

CATAclySMIC ERUPTIONS

The really big ones!

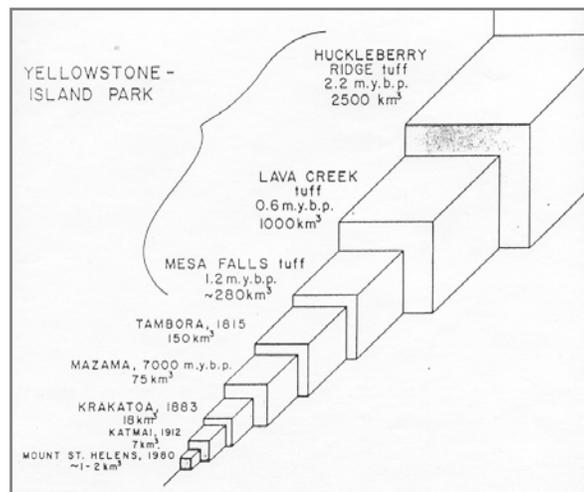


This figure compares the size of some recent, well-known eruptions.

Note how small the eruptions of Mount St. Helens and even Vesuvius are compared to Katmai, Krakatau and Tambora.

Within the very recent geological past, there have been extremely violent explosive eruptions several orders of magnitude greater in size than any historical eruptions:-

	<u>Date</u>	<u>Volume Km³</u>
Mount St Helens	1980	2
Pinatubo	1991	8
Krakatoa	1883	18
Santorini	1628 BC	39
Crater Lake	6845 BP	75
Long Valley	700,000 BP	600
Yellowstone	2 million BP	2500



These volcanoes have erupted vast volumes of rhyolite - dacite ash and pyroclastic flows. Some are still potentially active and could very well erupt again (Yellowstone, Long Valley, Rabaul, Pozzoli).

Calderas

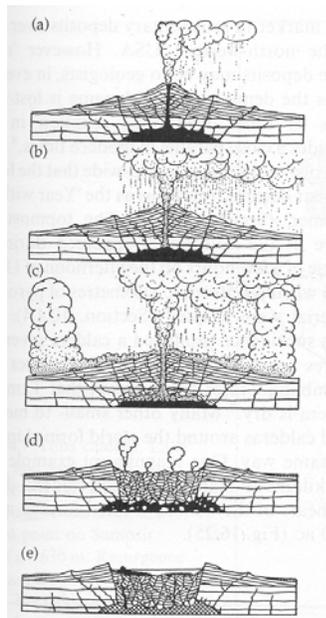
- Calderas are large elliptical volcanic depressions (2 – 80 km in longest dimension).
- They occur on all types of volcanoes
- Almost all of the large silicic eruptions are associated with calderas.
- Early debate on whether they were formed by explosions or collapse.

There are two basic types:-



- I. Volcanoes that have completely blown themselves apart, and then collapsed, leaving a huge crater in their place.

Crater Lake, Oregon	75 km ³
Santorini, Mediterranean	39 km ³
Krakatau, Indonesia	20 km ³



Classic interpretation of how “Crater Lake” type of calderas form (Williams, 1941). Initial plinian eruption (a,b) is followed by pyroclastic flows (c). Withdrawal of magma from magma chamber leaves volcano unsupported, resulting in collapse to form caldera (d). Subsequent volcanic activity occurs within the caldera (d,e).

Crater Lake (Mount Mazama)

- Started life as a typical stratovolcano about 400 ka.
- Erupting andesites to dacites.
- At least 5 successive overlapping volcanic cones.
- Activity continued to about 40 ka (with glaciation at 75 ka).
- Height of volcano estimated at about 11,000 ft.
- Surrounding Mt Mazama are monogenitic basaltic cones.
- Silicic magma (rhyodacite) system developed about 40 ka erupting domes and flows from radial vents until about 7 ka.
- Plinian eruption on N. flank produced extensive ashfall.
- Column collapse produced pyroclastic flow (Wineglass Tuff) along valleys to north.
- Caldera collapse led to eruption of copious compositionally stratified pyroclastic flows (Ring Vent Stage).
- Postcaldera eruptions of andesite (Wizard Island and Merriam cone).

