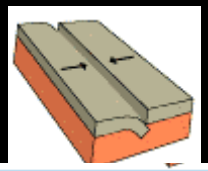
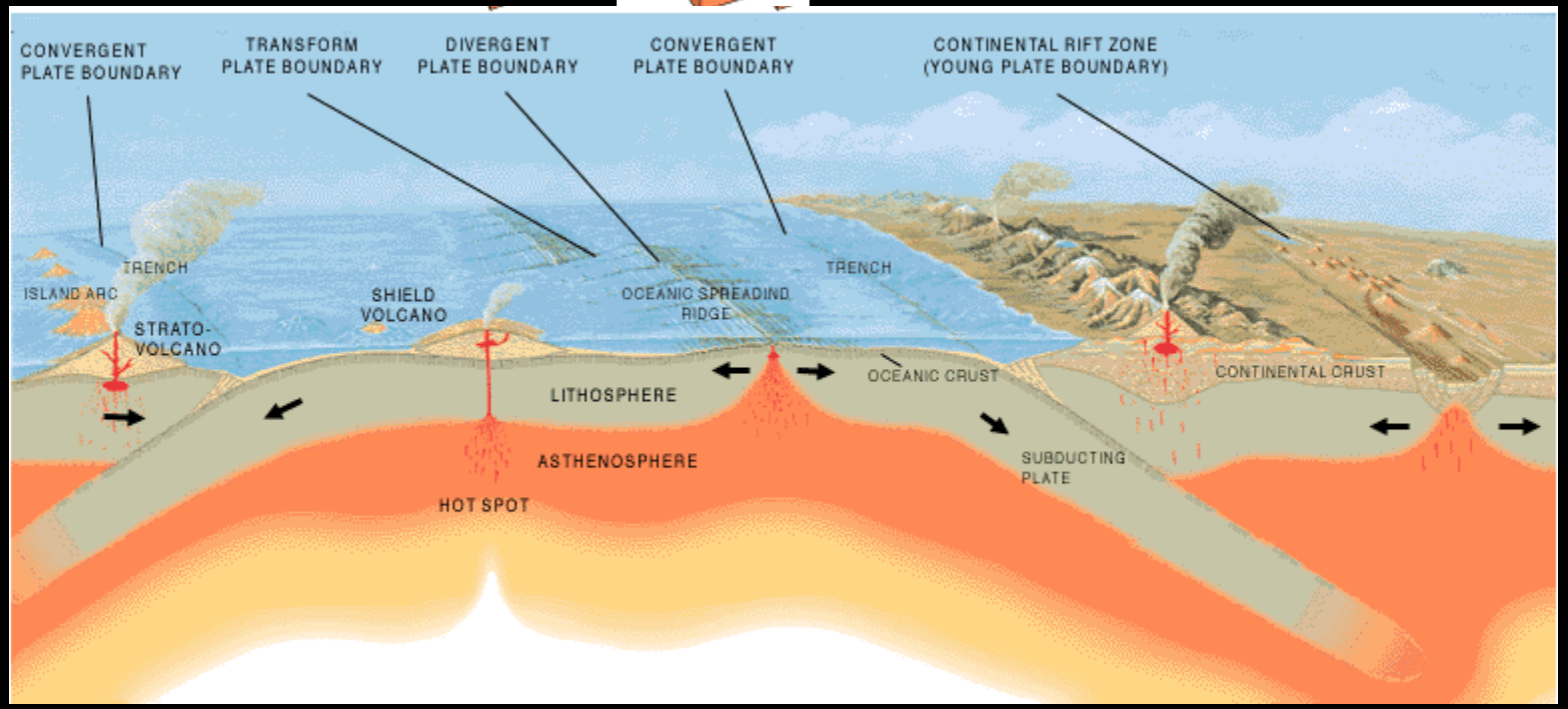
Living on the Edge: Unit 5: Convergent Plate Boundaries

Learning Objectives: By the end of this unit, you should be able to:

1. Interpret authentic eruption precursor data from multiple sources to develop hypotheses and forecast the geologic activity
2. Revise initial hypotheses based on new information
3. Be able to inform non-scientists of the impacts of potential geologic hazards and make recommendations for future mitigation





http://pubs.usgs.gov/gip/dynamic/Vigil.html

Review Pre-work:

5. Based on your knowledge of volcano monitoring and the interviews with USGS volcanologists from the Mount St. Helens 1980 eruption, describe 2-3 specific ways in which society benefits from monitoring volcanoes.

