

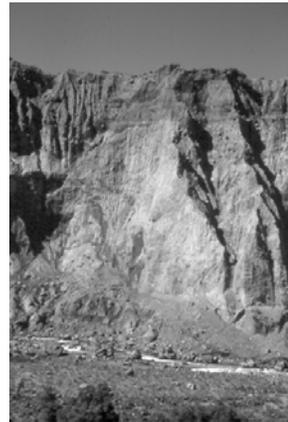
Debris Avalanches

Volcanoes are not very stable structures. From time to time, they collapse producing large rock and ash avalanches that travel at high speeds down valleys.

- Collapse maybe caused by an eruption or an earthquake.
- They can travel up to 50 miles from their source, burying everything in their path.
- First recognized at Mount St. Helens, but now known to be a very common process on all types of volcanoes (Mount Shasta, Hawaii).



Debris avalanche deposits on a volcano in Chile. All of the area in the foreground is buried by a thick debris avalanche.



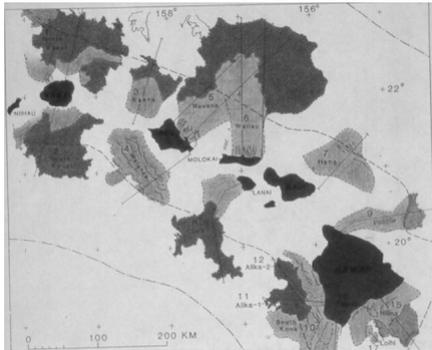
Close - up note the boulders and rubble in the cliff.

Hawaiian Debris Avalanches

[Debris avalanches are not confined to strato-volcanoes, they also occur on shield volcanoes]



Underwater sonar mapping shows debris avalanches extending to great distances from the islands of Oahu and Molokai.



Map showing debris avalanches (brown) associated with all of the Hawaiian volcanic islands (green). Note how they have traveled up to 200 km from their source.



A landslide scarp on the island of Hawaii left by a debris avalanche that occurred less than 200 thousand years ago.

Mud Flows (Lahars)

- Rapidly flowing mixtures of rock debris (often ash) and water originating on the flanks of volcanoes.
- The source of the water may come from:-
 - Melting snow or ice.
 - Crater lakes
 - Heavy rainfall
- Mud flows have the consistency of wet cement
- Travel along valleys at 20-40 mph for up to 200 miles.
- Destroy or bury almost everything in their path.
- They are the second most destructive volcanic hazard (after pyroclastic flows and surges) and are responsible for 27,000 deaths since 1600 A.D.

Pinatubo Mudflows

The large eruption of Mount Pinatubo (Philippines) in 1991 was accompanied by torrential rains. This combination of ash and rain produced numerous mudflows that still occur today after heavy rain.



Geologists watch an active mudflow.



Mudflow near Pinatubo - over 55,000 people were evacuated from around Pinatubo because of mudflows.



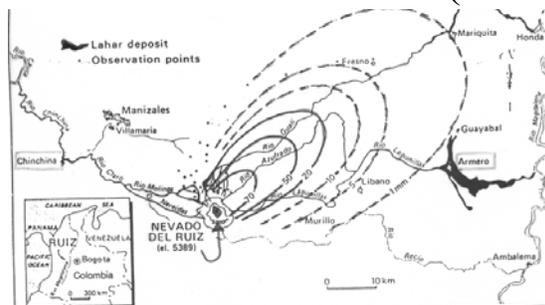
Mudflows, 15 ft,high destroyed the main bridge over this river.



Extensive flooding accompanies mudflows downstream from the volcano.



Nevada del Ruiz (Colombia)



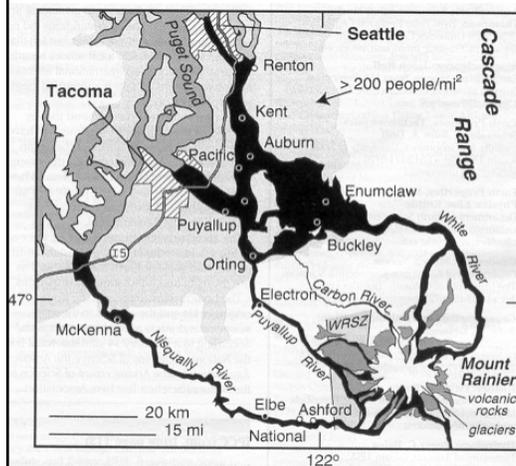
Notice how far Armero and Chinchina are from the volcano.