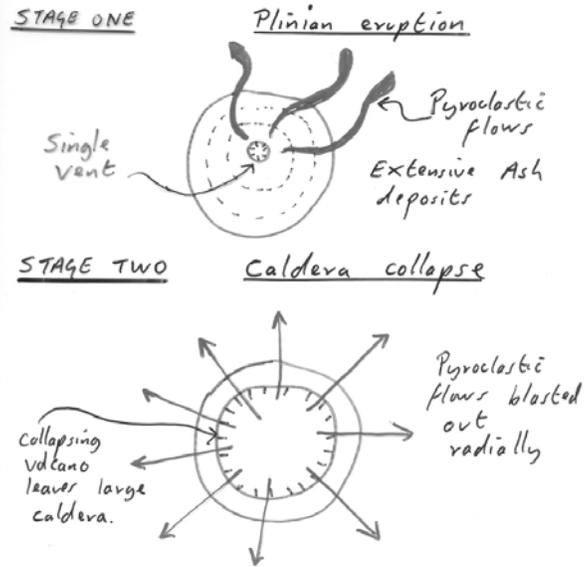


Sketch Map of Crater Lake (Mt Mazama).

Lao Rock (rhyodacite erupted about 7,000 yrs

Cleetwood Flow was still molten during climactic eruption at 6,845 B.P.

Crater Lake, Oregon (6,845 B.P.)

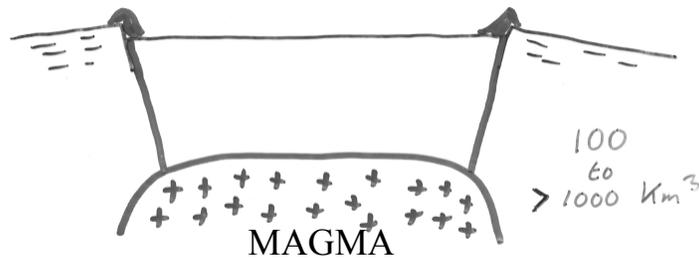
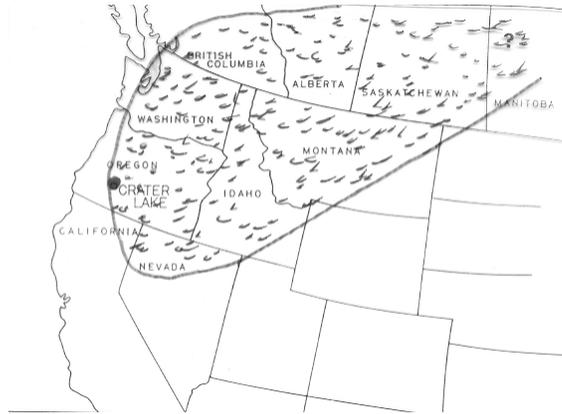


Crater Lake from the air. Diameter about 6 miles.



Crater Lake with Wizard Island

Map showing the aerial extent of Crater Lake ash fall, which blanketed all of the Pacific Northwest and extended into Canada.



