

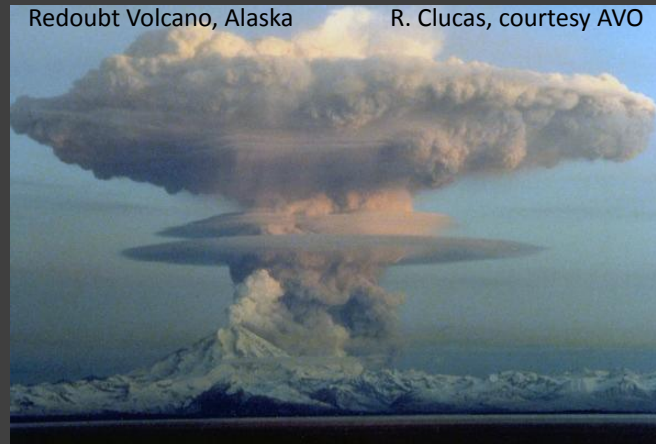
Volcanic hazards, volcano monitoring, and communications protocols

Jon J. Major

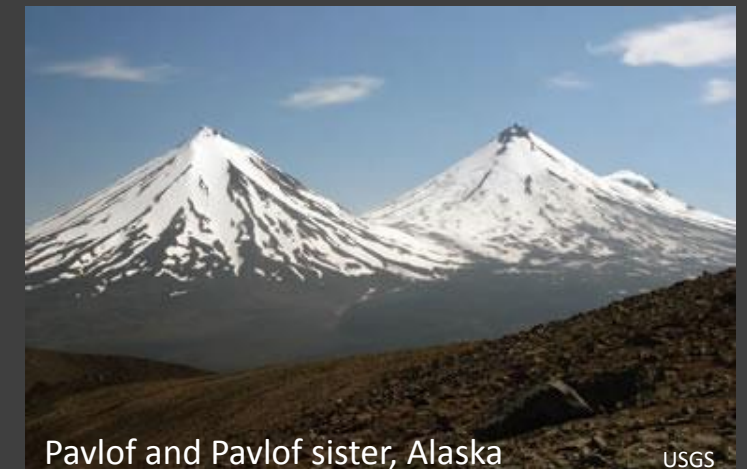
Scientist-in-Charge

Research Hydrologist

*U.S. Geological Survey
Cascades Volcano Observatory
Vancouver, Washington*



Volcanoes—charismatic landforms...