- Small eruption (November, 1985) produced ash-fall and pyroclastic flows which melted snow and ice producing large devastating mudflows.
- Mudflows (10 feet thick) inundated the towns of Armero and Chinchina killing about 22,000 people and completely destroying the towns.
- The worst volcanic disaster since Mt. Pelée in 1902.

Mudflow Video



Mount Rainier



- Mount Rainier is covered (75%) with snow and ice.
- It has a long history of producing mudflows.
- The Osceola mudflow occurred 5,000 yrs ago, and the Electron mudflow only 500 yrs ago.
- Towns such as Orting and Buckley (and the Puget Sounds Lowland) are in danger from future mudflows.

Mount St. Helens

Mount St. Helens has a long geological history (>3,000 yrs) of explosive eruptions.

The 1980 Events:

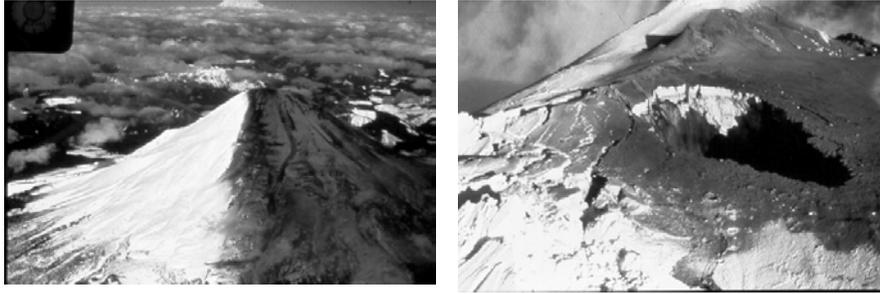
- Initial relatively mild steam and ash (Vulcanian) eruptions.
- Sustained plinian eruption (May 18th) for 9 hours, producing:-
 - Ash fall
 - Debris flow or avalanche
 - Lateral blast
 - Pyroclastic flows
 - Mud flows and flooding
- Continued, intermittent, dome growth, followed by smaller plinian eruptions and pyroclastic flows.



Mount St. Helens in 1971, with Spirit Lake in the foreground.



Mount St. Helens in June, 1980, viewed from the same place.



Steam and ash eruptions continue intermittently through March and April into May, covering the volcano with ash and enlarging the summit crater.

Note - no “juvenile” magma had yet been erupted - just fragmented pre-existing rocks. In other words the volcano was “clearing its throat”!

Continuing Steam and Ash eruptions



By April 12th the summit crater had expanded to 1500 ft long and 1000 ft wide and 900 ft deep.

Development of the bulge

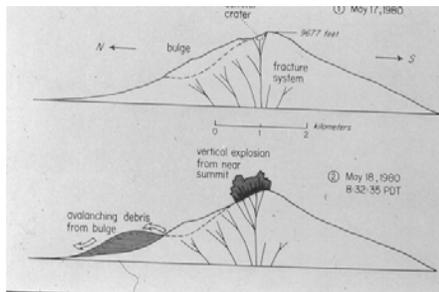


Throughout April and May, the north flank of the volcano began to bulge outwards due to the accumulation of magma at shallow levels.

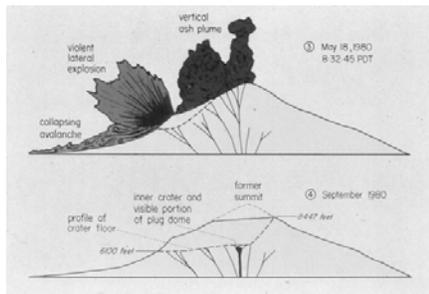


The bulge moved outwards at an astonishing 5 feet/day and by May 17th had moved a total of 320 feet from the pre-March position!

