**Mount Rainier**

1. Mount Rainier National Park is located about a hundred miles southeast of Olympic National Park and about 50 miles north northeast of Mt. St. Helens. It is even closer still to Tacoma, Washington – a city of about 200,000 people who are well within the radius considered at risk when this volcano erupts again.
2. Looking north from Mt. Saint Helens we can see Mt. Rainer protruding majestically above the snow level …
3. … to an elevation of 14, 411 feet …
4. … making it the highest mountain in the Cascade Ranges. Following this lesson on Mt. Rainier, we will examine two other volcanoes in the Cascades – Crater Lake and Mount Lassen.
5. Although all of the Cascadian volcanoes formed from magma generated by the subduction of the Juan de Fuca Plate beneath the North American Plate,
6. … Mount Rainier has several characteristics that set it apart from the rest of the Cascadian volcanoes. First up, the volcanic rocks here rest atop granodiorite bedrock. This indicates that before Mt. Rainier formed; some pre-existing volcano was uplifted and eroded, exposing its plutonic roots.
7. Second, the composition of this volcano is remarkably consistent. Unlike other composite volcanoes which have a fairly equal ratio of lava to pyroclastics, 90% of Mt. Rainier is comprised of andesite lava flows.
8. Third, at 14,411 feet, Mt. Rainier is unusually high for a Cascadian volcano, although as you can see from projecting upward the slope of less eroded lava flows near its base, the mountain was even higher before erosion. All of these unique characteristics are related. The uniform granodiorite bedrock probably made the formation of a near surface magma reservoir unlikely. Seismic studies do indicate a magma chamber under Rainier, but at about 8 kilometers down it is relatively deep. Without the cooling afforded by a shallow magma chamber, there would be less opportunity for magmatic differentiation to occur and consistently andesitic magma would feed the volcano directly from the zone of wet melting above the subduction zone. Magma consistency is further maintained because the chemical composition of granodiorite is pretty similar to andesite, so partial melting of the wall rocks would not alter the composition of the magma much either. Most of the gas in the andesitic magma would be released in massive Vesuvian-type eruptions which would deposit ash far and wide, leaving relatively little pyroclastic material on the volcano. A long period of effusive volcanism would follow, producing the andesite flows which comprise the bulk of the volcano. Mount Rainier is higher than other Cascadian volcanoes because flows are more resistant to erosion than pyroclastics.
9. Eruption frequency varies considerably across the Cascadian volcanoes. Note the numerous eruptions of Mt. St. Helens over the last 4,000 years. It’s not surprising that Native Americans that have lived in the vicinity of Mt. St. Helens during this period have past-down an awesome respect for the volcano in their tribal legends. The varying eruption frequency indicates that magma formed over subduction zone will have a higher preference for certain well-established conduits to the surface, much in the same way bubbles will reappear in the same spot over and over in simmering spaghetti sauce. Note that Mt. Rainier has a pretty typical eruption frequency relative to other Cascadian volcanoes. Furthermore, it has erupted in the last 200 years.
10. Because Rainier erupted relatively recently, its overall shape is a relatively symmetrical cone.
11. A volcano that has not erupted recently will have a much more irregular shape due do prolonged erosion from streams and glaciers.
12. The longer the period of inactivity, the more magma will harden in the volcano’s conduits, and the more likely the volcano is to become completely extinct.
13. The most recent recorded eruption of Mt. Rainier was between 1820 and 1854, but many eyewitnesses reported sporadic activity between 1858 and 1894 as well. It is only a matter of time before this volcano erupts again, so the associated geologic hazards are taken very seriously in the park.
14. There are even posted evacuation routes.
15. The looming specter of volcanic disaster is particularly ominous in Tacoma, Washington. From this vantage point the enormous amount of gravitational potential energy of the volcano relative to sea level is unsettlingly apparent.
16. The fact that Mount Rainier is well over 14,000 feet high also means that …
17. … the top of Mt. Rainier is glaciated.