...that sometimes put on awesome

displays

Mount St. Helens--1847



Paul Kane, © Royal Ontario Museum



Kīlauea lava lake, Hawaii

USGS



Tungurahua volcano, Ecuador

© L. Joust

Fuego, Guatemala



lavceivolcano.org



Eyjafjallajökull, Iceland

© Sigurdur Stefinsson



Redoubt volcano, Alaska

© R. Clucas

Cordón Caulle—Puyehue, Chile



C. Santana/Getty Images



Kīlauea lava flow, Hawaii

USGS



Mayon volcano, Philippines

USGS



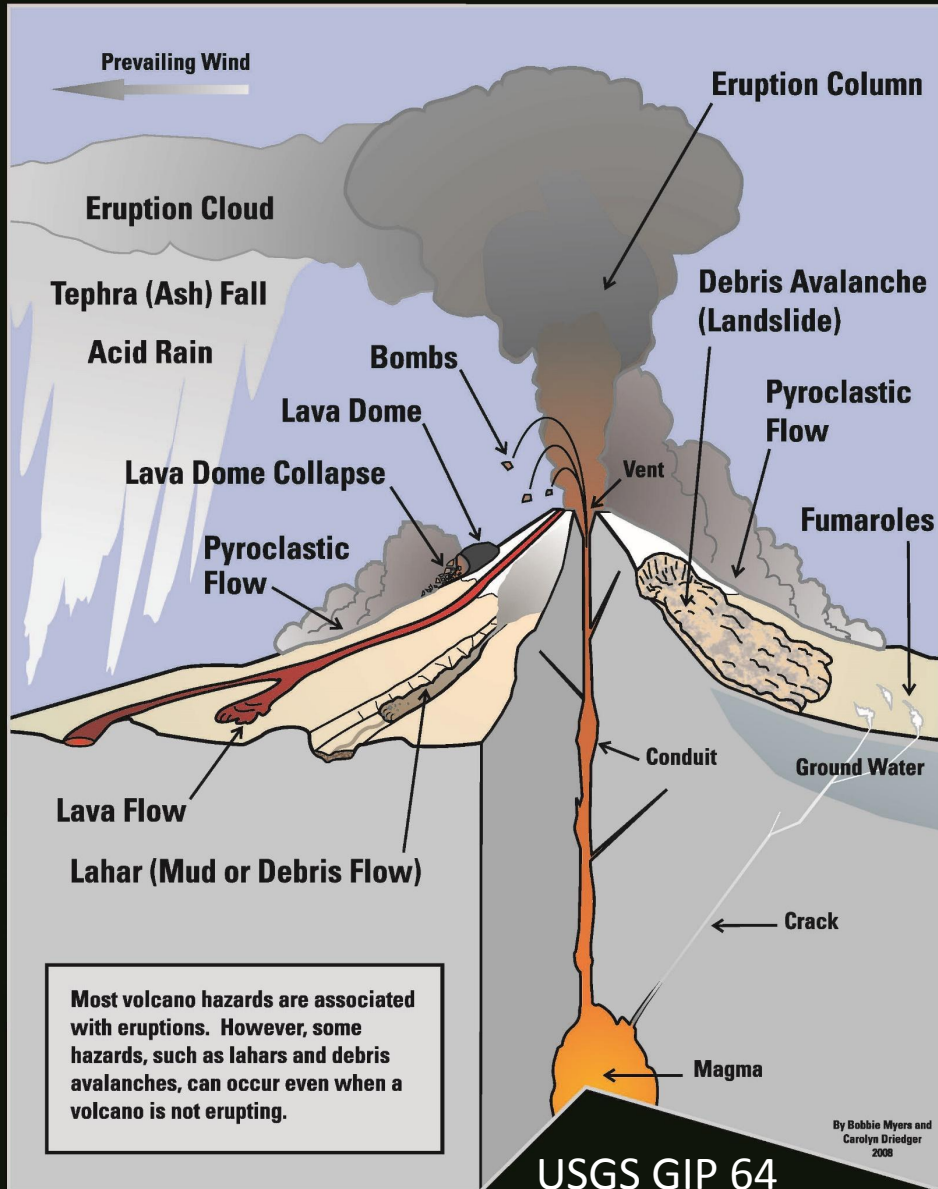
Mount St. Helens, Wash.--1980

© G. Rosenquist

...but can pose serious threats to



Geologic Hazards at Volcanoes



Volcanic processes flow and fall hazards

Impacts depend on time and distance from volcano

- Multiple processes, near source areas, **minutes to hours**
- Volcanic mudflows (lahars), far downstream valleys, **tens of minutes to hours**
- Volcanic ashfall (tephra fall), far downwind, **hours to days**
- Excess sediment, unstable channels, **years to decades**

Lahar (volcanic mudflow)

- Slurry of rock, sand, mud, water and debris
- Sometimes called volcanic mudflow (think river of soupy milkshake)
- Follows valleys; range of sizes; forms many ways