What are the possible roles of local citizens during a volcanic crisis?

Living on the Edge: Unit3: Convergent Plate Boundaries (Google Earth)

Color codes for convergent plate boundaries:

Ocean-ocean convergent boundary

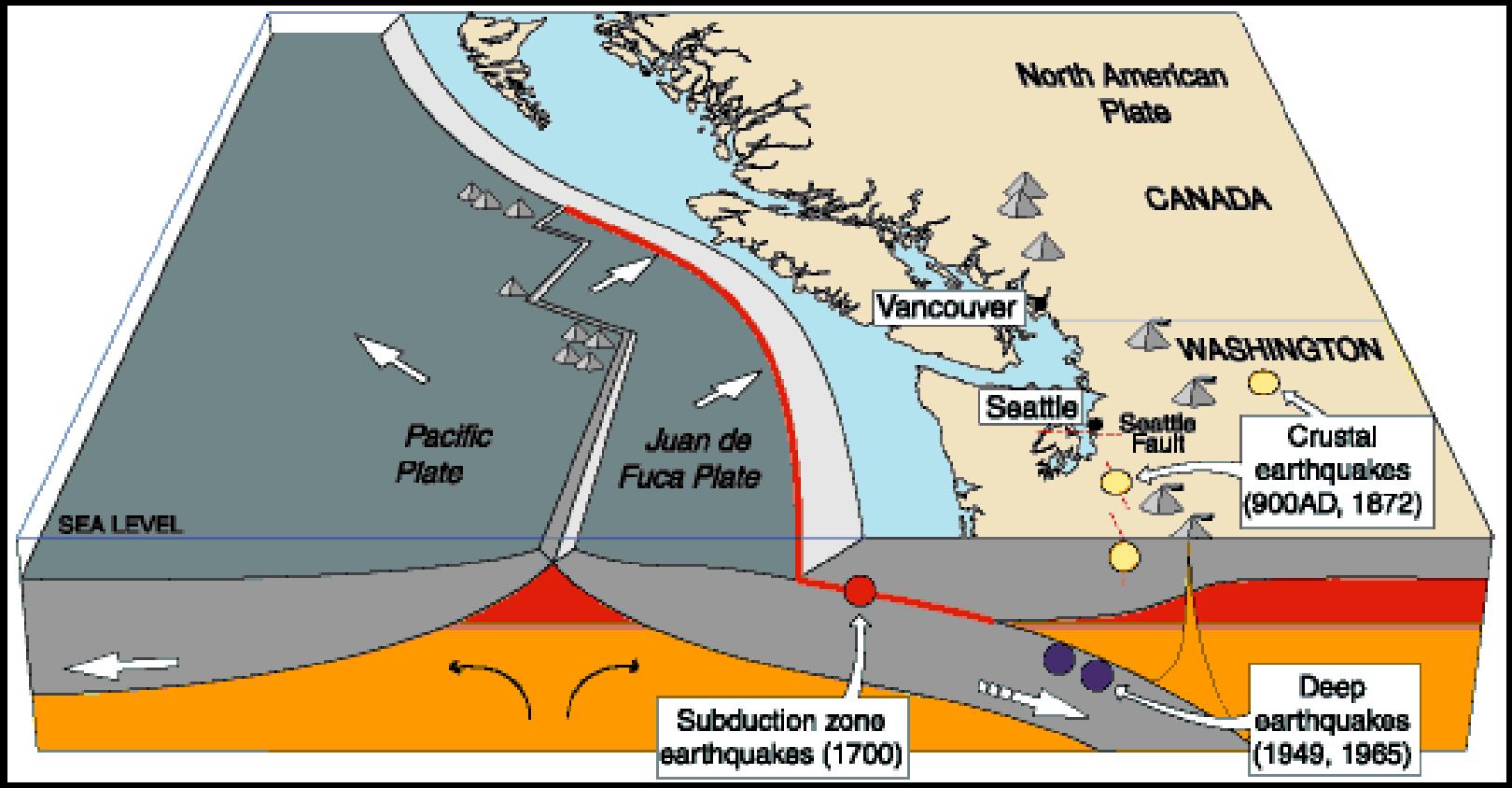
Continental convergent boundary

Subduction zone (ocean or continental)

US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2009 GeoBasis-DE/BKG
© 2013 Google

US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2009 GeoBasis-DE/BKG
© 2013 Google

