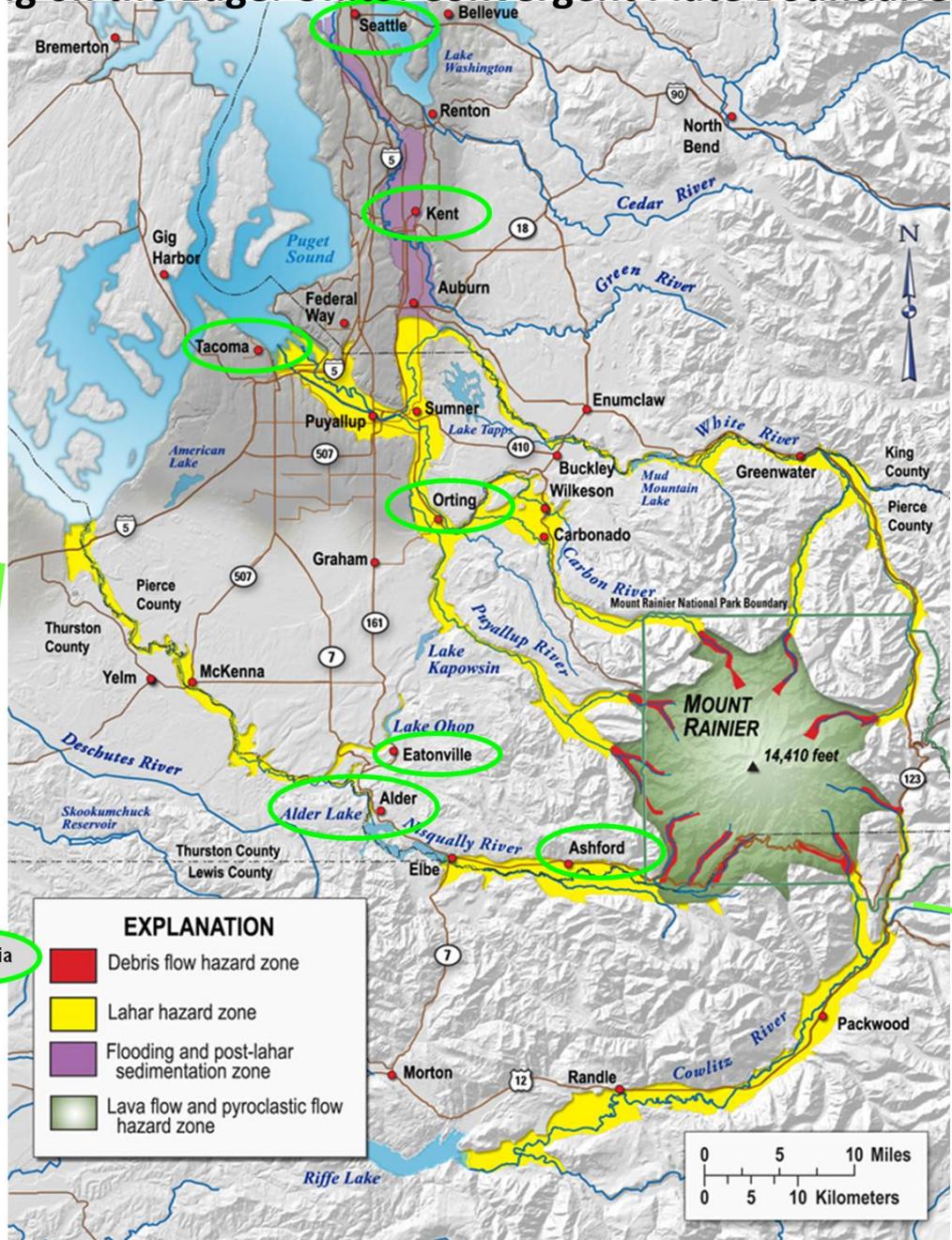


# Living on the Edge: Unit3: Convergent Plate Boundaries

Because of its elevation (4,392 m), relief, hydrothermal alteration, ice cap, glacier-fed radial valleys, and proximity to suburbs of the Seattle-Tacoma area, **Mount Rainier is the most threatening volcano in the Cascades**. Its next eruption could produce volcanic ash, lava flows, and *avalanches of intensely hot rock and volcanic gases, called pyroclastic flows*. Some of these events swiftly melt snow and ice and could produce torrents of meltwater that erode loose rock and become *rapidly flowing slurries of mud and boulders known as lahars*, which is the greatest risk at the volcano, rather than from an eruption itself.

[http://volcanoes.usgs.gov/volcanoes/mount\\_rainier/mount\\_rainier\\_hazard\\_49.html](http://volcanoes.usgs.gov/volcanoes/mount_rainier/mount_rainier_hazard_49.html)



<http://pubs.usgs.gov/pinatubo/harlow/fig2.gif>

Centralia

Yakima

"We call it low probability, high consequence," says Steven Bailey, Pierce County, Washington's director of emergency management. "It's a low probability it's going to occur in our lifetime. But if and when it does, the consequences are going to be huge."  
[www.geographyalltheway.com/igcse\\_geography/natural\\_environments/plate\\_tectonics/igcse\\_volcanoes\\_manage.htm](http://www.geographyalltheway.com/igcse_geography/natural_environments/plate_tectonics/igcse_volcanoes_manage.htm)

# Living on the Edge: Unit3: Convergent Plate Boundaries

The USGS has established an alert level system to communicate the likelihood of increasing or decreasing volcanic activity. Keep these alert levels in mind as you look through the geologic activity data attached.