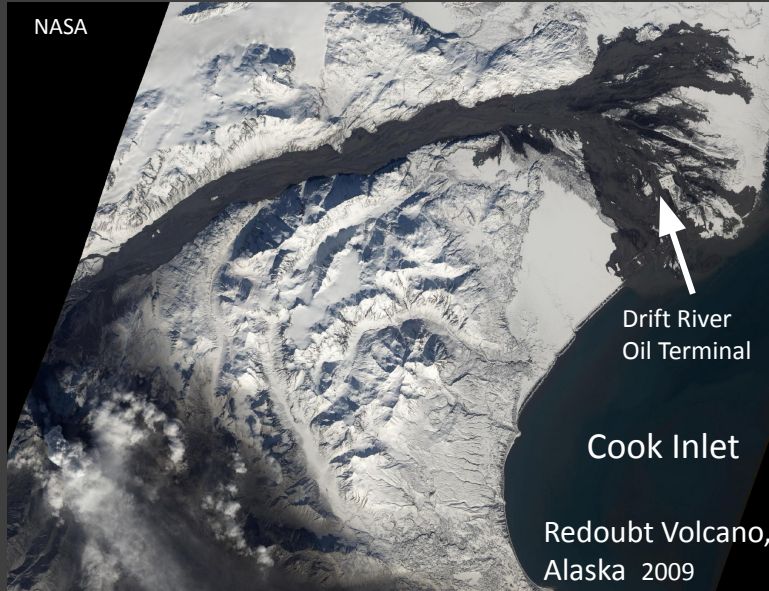


Example of very small lahar

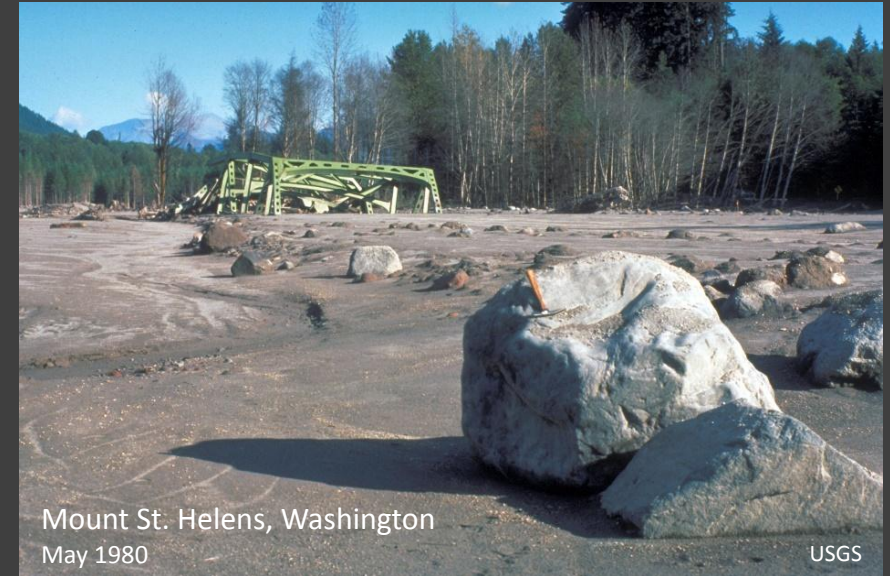
Semeru volcano, Indonesia



Lahar impacts



- Far traveled
- Bury/demolish along path
- Fill, drape, and smooth channels



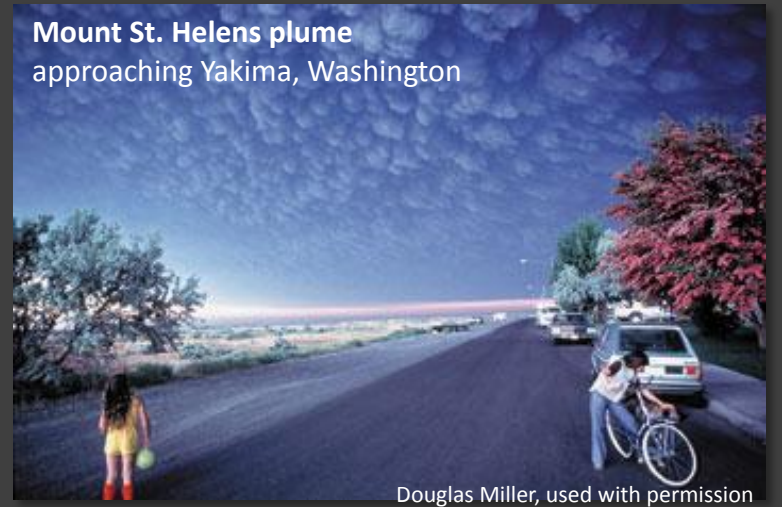
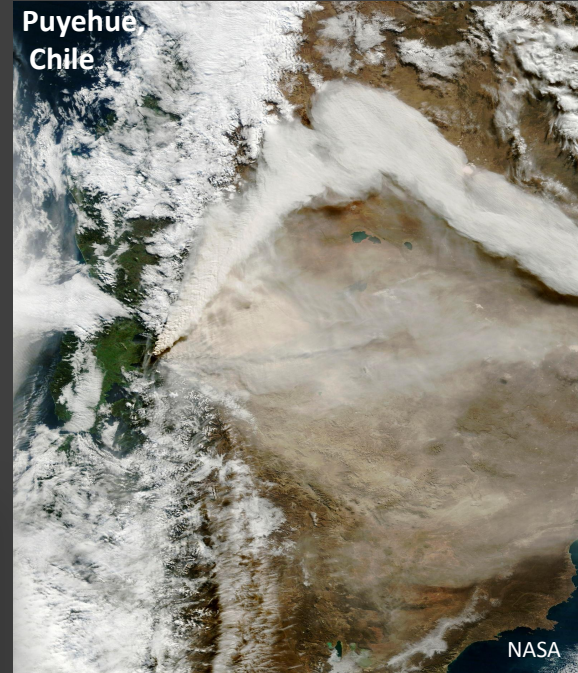
Tephra fall (volcanic ash)

- Shattered fragments carried by volcanic plumes
- Ash is sharp rock, minerals, and glass particles <2mm



Tephra plume/fall hazards

- Far reaching
- Loads structures
- Reduces visibility
- Abrasive and conductive
- Health risks
- Large areas; long duration
- Danger to aircraft