Living on the Edge: Unit3: Convergent Plate Boundaries



http://geomaps.wr.usgs.gov/pacnw/graphic/a1.gif

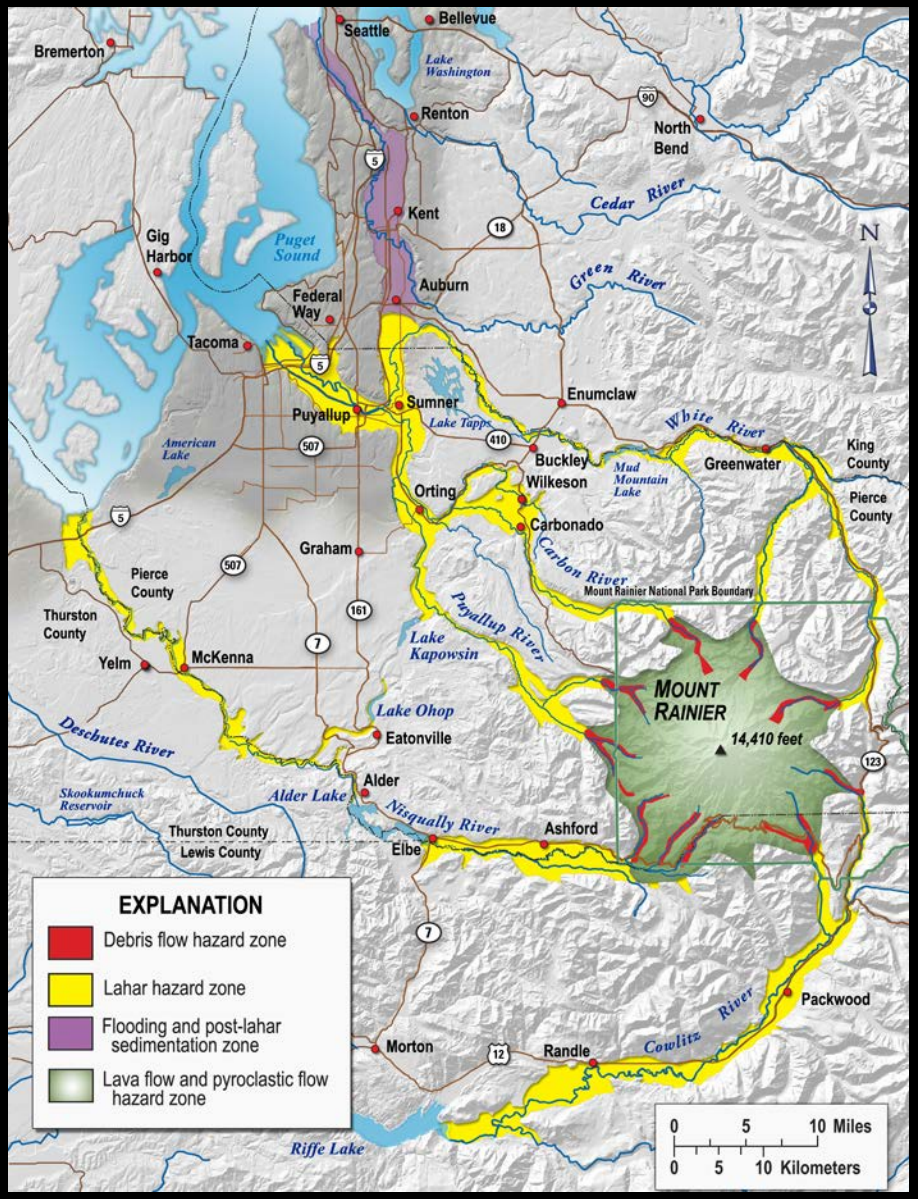
Living on the Edge: Unit3: Convergent Plate Boundaries

Instructions:

1. In small groups, **review data** and use the worksheet to describe and interpret the geologic activity.

IMPORTANT NOTE! *We will switch groups during the next class period and you will teach other students how to interpret this data!! Be sure everyone in your group knows how to help others learn about this data!*

2. Prepare a **forecast** for the potential geologic activity using the USGS Volcano Alert Level system to assign an alert level based on the data examined.