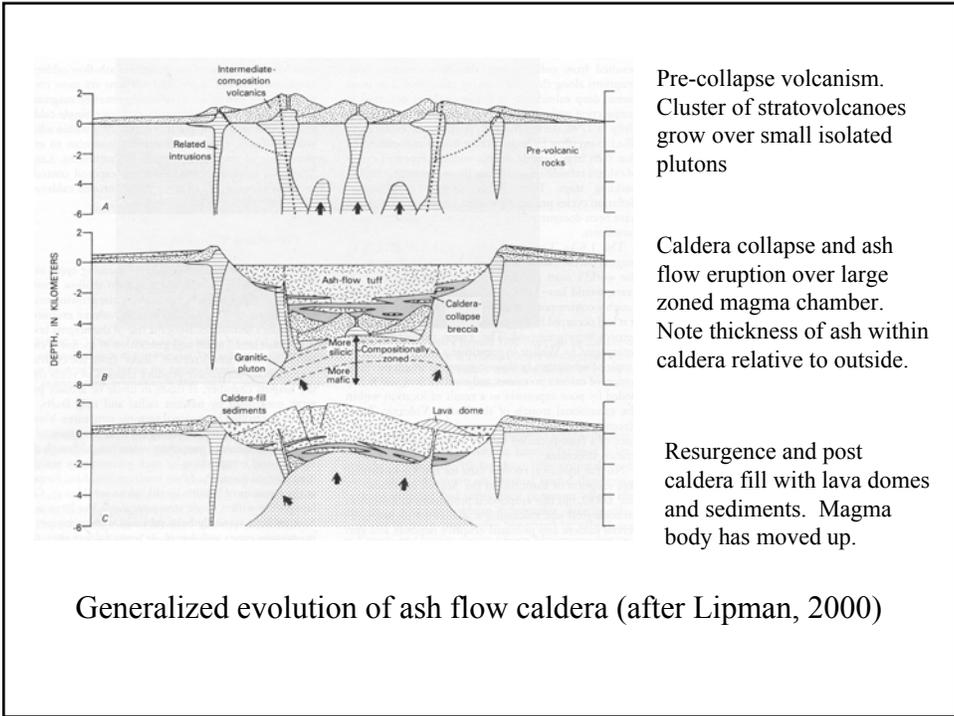
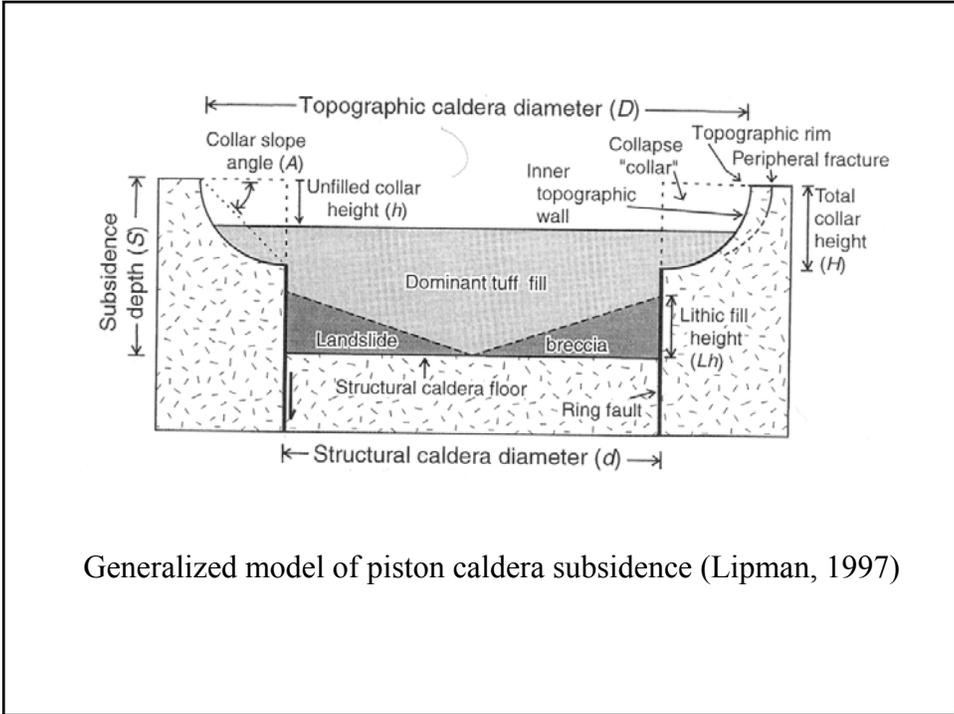
II. Huge elliptical depressions (calderas) above a very large magma reservoir.