What happens next

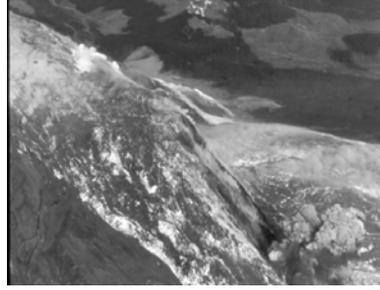
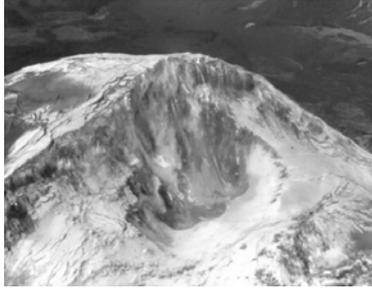


At 8:32 a.m. on May 18th the bulge collapses producing a giant debris avalanche which flowed into Spirit Lake and down the Toutle river valley for 12 miles.



The release of pressure results in a lateral blast and the initiation of a plinian eruption column. Mount St. Helens is now over 1000 ft lower, with a huge crater excavated into the north flank.

Debris Avalanche and lateral blast



A sequence of photos taken by the Stommell's while flying over Mount St. Helens at 8:30 a.m. on May 18th.

Another view of the lateral blast

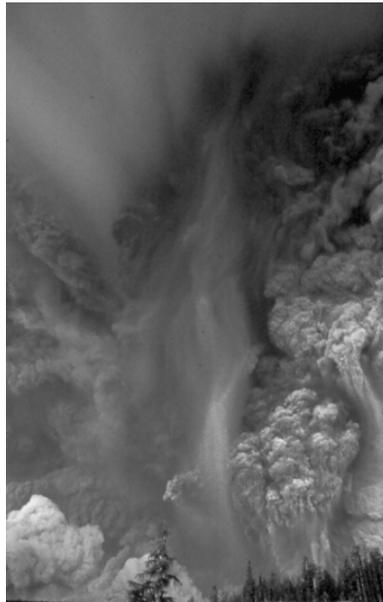
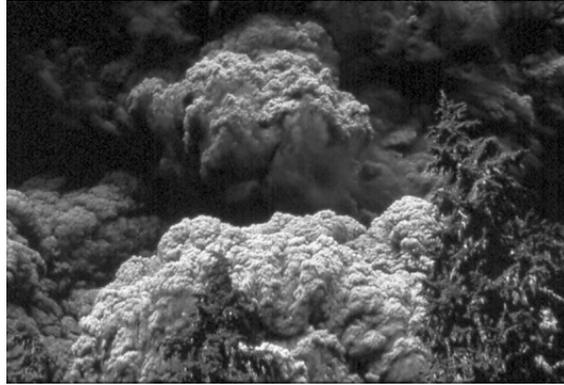
A sequence of photos taken by Keith Runholm











“Vancouver, this is it”

Dave Johnson, 1980

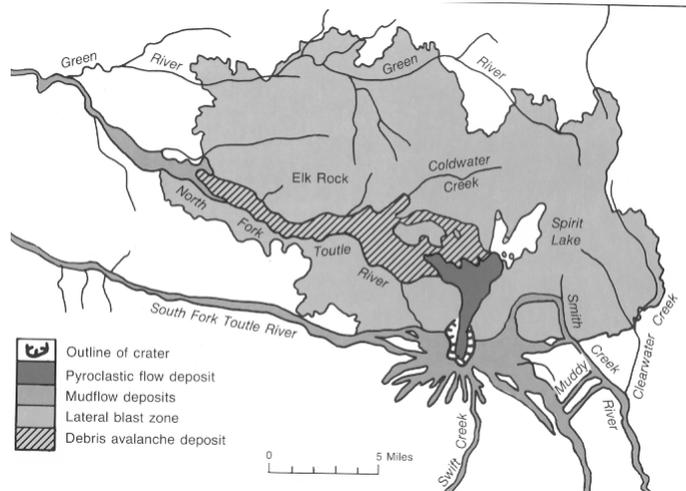


The May 18th Eruption

Within a matter of minutes all of the following processes occurred:-

- Debris avalanche
- Lateral Blast
- Plinian eruption
- Ash fall
- Pyroclastic flows
- Mud flows

Satellite View of Destruction

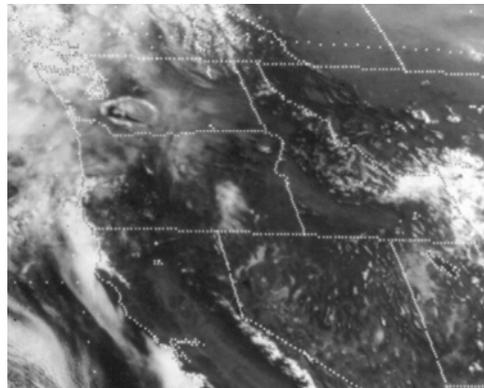


Map showing the effects of the May 18th eruption



The plinian eruption continued for 9 hours, with an eruption column rising to over 24 km in height.