Recall: Learning Objectives:

By the end of this unit, you should be able to:

1.Interpret authentic eruption precursor data from multiple sources to develop hypotheses and forecast the geologic activity

3. Be able to inform non-scientists of the impacts of potential geologic hazards and make recommendations for future mitigation

Modified from: USGS Fact Sheet 2008-3062;
http://volcanoes.usgs.gov/vsc/images/image_mngr/300-399/img350.jpg

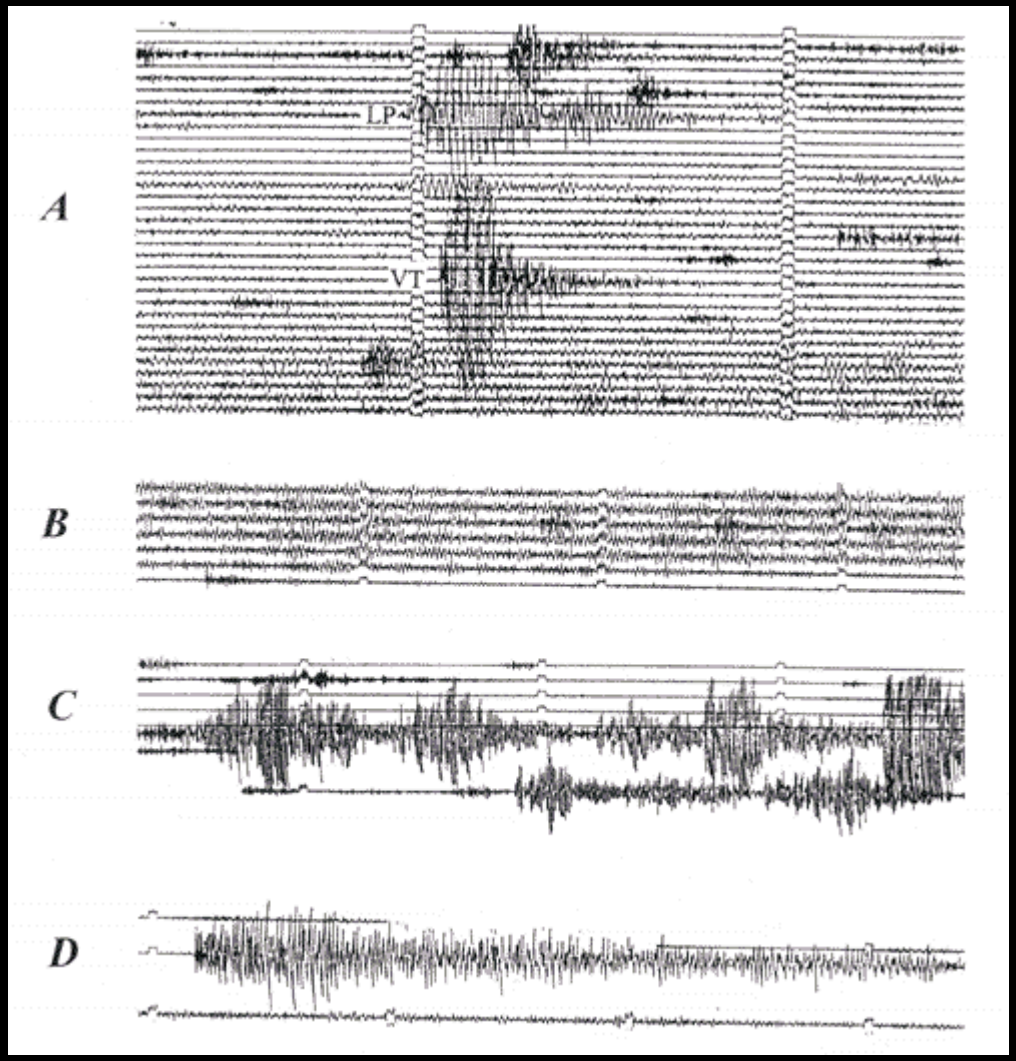
Note to instructors:
The following slides include each data set for all three groups and we recommend each data set is posted on the internal class site (or otherwise made available to students to access as they complete their pre-work for the next class period (Unit 3 day 2 AKA Unit 6).

Please share information about the *next* class period (included in the last slide, #21) at the end of today's class period.