**Standard Volcano Icons**

**Ground-based Volcano Alert Levels**

Normal    Advisory    Watch    Warning

**Aviation Color Codes**

Green    Yellow    Orange    Red

————— Increasing level of concern —————>

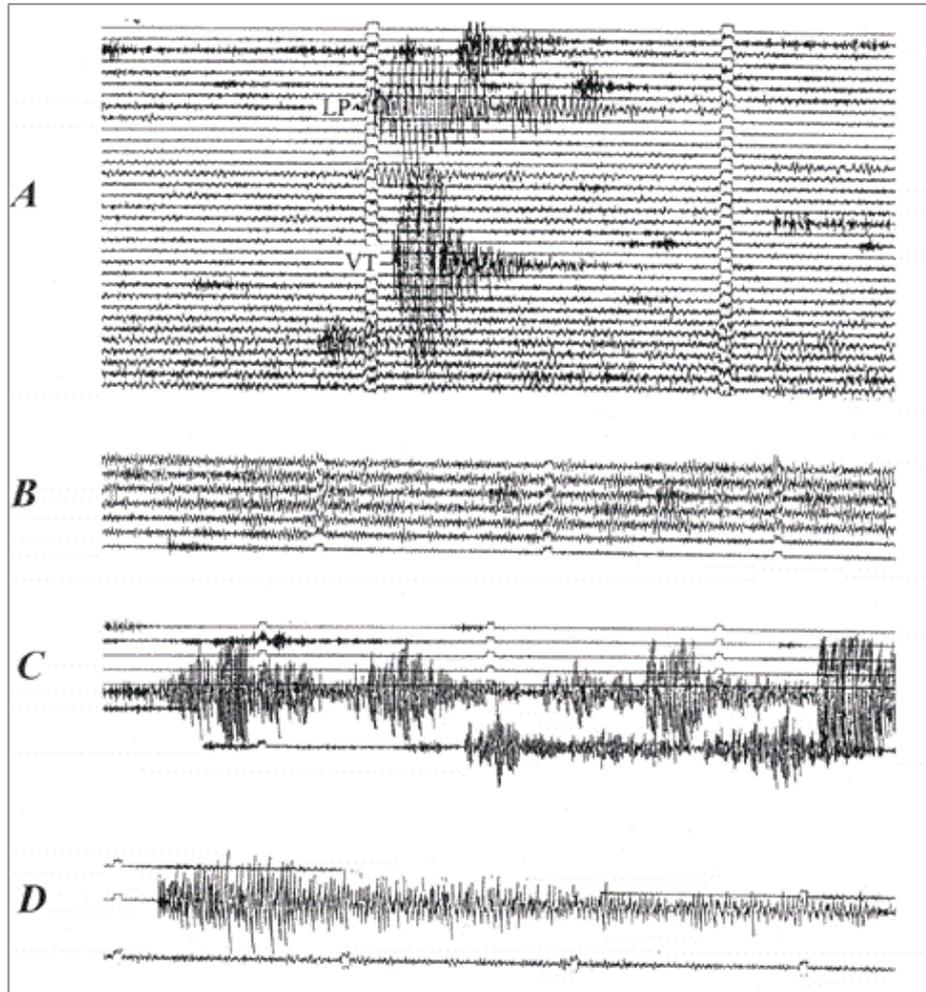
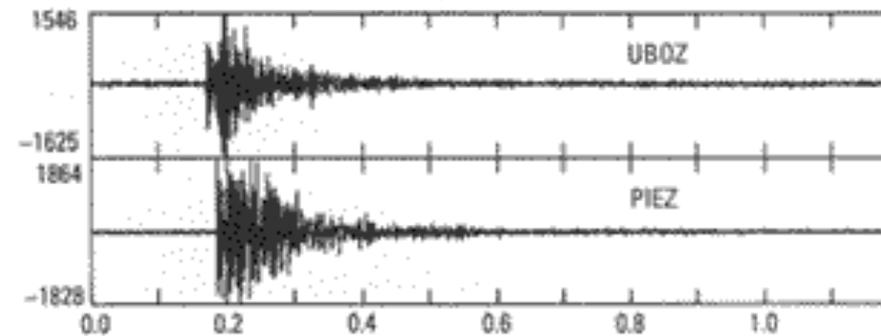
 Unassigned (Insufficient monitoring to make assessment)

ALERT LEVEL	DESCRIPTION
<b>NORMAL</b>	Volcano is in typical background, non-eruptive state <i>or, if changing from a higher level:</i> The activity has ceased and volcano has returned to non-eruptive background state.
<b>ADVISORY</b>	Volcano is exhibiting signs of elevated unrest above known background level; <i>or, if changing from a higher level:</i> Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
<b>WATCH</b>	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, OR eruption is underway but poses limited hazards.
<b>WARNING</b>	Hazardous eruption is imminent, underway, or suspected.

<http://volcanoes.usgs.gov/activity/alertsystem/index.php#alertlevel>

Note: Data included in the following handouts are from the USGS. References for specific figures and information can be obtained from your instructor.