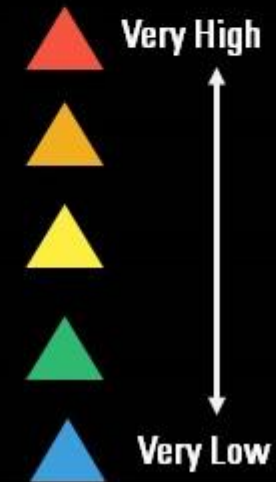


VOLCANO HAZARDS PROGRAM

Volcano Observatories

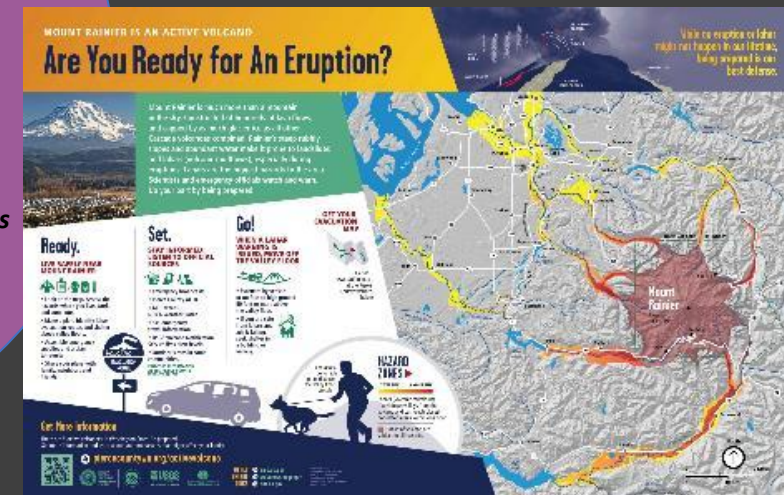
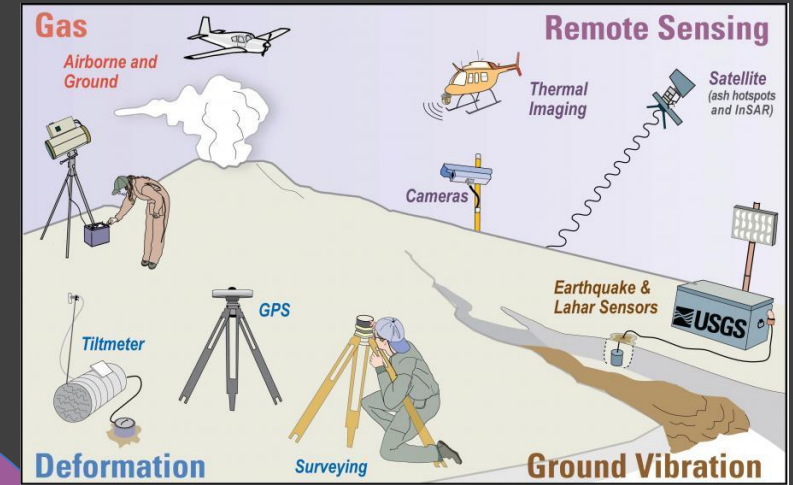
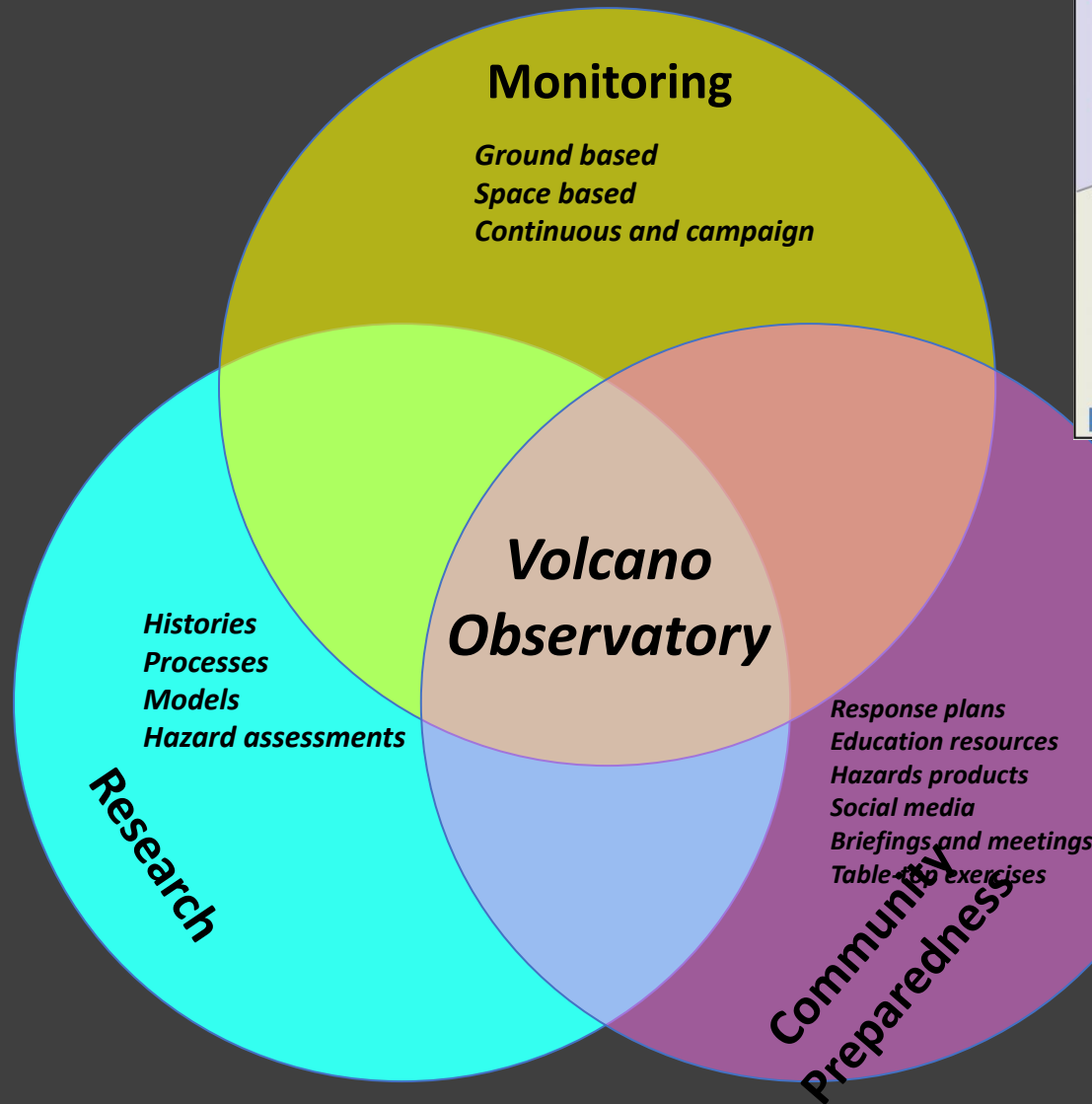
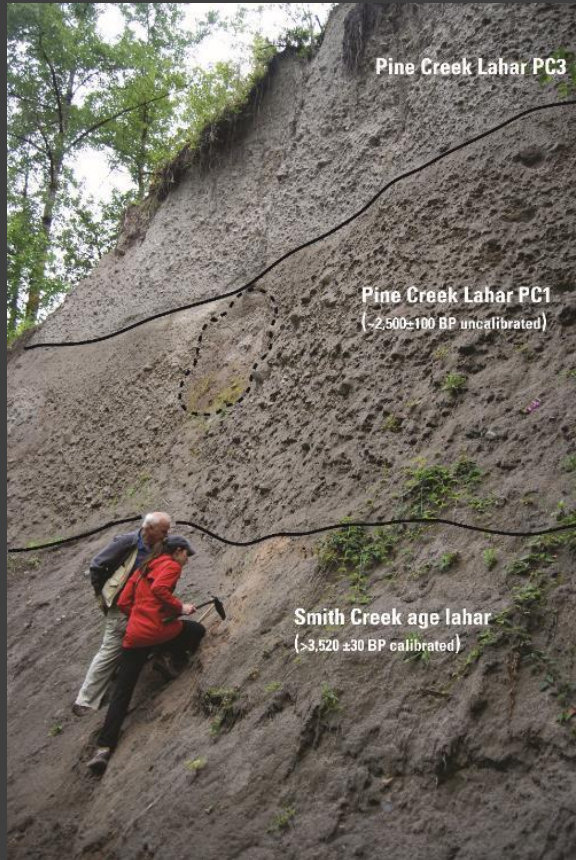
- Hawaiian - HVO
- Alaska - AVO
- California - CalVO
- Yellowstone - YVO
- Cascades - CVO [VDAP]