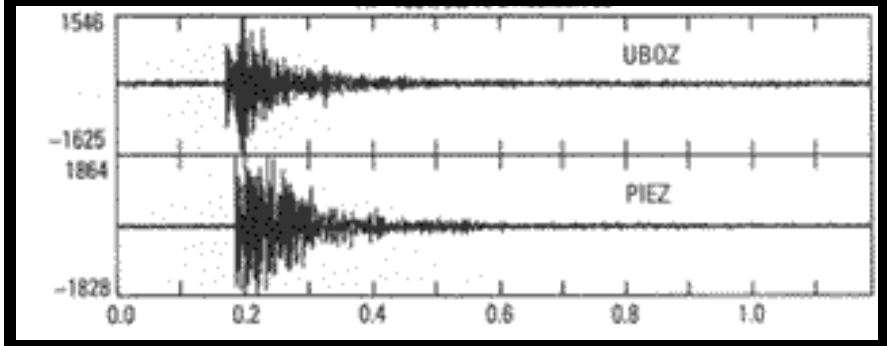
SEISMIC DATA SET 1: THROUGH JUNE 8

EARTHQUAKES

DATA SET 1: THRU JUNE 8



May 15th

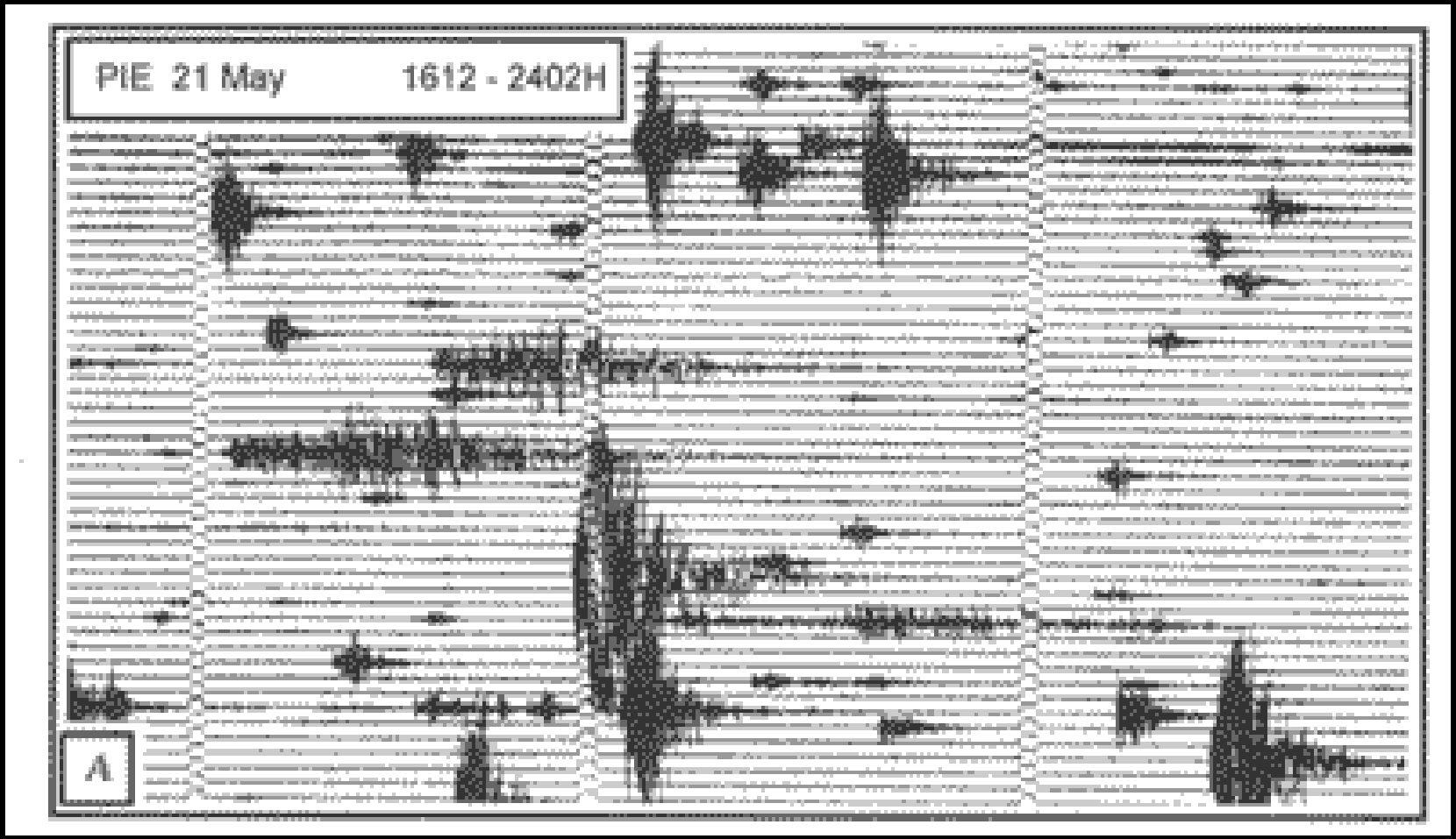


Seismograms of May 15 recorded at stations UBO and PIE (Z). Time marks in seconds are shown.