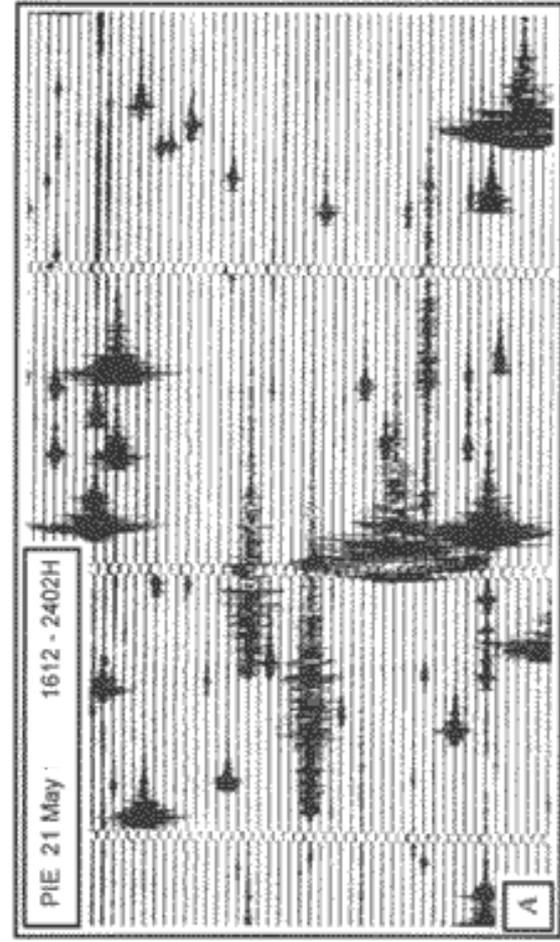
**SEISMIC DATA SET 1:  
(THROUGH JUNE 8)**

May 15<sup>th</sup>

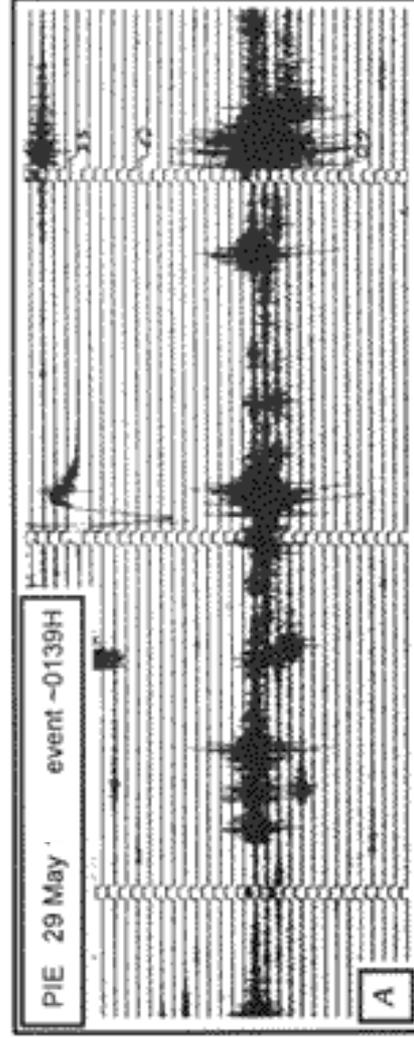
Seismograms of May 15 recorded at stations UBO and PIE (Z). Time marks in seconds are shown.

**Examples of seismic event types:** A. **VT = Volcano-Tectonic** earthquake (associated with deep earthquakes indicating stress changes in solid rock due to injection or withdrawal of magma) and **LP = Long-Period** (associated with shallow injection of magma into surrounding rock) often associated with shallow magma movement, suggesting imminent eruption. B. **Tremor-like** episode of closely-spaced long-period events. C. **Harmonic tremor** (long-lasting, continuous release of seismic energy typically associated with shallow, underground movement of magma; harmonic tremor contrasts distinctly with the sudden release of seismic energy associated with slippage along a fault).

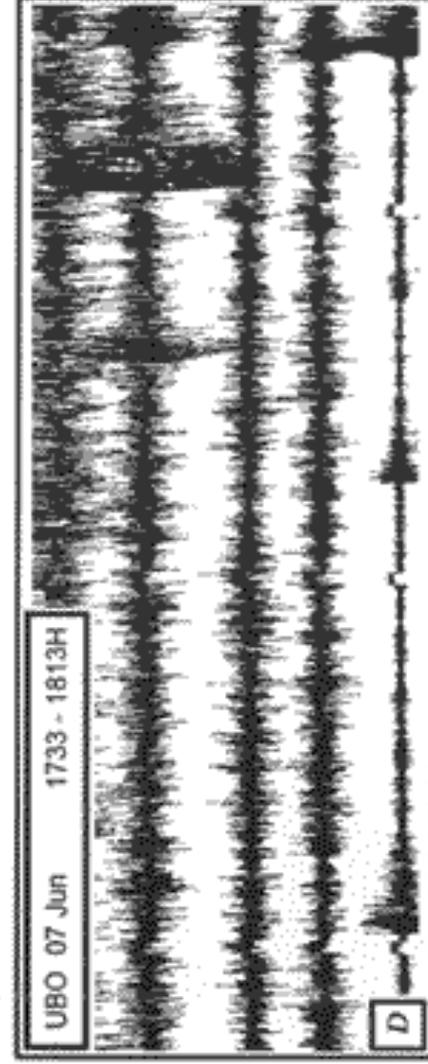
D. Seismic signal from **explosive eruption** at station CAB. Time marks represent 1-min interval.



Seismogram from May 21. Time marks are 60 sec apart.



Seismogram of station UBO (note: this signal fades to the background 2 h after the segment shown). Time marks are 60 sec apart.



