lahar to occur in the past 10,000 years had deposits cover an area of approximately 212 square miles in the Puget Sound lowlands, extending north to Auburn, Washington.

The smallest lahars (Case 3 flows) are the most frequent.

- How often do these Case 3 lahars happen? Do they affect populated areas?

Moderate to large lahars (Cases 1 and 2) occur less frequently, but can affect larger areas. These flows can extend all the way to Puget Sound.

- Does the land use of this area seem to take this into consideration? Explain.

- Which town would you choose to live in if you got a job in Tacoma and relocate to the area? Explain your choice.
MAP #2
Figure 1. Tephra fallout and deposition.
Figure 3.—Hazard zones for lahars, lava flows, and pyroclastic flows from Mount Rainier (Hoblitt and others, 1998; US Geological Survey Open-File Report 98-428).