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.

Both figures from Harlow et al., 1996

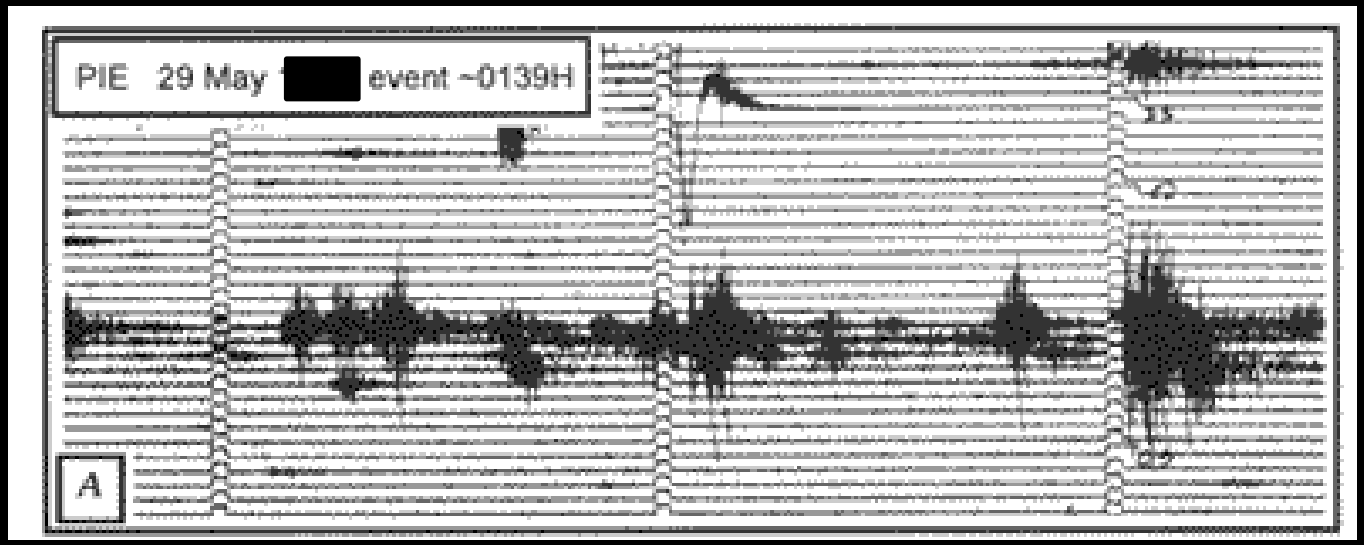
DATA SET 1: THRU JUNE 8



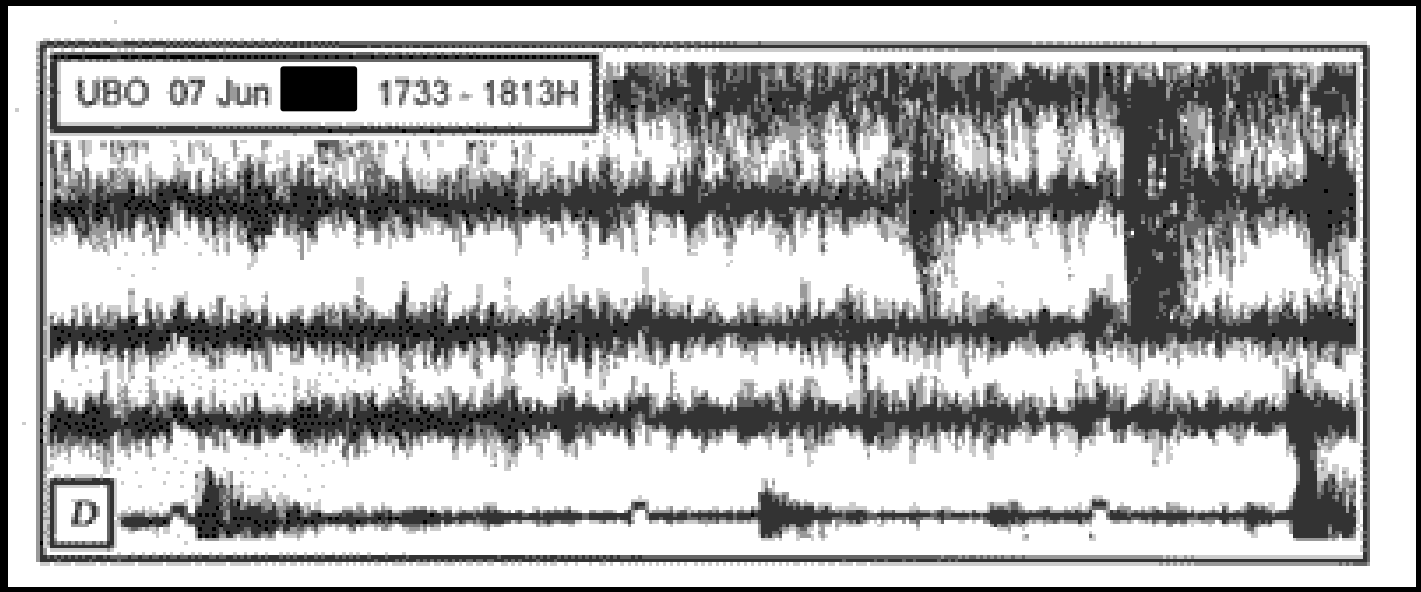
Seismogram from May 21st. Time marks are 60 sec apart.