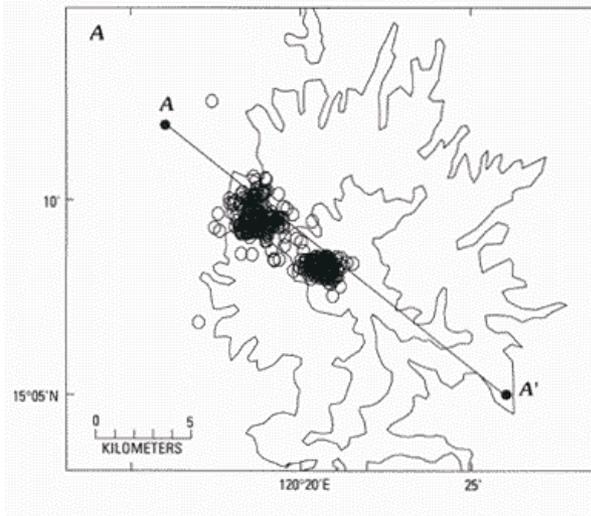
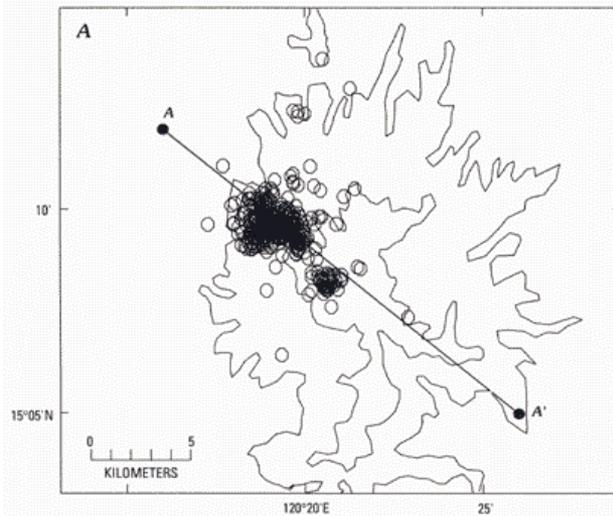
Seismogram from station PIE recorded May 21. Time runs from top to bottom, left to right. Time marks are 60 sec apart. Date and time shown are local.

May 6- 31

June 1-7

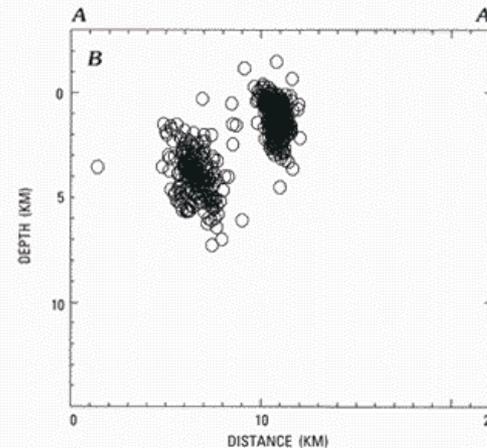
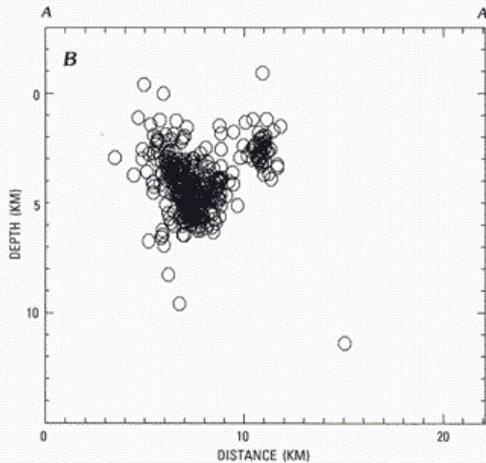
MAP  
VIEW

MAP  
VIEW



CROSS SECTION  
A side view of  
earthquake  
locations under  
the volcano (note  
location of line A-A' on  
map above)

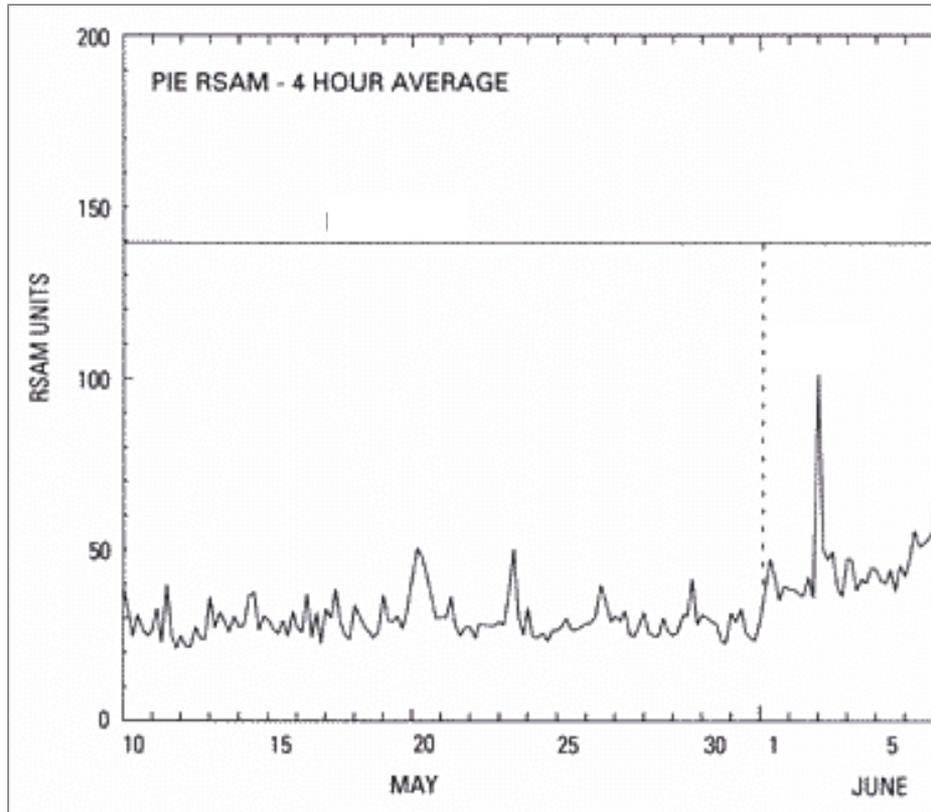
CROSS SECTION  
A side view of  
earthquake  
locations under  
the volcano (note  
location of line A-A' on  
map above)