Long Valley, USA

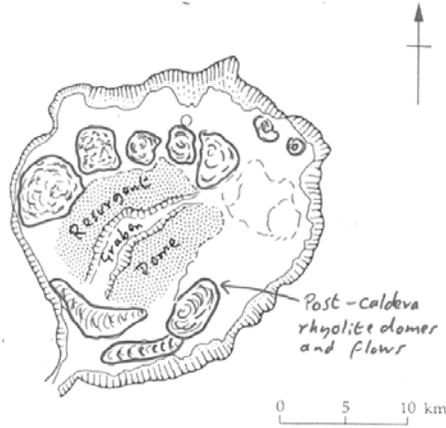
Yellowstone, USA

Rabaul, Papua, New Guinea

Pozzoli, Italy

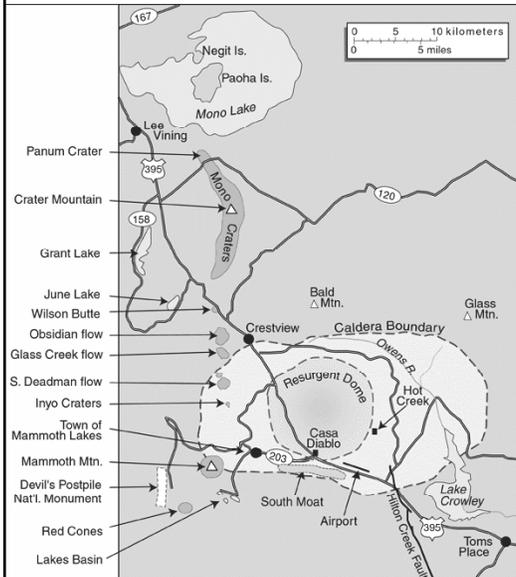


Resurgent Calderas (Valles Type)



Renewed rise of magma results in doming of the central part of the caldera (resurgence). Often, post-caldera flows and domes, together with volcanoclastic sediments, begin to fill the surrounding moat.

Long Valley, California



Caldera (15 x 30 km) formed some 760,000 years ago, following massive outpouring about 600 km³ of ash and pyroclastic flows (Bishop Tuff).

Most recent volcanic activity (rhyolite flows and domes) was about 250-600 years ago.

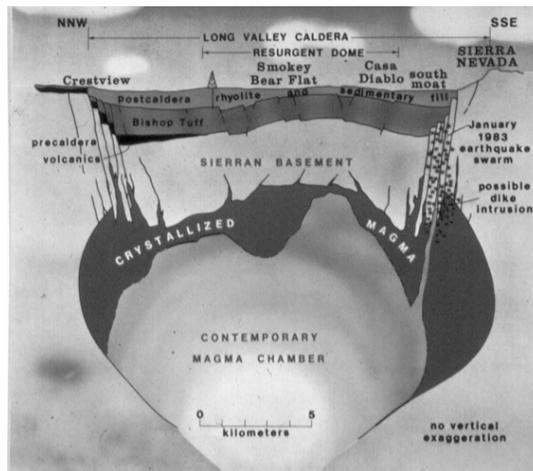
Recent seismic activity and 25 cm uplift of the resurgent dome, caused anxiety in the 1980's.



Views of the huge depression of the Long Valley Caldera

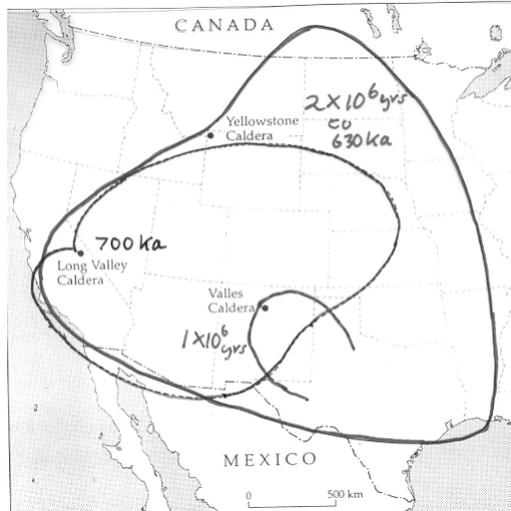


Rhyolite flows and domes constitute the most recent eruptions about 250 -600 years ago.



Schematic cross-section beneath Long Valley Caldera. Note the huge inferred magma chamber. The caldera, initially 2-3,000 ft deep was filled by pyroclastic flows and lava flows. The xx's mark the location of 1983 seismicity.