Figure from Harlow et al., 1996

DATA SET 1: THRU JUNE 8



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



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

Both figures from Harlow et al., 1996

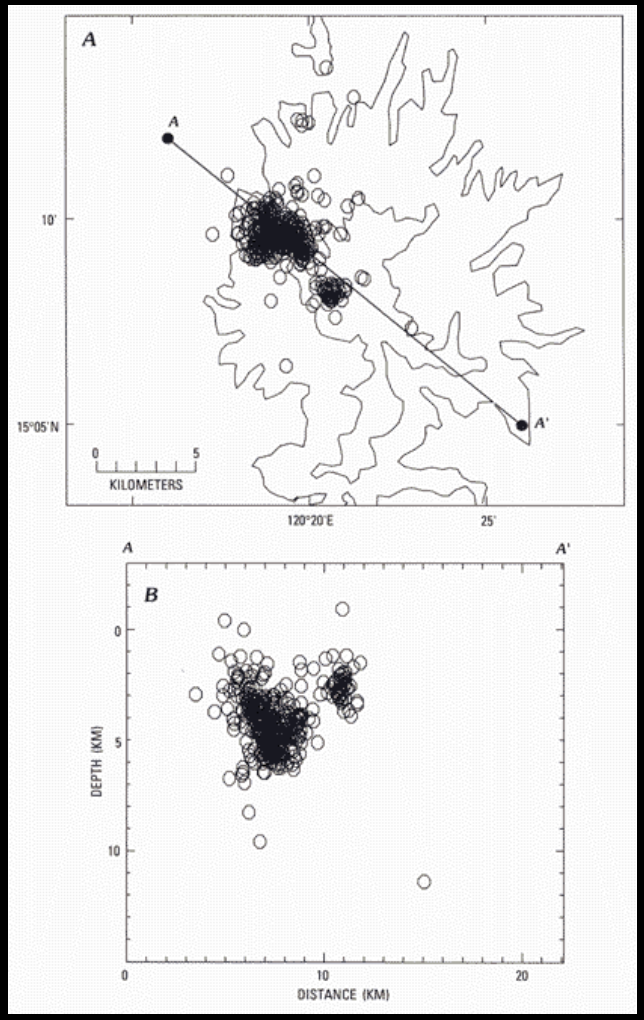
EARTHQUAKES

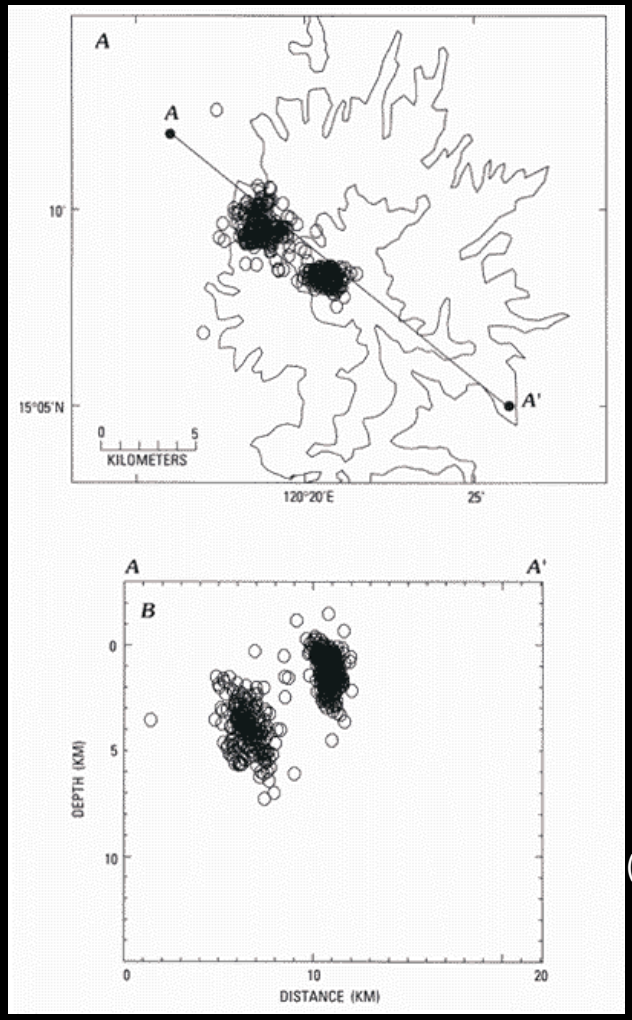