# SEISMOLOGY: EARTHQUAKES

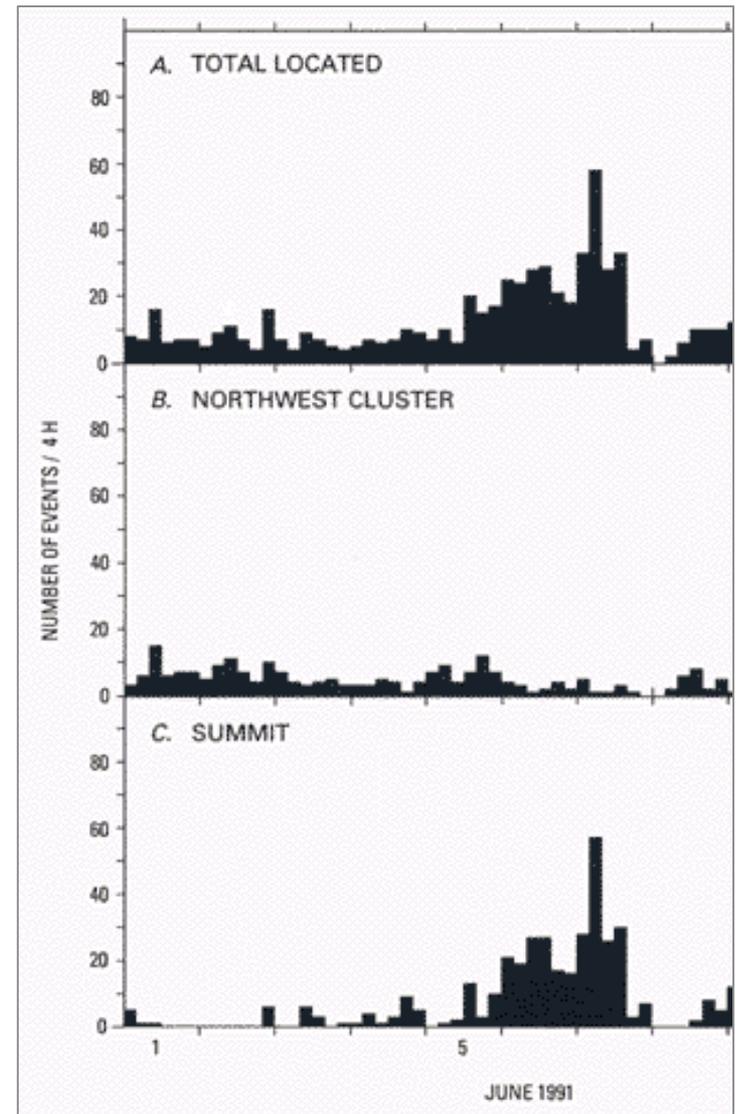
SEISMIC DATA SET 1 (through June 8)

RSAM data: recall that RSAM (Real-time seismic amplitude measurement) represents an average of absolute seismic amplitudes for seismic stations. RSAM does not discriminate between *types* of earthquakes, but all seismic signals are averaged and recorded.



RSAM values (averages of 4 hour intervals) from May 10 to June 8 at the PIE station.

EXTENDED CAPTION: Plot of (A) the SO<sub>2</sub> volumes from **May 10 to June 12, 1991**, estimated from COSPEC measurements and (B) 4-hour average RSAM values from May 10 to June 12, 1991; **shows the marked division between the Metastable and Pre-explosive Buildup seismic phases.**



Number of seismic events per 4-hour intervals between **June 1 and June 8** from (A) the entire volcano network, (B) the cluster of seismic activity 5 km northwest of the summit, and from (C) beneath the summit.