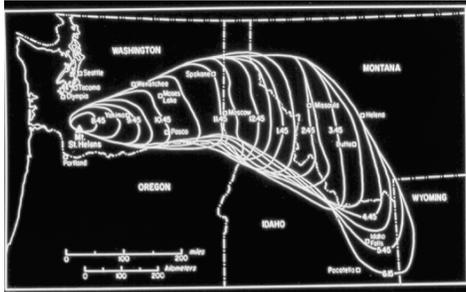
Ash Fall



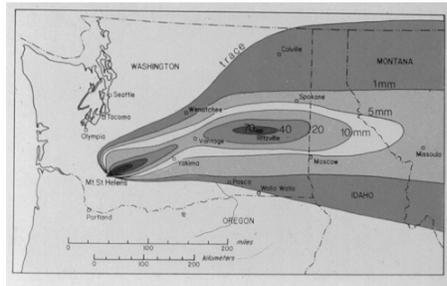
A satellite view of the beginning of the eruption



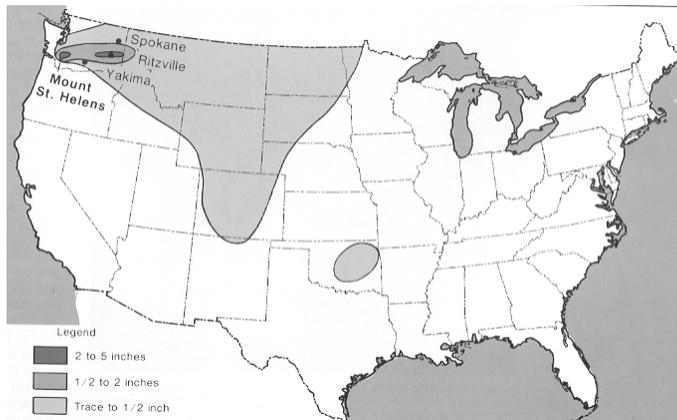
Ash clouds spread over central Washington



Map showing the eastward movement of the ash cloud.



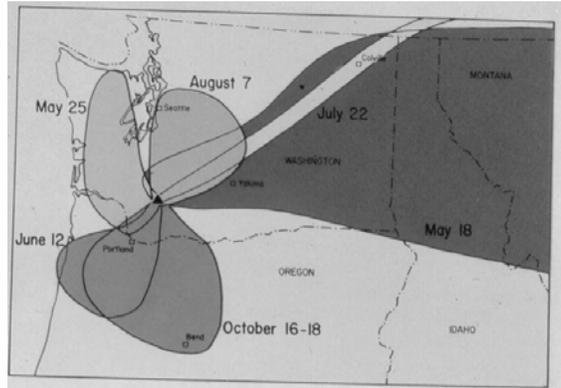
Isopach map of the ash deposits from the May 18th eruption.



Distribution of ash over the western United States

Ash Fall Video





Following the May 18th eruption, there were five subsequent (but smaller) eruptions that deposited ash in Washington and Oregon.

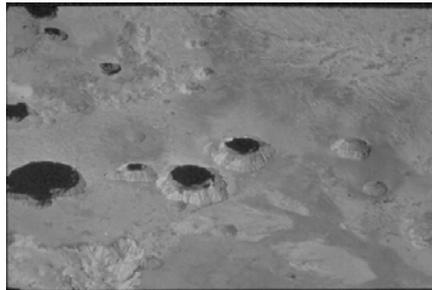
Debris Avalanche Deposits



Debris avalanche deposits in the north branch of the Toutle River. The avalanche traveled 12 miles from the volcano. Here they are 60 ft thick, but are 500 ft thick closer to the volcano,



Thick debris avalanche deposits, covered by mudflow deposits and cut by subsequent erosion.



There are water-filled craters in the avalanche deposits, produced by the interaction of blocks of ice with hot rocks and ash.

Effects of the Lateral Blast



Spirit Lake before the eruption, April, 1980.