VOLCANO THREAT CATEGORY

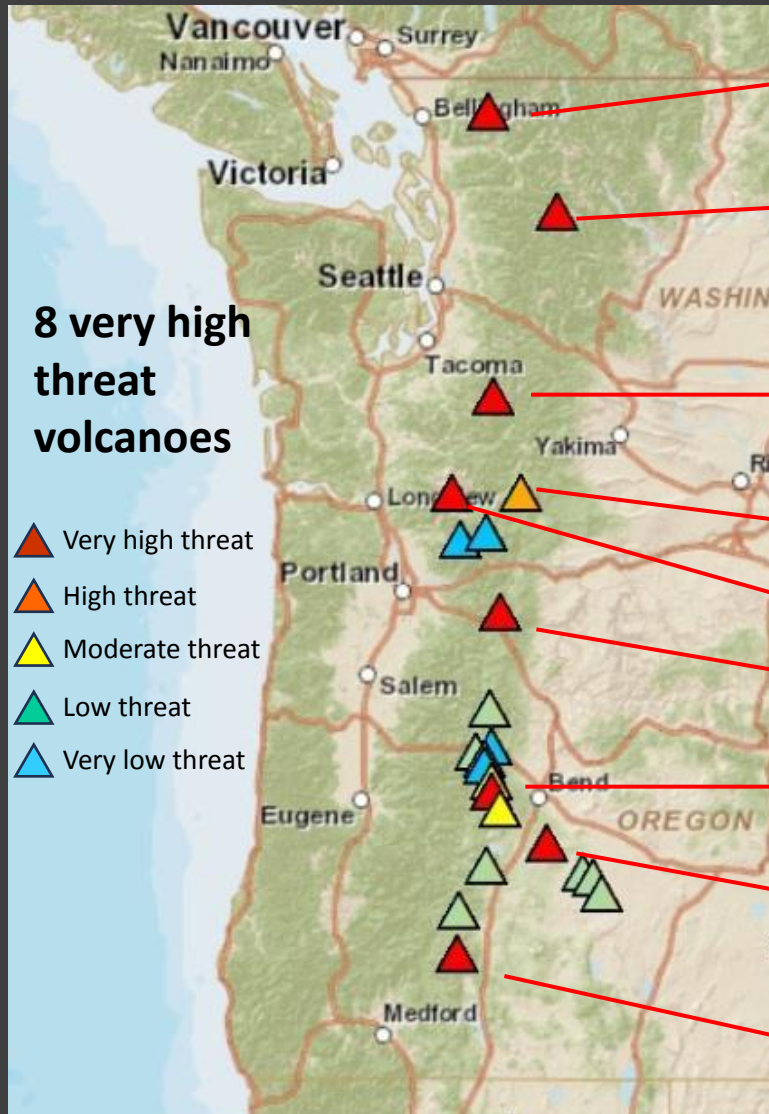


More than 10% of the world's known active and potentially active volcanoes are within U.S. territories (~170 volcanoes)

CVO: Core Functions



Cascades Volcanoes Instrumentation



Baker – 3 **PNSN** seismometers (10 mi) (scoping new sites, planning permits)

Glacier Peak – 1 **PNSN** seismometer (plan 4 new stations and upgrade of existing station approved; working out installation logistics)

Rainier – 22 seismometers, 9 GPS, 2 tilt, 6 cams, infrasound (10 mi)
(CVO/PNSN—mostly CVO) (lahar detection system buildout nearly complete)

Adams – 1 **PNSN** seismometer (plan 5 new stations; permit app in review)