<http://pubs.usgs.gov/pinatubo/harlow/fig8.gif>

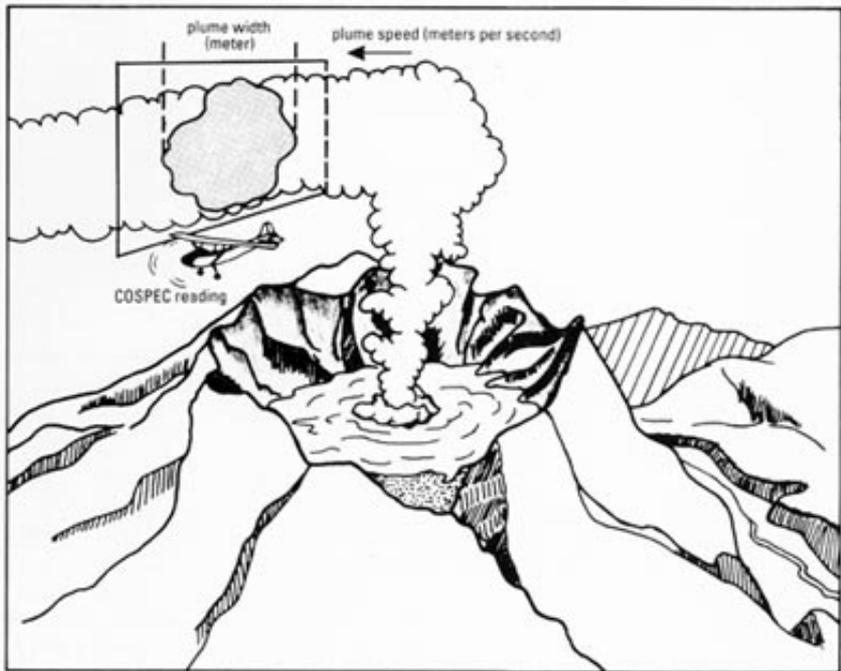
**GAS AND ASH DATA SET  
1:  
(THROUGH JUNE 8)**

# GAS & FUMAROLES

Below and at right: Photos of fissure and line of new craters formed by explosions of April 2 on upper north flank of the volcano. View in photo above: looking to the south, with prominent fumaroles in distance at the head of river drainage. View above right shows north arrow.



Right: To collect SO<sub>2</sub> flux data, an aircraft carrying the COSPEC instrument flies the plume to measure the concentration of SO<sub>2</sub>, which is integrated over the width of the plume and multiplied by the wind speed to get the rate of SO<sub>2</sub> emission.



From Daag et al., 1996; at

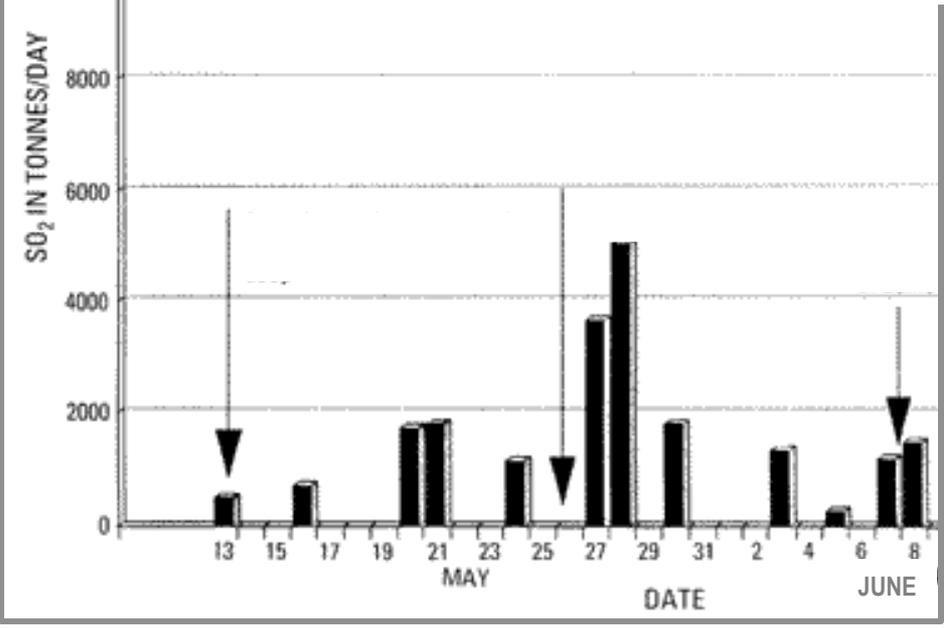
Upper left from Wolfe & Hoblitt, 1996 at: <http://pubs.usgs.gov/pinatubo/wolfe/fig5.jpg>

Upper right from Ewart et al., 1996: <http://pubs.usgs.gov/pinatubo/ewert/fig5.jpg>

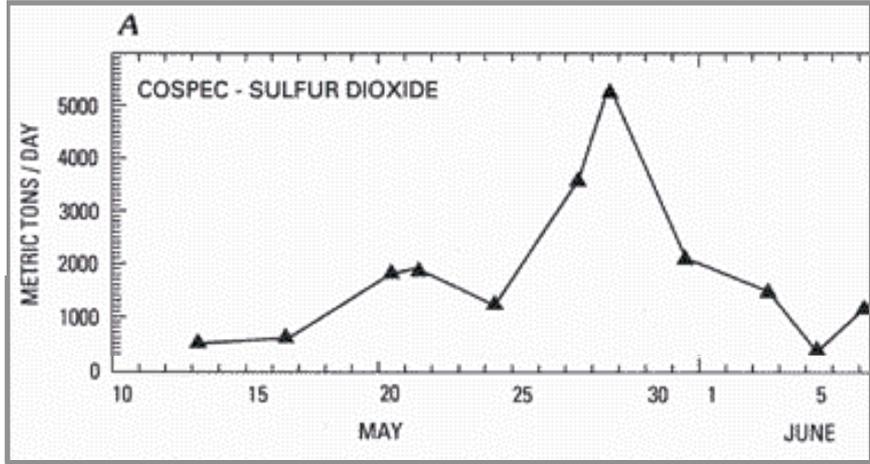
<http://pubs.usgs.gov/pinatubo/daag1/fig1.jpg>