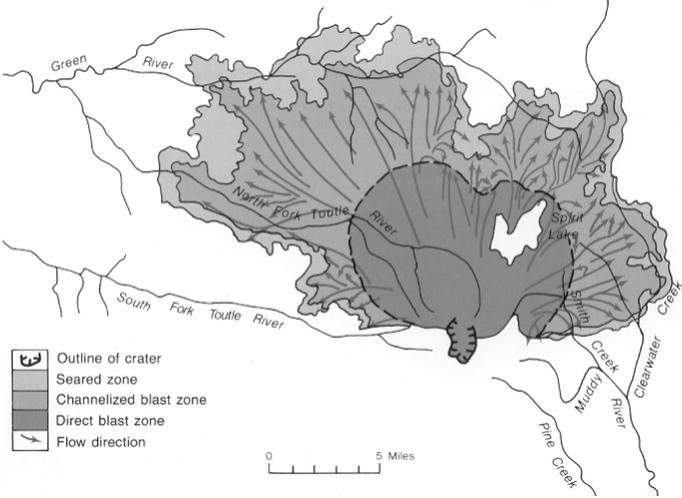


Spirit Lake after the eruption, June, 1980. Note the complete lack of trees!



Mount St. Helens, before and after the May 18th eruption.

The Extent of the Lateral Blast

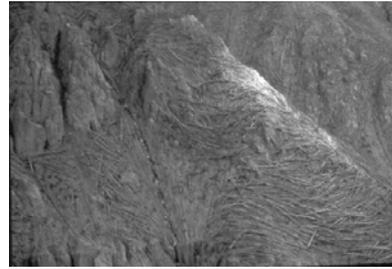
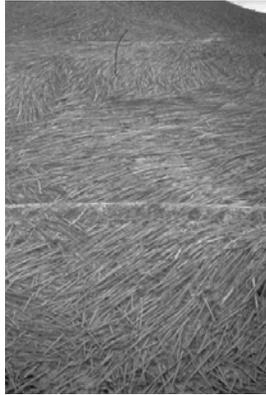




Nothing survived within the inner blast zone.
Trees were uprooted, snapped off and carried
away.



More views of the
inner blast zone.



Blowdown area in
the outer blast zone



Overview of tree damage from
15 miles NW of the volcano.

In the foreground are live
trees, with standing dead trees
(killed by hot gases) beyond.
In the middle distance is the
blowdown zone, with the blast
zone beyond that.

Mudflows



View from the south at 11:00 a.m. Note the pyroclastic flows (dark streaks). To the right are active mudflows traveling into the Pine Creek drainage.



Active mudflows running into the Swift River drainage.



Active mudflow flowing over debris avalanche deposits in the Toutle River valley.



Mudflow deposits, Toutle River valley

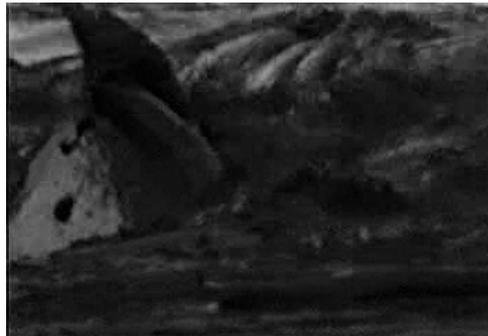


Mud on trees, about 8 ft above ground, indicating the depth of the flow.



House dissected by mudflow in the lower Toutle River valley

Mount St. Helens Mud Flows



Pyroclastic Flows



Pyroclastic flows occurred during the 9 hour plinian eruption on May 18th. They also occurred during subsequent eruptions. This one is on July 22nd. Note the cloud from the pyroclastic flow in the foreground.