Distribution of ash from Yellowstone, Long Valley and Valles calderas



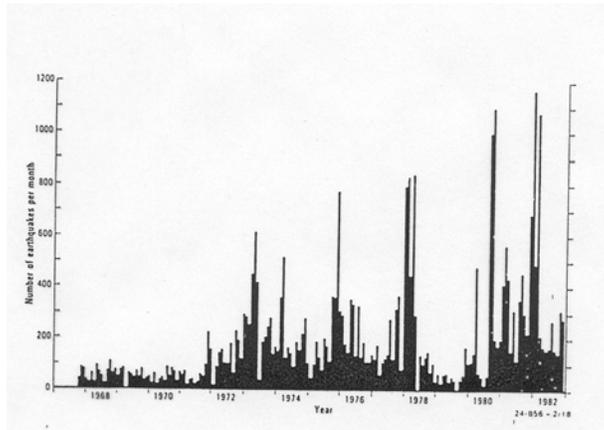
Yellowstone ———

Long Valley ———

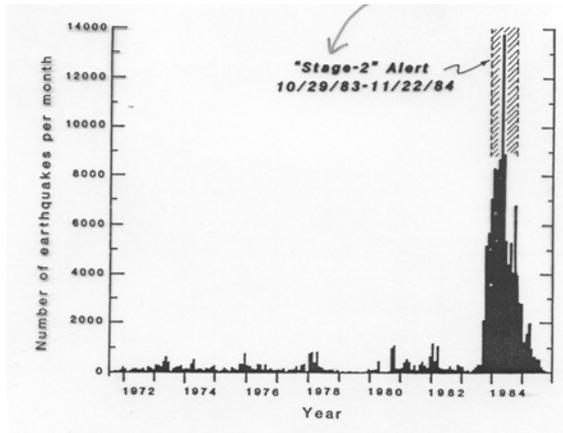
Valles ———

Can this type of eruption occur today?

- All of these eruptions have occurred within the last 2 million years.
- Some, within the last 10,000 years.
- There is no reason to believe that they can't happen again.
- In fact, there have been three examples of "caldera unrest" in the 1980's (Long Valley, Rabaul, Pozzoli).
- The problem is we have no idea what to anticipate.

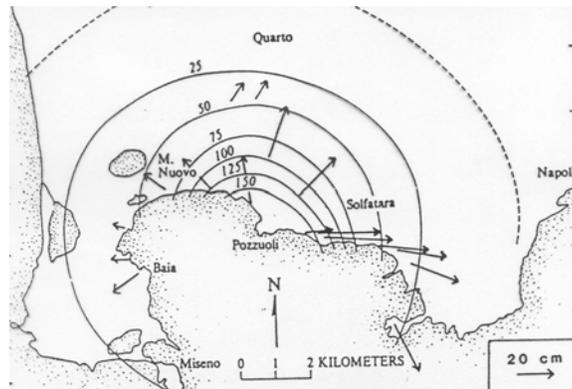


Monthly earthquake activity at Rabaul. Note increase in activity starting in August 1971.



The seismic activity accompanied the uplift, but increased dramatically between Sept. 1983 to July 1985, reaching a maximum rate of 13,000 quakes/month in April, 1984. Then everything settled down, with an eruption occurring in 1994.

Pozzuoli, Italy



This caldera formed with a giant eruption about 35 thousand years ago, producing 80 km^3 Campania Tuff. Between 1982 and 1984 the caldera started to uplift, accompanied by earthquake swarms. The map shows a maximum uplift of 150 cms centered near Pozzuoli.

What happened at Pozzuoli?



What might happen?



As with Rabaul and Long Valley, the activity died down in 1986. But, what if there was an eruption, similar in size to the one that formed the caldera at 35 ka?

- Total destruction of an area of 120 km radius by pyroclastic flows and surges (red circle)
- Extensive ash fall (10 - 100 cms) over much of eastern Europe (purple area).

Video - Volcanic Hazards

- Was made in 1991 by Maurice and Katia Krafft for UNESCO following the unnecessary, loss of life at Nevada del Ruiz in Colombia in 1985.
- The aim was to clearly and simply illustrate volcanic hazards, so that populations living on, or close to, volcanoes could be better informed.
- Tragically the Kraffts were killed while filming on Unzen volcano, Japan in 1991.

Major Volcanic Causes of Death

	Deaths
▪ Lava Flows	900
▪ Ash Falls	11,000 ?
▪ Mud Flows	27,000
▪ Pyroclastic Flows & Surges	55,000
▪ Lateral Blasts	(67)??
▪ Volcanic Gases	??
▪ Tsunamis (Volcanic)	45,000?
▪ Famine	123,000?
▪ TOTAL	262,000