# GAS & FUMARoles

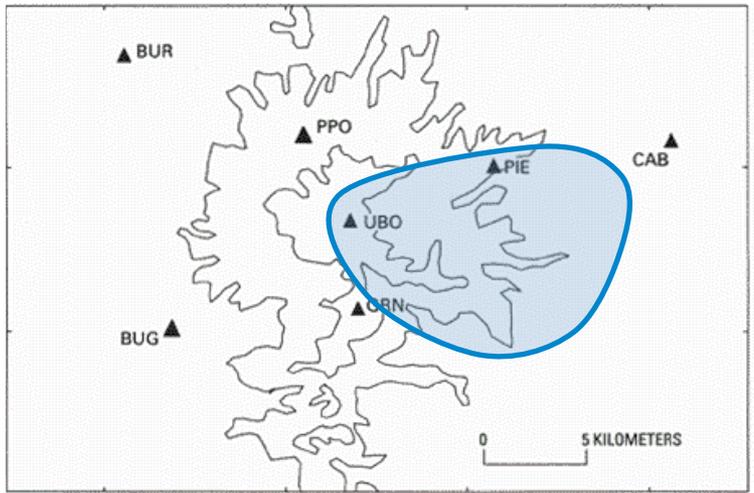
On April 2, people in the vicinity smelled hydrogen sulfide (H<sub>2</sub>S). On April 4, 1991, a volcanology team flew over the volcano and found a chain of vigorously steaming vents across the north face of the volcano (see images attached). The team judged that the activity was of hydrothermal origin. Vents at the northeastern side were short lived; by the time COSPEC surveys were started, only five vents nearer to the summit were actively steaming.



SO<sub>2</sub> emission from May 13 to June 10  
 From: <http://pubs.usgs.gov/pinatubo/daag1/fig2.gif>



Plot of SO<sub>2</sub> volumes from **May 10 to June 8**, estimated from COSPEC measurements; From: <http://pubs.usgs.gov/pinatubo/wolfe/index.html>

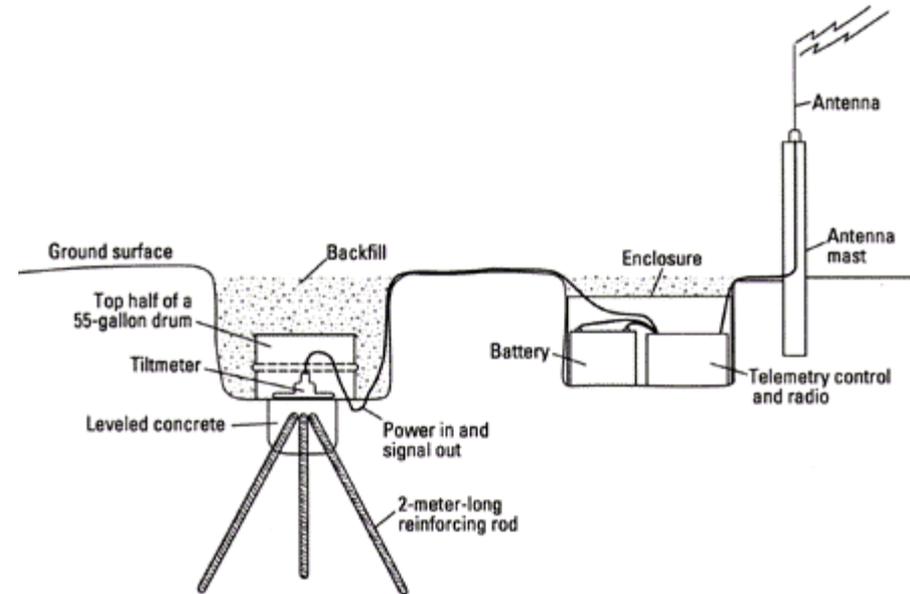


Outline of areas affected by tephr fall on April 2.

Left: Daag et al., 1996 <http://pubs.usgs.gov/pinatubo/daag1/>; Right: Wolfe & Hoblitt, 1996 at: <http://pubs.usgs.gov/pinatubo/wolfe/>; Lower right image modified from Lockhart et al., 1996, <http://pubs.usgs.gov/pinatubo/lock/fig1.gif>.