St. Helens – 20 seismometers, 24 GPS, 3 tilt, 2 gas, infrasound (10 mi)

Hood – 11 seismometers, 6 GPS (10 mi) (mix of CVO/PNSN)

3 Sisters – 5 seismometers, 3 GPS (10 mi) (mix of CVO/PNSN)

Newberry – 10 seismometers, 8 GPS (10 mi) (all but 2 seismo are CVO)
(additional sites scoped out; seeking amendment to permit for more installs)

Crater Lake – 4 seismometers, 4 GPS (all CVO)

Not listed are cameras, infrasound which are scattered across many sites at many volcanoes; also conduct campaign GPS and InSAR surveys



PNSN is the Pacific Northwest Seismic Network

Mount Rainier – Lahar Detection System



How to mitigate risk posed by eruptions?

Alaska Interagency Plan for Volcanic Ash Episodes



June 2022

PACIFIC NORTHWEST

Federal INTERAGENCY OPERATING PLAN for VOLCANIC ASH EVENTS

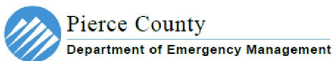


July 2024



MOUNT RAINIER VOLCANIC INCIDENT PLAN

12 May 2023



- Assess hazards
 - Eruptive histories, frequencies, magnitudes
 - Analogs from recent eruptions at similar volcanoes
- Monitor hazardous volcanoes
 - Detect onset of unrest (days to months)
 - Provide forecasts of likely events
 - Detect eruptions
- Mitigate risks -- **communications**
 - Requires trusted institutional partnerships
 - Educated officials, media, and public
 - Emergency-coordination plans
 - Institute-appropriate policies
 - Understanding of communications protocols

USGS Alert Notification Products

- USGS uses the Hazard Alert Notification System (HANS) to provide relevant, update-to-date, and dependable information about status of volcanoes

<https://volcanoes.usgs.gov/vns2/>

- Three categories of notification products
 - Event-driven
 - Time-driven
 - General informational

USGS Alert Notification Products

Event-driven are urgent, formal notifications

- Volcano Activity Notice (VAN)
- Volcano Observatory Notice for Aviation (VONA)
- Status Report

Time-driven are periodic (daily, weekly, monthly)

Summaries of volcano status for situational awareness

Information Statements

Notable observations and non-urgent but important technical or operational information

Communicating Volcanic Hazards: National Volcano Alert Level System

Volcano alert level (ground-based hazards)

TERM	DESCRIPTION
NORMAL	Typical background, non-eruptive state
ADVISORY	Elevated unrest above known background activity
WATCH	Heightened/escalating unrest with increased potential for eruptive activity. timeframe variable, <u>OR</u> , minor eruption underway that poses limited hazards
WARNING	Highly hazardous eruption underway or imminent
UNASSIGNED	Insufficient monitoring to make an assessment

Aviation color code (applies to the volcano)

COLOR	DESCRIPTION
GREEN	Volcano is in normal non-eruptive state
YELLOW	Volcano is exhibiting signs of elevated unrest above known background levels
ORANGE	Volcano is exhibiting heightened/escalating unrest with increased potential of eruption; timeframe variable <u>OR</u> , eruption underway with no or minor ash emissions
RED	Eruption is forecasted to be imminent with significant emission of ash into the atmosphere likely <u>OR</u> , Eruption is underway with significant ash into the atmosphere
UNASSIGNED	Insufficient monitoring to make an assessment

Volcano Observatory Notice for Aviation (VONA)

- VONA communicates volcanic unrest; recommended practice by ICAO
- VONA is issued when:
 - volcano alert level color code is changed
 - ash-producing event or other significant change in volcanic behavior occurs
 - episodes of re-suspended ash that could pose a hazard to aviation
- VONAs are part of the international aviation communications network

USGS Collaboration with NWS

- Primary interactions with AVO and CVO – establishing partnerships
 - Anchorage and Washington Volcanic Ash Advisory Centers (VAAC)
 - Anchorage and Seattle Center Weather Service Units (CWSU)
 - Anchorage, Seattle, Portland Weather Forecast Offices (WFO)
 - Alaska Regional Operations Center (ROC)
- Communications prior to and during eruptive events aims to insure consistency in hazard messaging in USGS and NWS products
- Facility tours, periodic informal talks, response plan coordination, pre-eruption briefings, call-down and table-top exercises