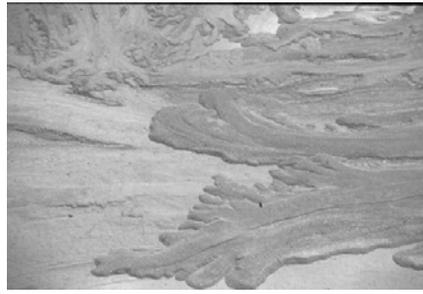
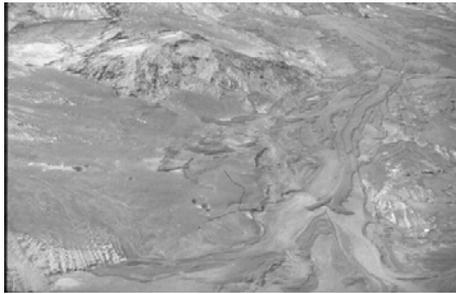
Pyroclastic Flow Deposits



Pyroclastic flow deposits flowing out of the crater towards Spirit Lake

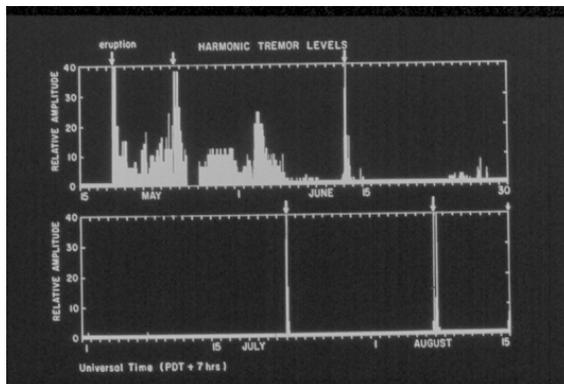


Note avalanche deposits beneath the pyroclastic flows



Details of pyroclastic flow deposits.

Dome Growth and Subsequent Eruptions

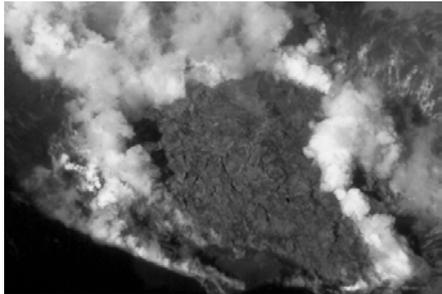


May 25th
June 12th
July 22nd
August 7th
October 16th

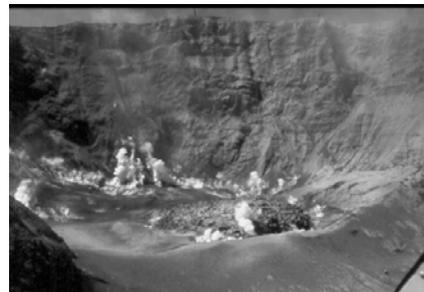
Following the May 18th eruption, there were five subsequent eruptions. Each was preceded by distinct bursts of seismic activity (harmonic tremor) as shown above.



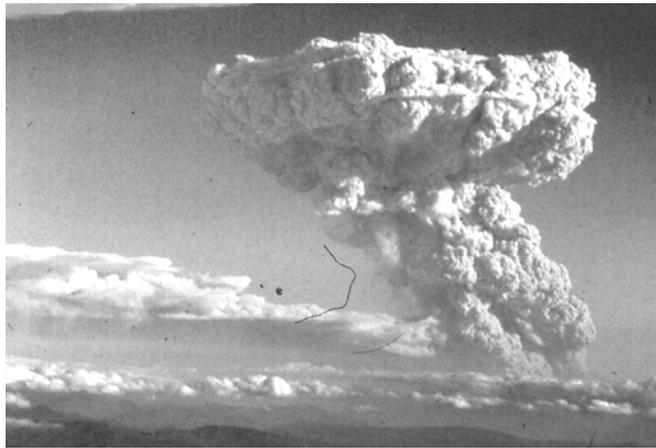
The first dacite lava dome formed after the June 12th eruption. Steam rises from the dome.



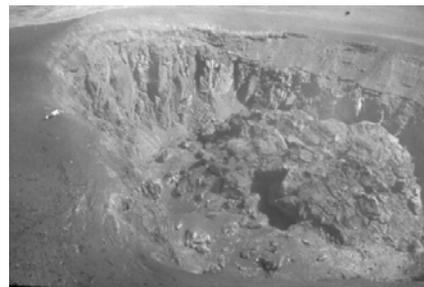
Aerial view of the June 12th dacite dome.



More views of the June 12th dome.



The July 22nd eruption destroyed the June 12th dome. A new dome begins to grow. View from Seattle.



Views of the July 22nd dome (note helicopter for scale)

Subsequent Continuing Activity

After 1980, the dacite dome continued to grow, slowly filling the crater. It is still growing today.



May, 1983 - small
steam blast eruption



The dome in 1991