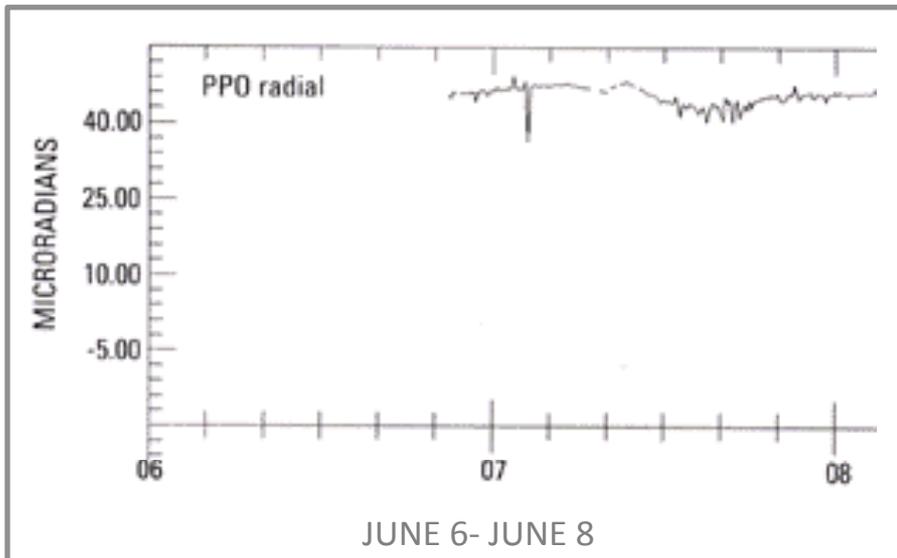
**TILT DATA SET 1:  
(THROUGH JUNE 8)**

The PPO Tilt station was installed 4 km north of the summit, on May 2. Two additional tiltmeters were installed during the last week of May. Starting almost immediately after installation, the UBO tiltmeter record was reasonably stable. Instrumental and logistical problems, along with the increasing volcanic activity, prevented getting useful data from the second tiltmeter. Data telemetered from tiltmeters can provide information from high-hazard areas that are too dangerous to revisit.



Schematic of the UBO tiltmeter installation on the east side of the Mount Pinatubo summit dome From:

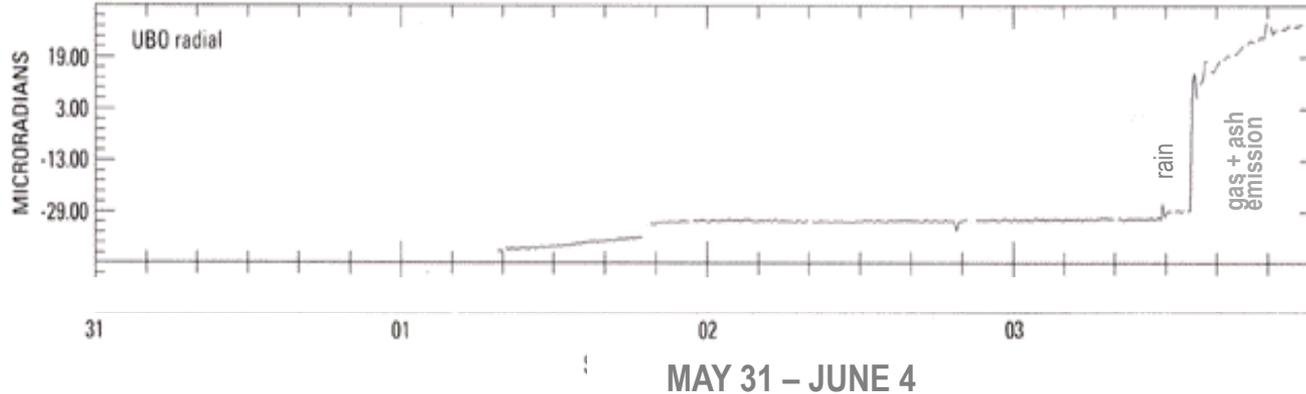
<http://pubs.usgs.gov/pinatubo/ewert/fig3.gif>



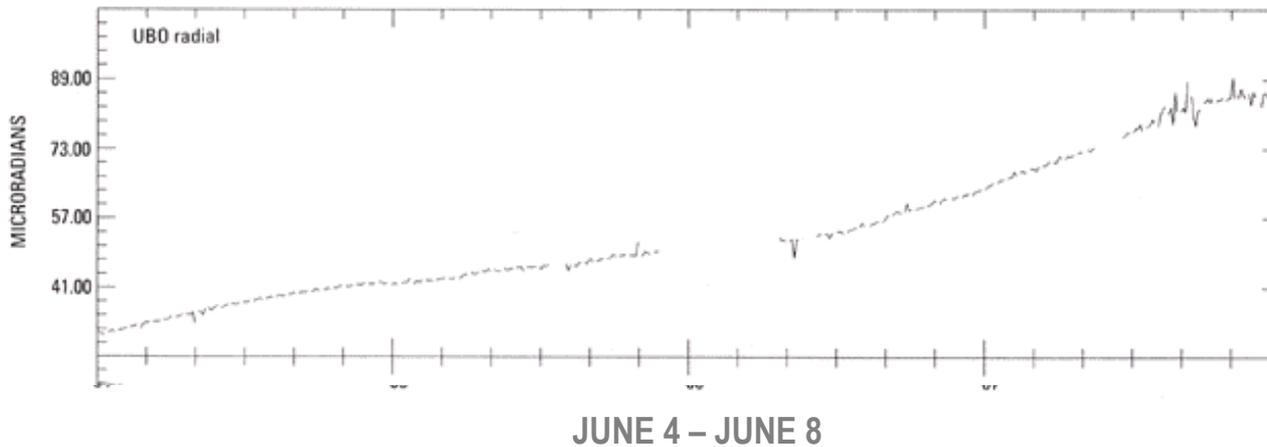
PPO tiltmeter, north side of volcano. Tiltmeters are sensitive to even slight changes in temperature, so burial 1 to 2 m deep is necessary in order to isolate the instrument from diurnal temperature changes.

Modified from <http://pubs.usgs.gov/pinatubo/ewert/fig4.gif>.

**RADIAL DATA:** increasing values indicate west up, or edifice inflation.



**May 31-June 3:** Data from the tiltmeter located at UBO. Rainstorm on June 3 is indicated, as is the ash emission that followed.



**June 4 – June 8:** Data from the tiltmeter located at UBO. **NOTE** the change in vertical scale from previous UBO data (above).