USGS, NWS, FAA eruption interactions

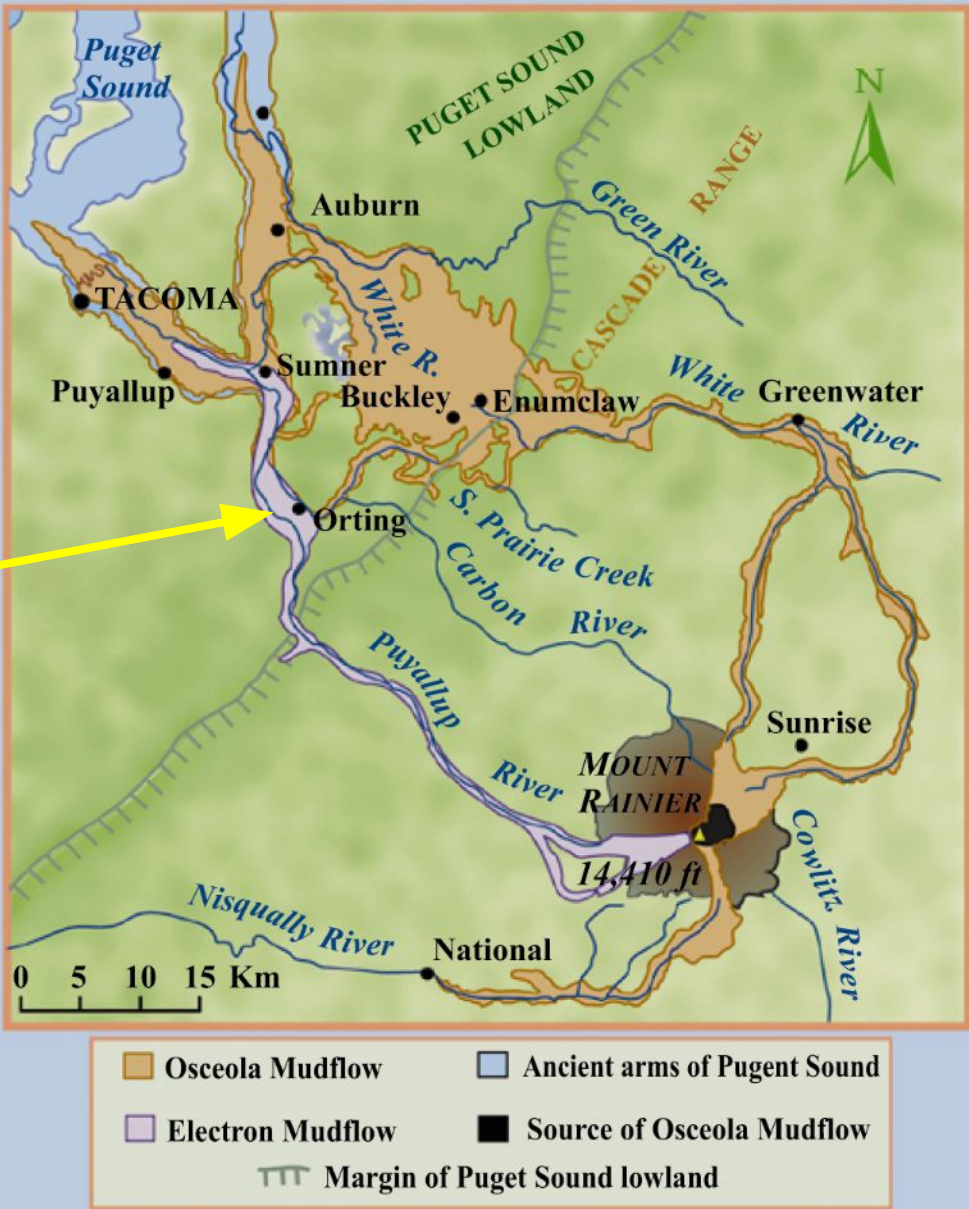
- **Call down** from USGS to respective VAACs, NWS WFOs, CWSUs, FAA
- **Collaboration** between groups on eruption (event) onset time, volcanic plume height, drainages affected by lahars
- USGS **runs Ash3D model** using eruption source parameters and posts output to public web page for use by WFO. Updates as necessary (duration, height)
- USGS **maintains situational awareness** regarding lahar location, speed, potential size on drainages (appropriately instrumented)

Significant potential risk

Orting, Washington (Mount Rainier)



Armero, Colombia, 1985 (Nevado del Ruiz volcano)



Modified from Vallance and Scott, 1997

Redoubt Volcano (AK) ash encounter

- 150 miles downwind of Redoubt; B747 flew into what crew thought was a normal cloud but was instead an ash cloud from (1989) eruption.
- All 4 engines failed in 59 seconds
- False warning of cargo-compartment fire displayed
- Airspeed indicators failed
- Aircraft descended without power for 4 minutes over mountainous terrain
- 2 engines restarted with <2 minutes before impact
- Crew managed safe landing in Anchorage, but >\$80 million in damage incurred (\$204 million in today's \$)