18. Indeed, there are more than a dozen named glaciers carving away at Rainier’s summit. Glaciers and volcanic eruptions combine…
19. … to form devastating volcanic debris flows known as lahars.
20. Lahars form when snow and or glacial ice on a volcano …
21. … melt upon contact with a rain of hot, pyroclastic particles …
22. … forming a slurry of rock, ash and water which flows rapidly down the steep slopes of the volcano..
23. Mount Rainier has experienced repeated lahars including this one which devastated the Nisqually Valley …
24. … and deposited this mass of unsorted volcanic debris downstream near Cougar Rock Camp.
25. Another lahar killed these trees in Kautz Creek.
26. Lahars move rapidly with a viscosity similar to wet concrete. This is not a situation that one could outrun or swim free of.
27. Lahars are especially dangerous because they can be lethal at far greater distances relative to other volcanic hazards. The ancient Electron and Osceola lahars flowed more than 40 and 70 miles from Mt. Rainier respectively.
28. This tree stump was buried by the Electron lahar about 500 years ago. With Mount Rainier in the background, this photo gives you a good idea of the long run-out possible for lahars.
29. Fortunately, with a recurrence interval between 500-1000 years, such long run-out lahars are relatively infrequent. Small lahars are much more frequent, and because near the volcano they are just as deadly, they’re probably the greatest volcanic threat to visitors of Mount Rainier National Park.
30. Glacial outburst floods are far more common than lahars, but they are not as far reaching in their effects.
31. Outburst floods at Mount Rainier form from the sudden release of water stored at the base of glaciers or within the glacier ice and are not related to volcanic activity.
32. South Tahoma Glacier has been particularly dangerous in the last two decades - releasing about one outburst flood every year. Floods typically occur during periods of unusually hot or rainy weather in summer or early autumn, apparently because of rapid input of melt water or rainwater to the base of the glacier.
33. Glacial melt water typically has a milky appearance due to the presence of fine, glacially-pulverized particles known as rock flour. This is generally the type of water which comprises outburst floods.
34. The flow of water under the park’s glaciers isn’t all bad. In several places it initiated the formation of ice caves which later where enlarged mainly by air flow through the cave. Although at one time there were over 8 miles of passages mapped and they were considered the longest ice caves on earth, Rainier’s glaciers have melted back considerably, and by one report, only about a hundred feet of the cave remains.
35. Not to be confused with the ice caves are the steam caves, which are formed by fumaroles near the summit crater.
36. Although mostly steam, the volcanic gases emanating from the volcano’s numerous fumaroles are rich in corrosive vapors like sulfuric acid.
37. Such hot, corrosive vapors weaken the volcanic rock near the summit promoting the gravitational collapse of a portion or sector of the volcano.
38. Sector collapse is a threat wherever such hydrothermal alteration has occurred.
39. Although not the most common of Mount Rainier’s geologic hazards, lava and pyroclastic flows are probably the most feared. After all, who wants to burn to death?
40. Narada Falls cascades over one of the ubiquitous andesite lava flows that built Mount Rainier.
41. A closer look reveals columnar jointing formed by thermal contraction. Although this lava was once hot enough to vaporize fresh, the relatively high viscosity of andesitic magma means that anything faster than a snail could probably avoid being overtaken by one of these flows.
42. Pyroclastic flows are different. They originate from coarse pyroclastics that fall near the vent and then tumble down the volcano’s slopes as searing avalanches that can reach speeds of 200 mph.
43. Unlike lahars, the area potentially affected by lava and pyroclastic flows is limited to about 5-10 miles from the summit.
44. Ash falls are the least deadly but most far-reaching of Rainier’s potential hazards.
45. This photo of the 1980 eruption of Mt. Saint Helens’ shows a typical Vesuvian-type eruption blasting ash high into the troposphere …
46. … where the jet stream can carry the volcanic ash for hundreds of miles.
47. Near the volcano ash fallout will obviously be greater …
48. … where the most common hazard is the disruption of ground and air transportation. However, if ash thickness exceeds 4 inches, roofs may collapse.