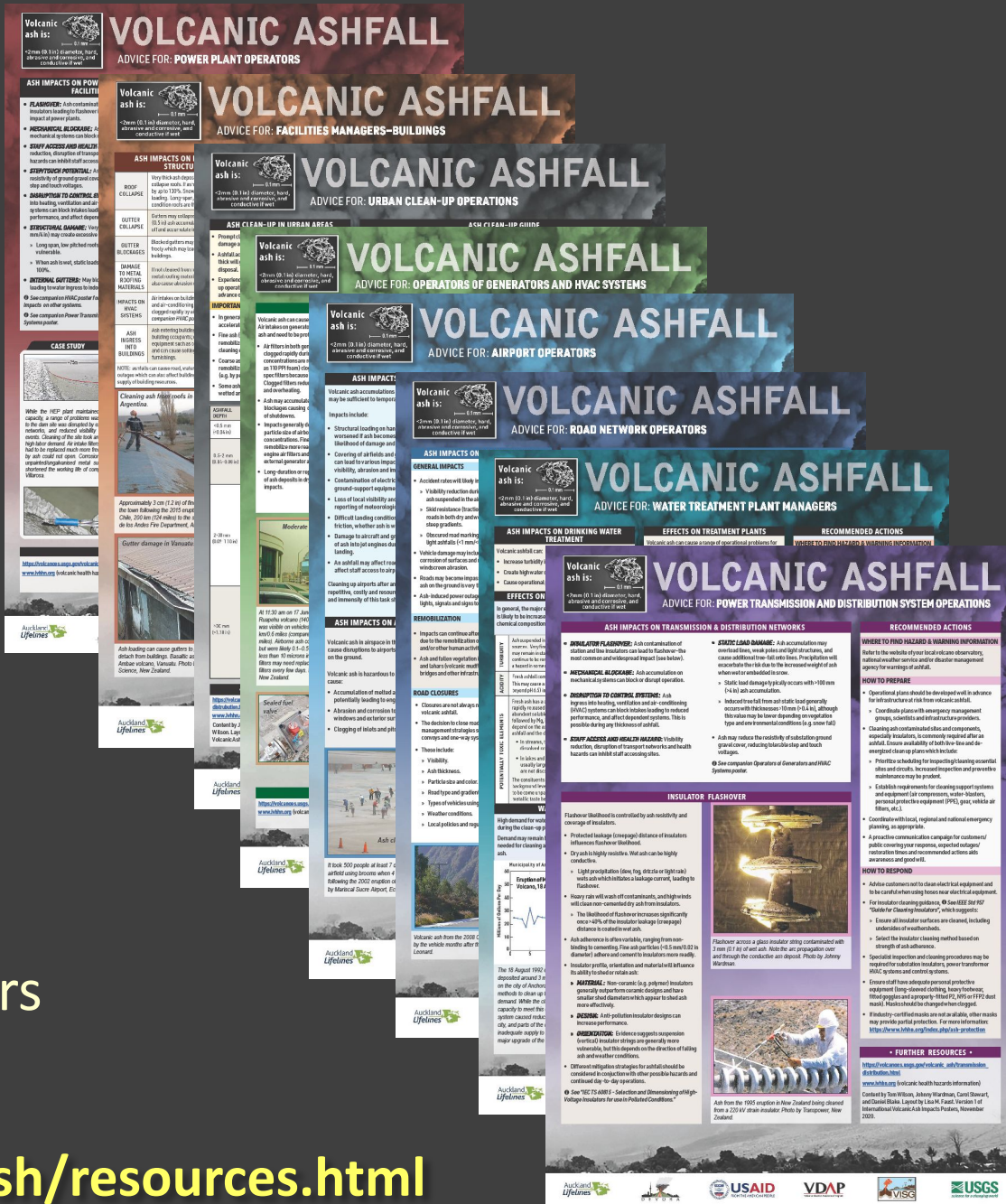
Ashfall Impact Posters

Advice for:

- Airport Operators
- Facilities Managers & Buildings
- Operators of Generators & HVAC Systems
- Power Plant Operators
- Power Transmission & Distribution System Operations
- Urban Cleanup Operations
- Water Supply Managers
- Wastewater Collection & Treatment Managers
- Road Network Operations



https://volcanoes.usgs.gov/volcanic_ash/resources.html



Where you can find information

Volcano Notification Service: <https://volcanoes.usgs.gov/vns2/>

Websites: <https://www.usgs.gov/science/observatories>

Facebook: <https://www.facebook.com/USGSVolcanoes>

X (Twitter): <https://twitter.com/USGSVolcanoes>

Instagram: <https://www.instagram.com/USGSVolcanoes/>

Eyjafjallajökull 2010

AVOID! AVOID! AVOID!

- 2010 eruption of Eyjafjallajökull caused huge disruption to aviation
- Highlighted need to identify volcanic ash concentration thresholds that could improve route efficiency without posing a safety concern for aircraft
- International Civil Aviation Organization (ICAO) developed standards for quantitative volcanic ash information, to be provided by VAACs

DEPARTURES				
e	Destination	Flight	Gate	Remark
5	FRANKFURT	LH4809		DUE TO VOLCANIC ASH
0	ZURICH	LX465		DUE TO VOLCANIC ASH
0	EDINBURGH	BA8712		CANCELLED
0	DUBLIN	AF5119		CANCELLED
5	AMSTERDAM	VG240		CANCELLED
5	EDINBURGH	AF5165		DUE TO VOLCANIC ASH
5	NANTES	AF5209		DUE TO VOLCANIC ASH
0	ROTTERDAM	VG290		CANCELLED
0	AMSTERDAM	VG240		DUE TO VOLCANIC ASH
0	MILAN/LINATE	AP4219		CANCELLED
0	EDINBURGH	BA8708		CANCELLED
5	ANTWERP	AF5237		DUE TO VOLCANIC ASH
0	GLASGOW	BA8728		CANCELLED
0	ROTTERDAM	VG292		DUE TO VOLCANIC ASH
0	ZURICH	LX467		DUE TO VOLCANIC ASH
0	PARIS - ORLY	AF5027		CANCELLED
0	COPENHAGEN	QI3626		CANCELLED
Som: Thursday 15 April 2010				15