DATA SET 1: THRU JUNE 8

May 6- 31

June 1-7

MAP VIEW





MAP VIEW

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

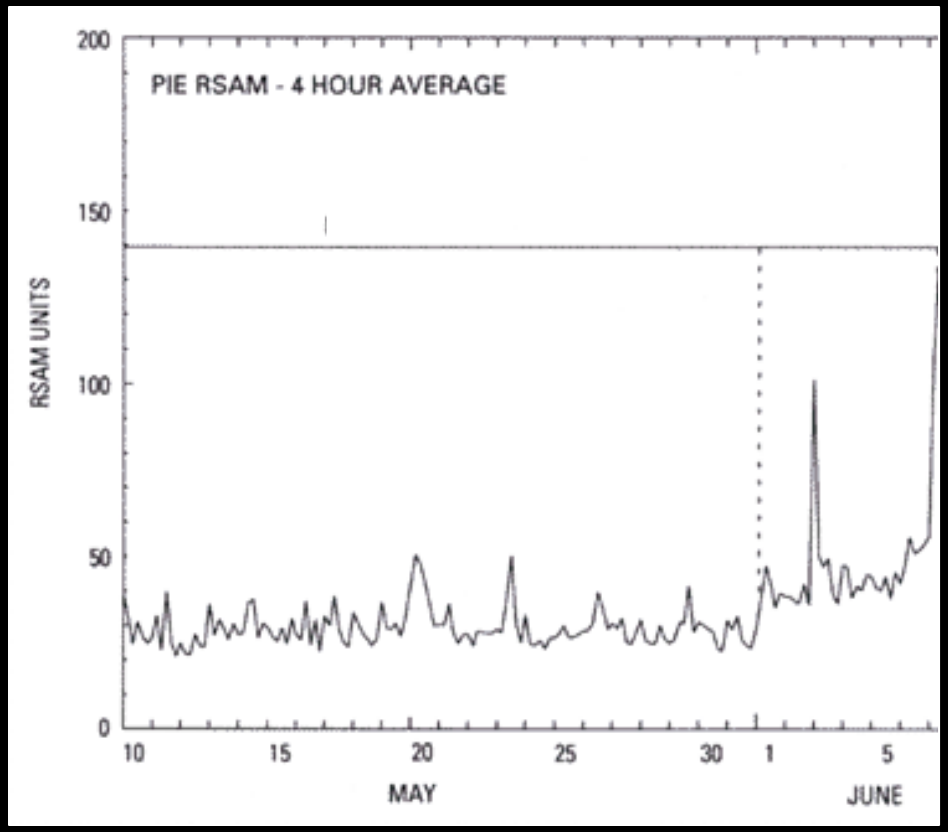
CROSS SECTION (side view) of earthquake locations under the volcano (note location of line A-A' on map above)

Figures from: Harlow et al., 1996

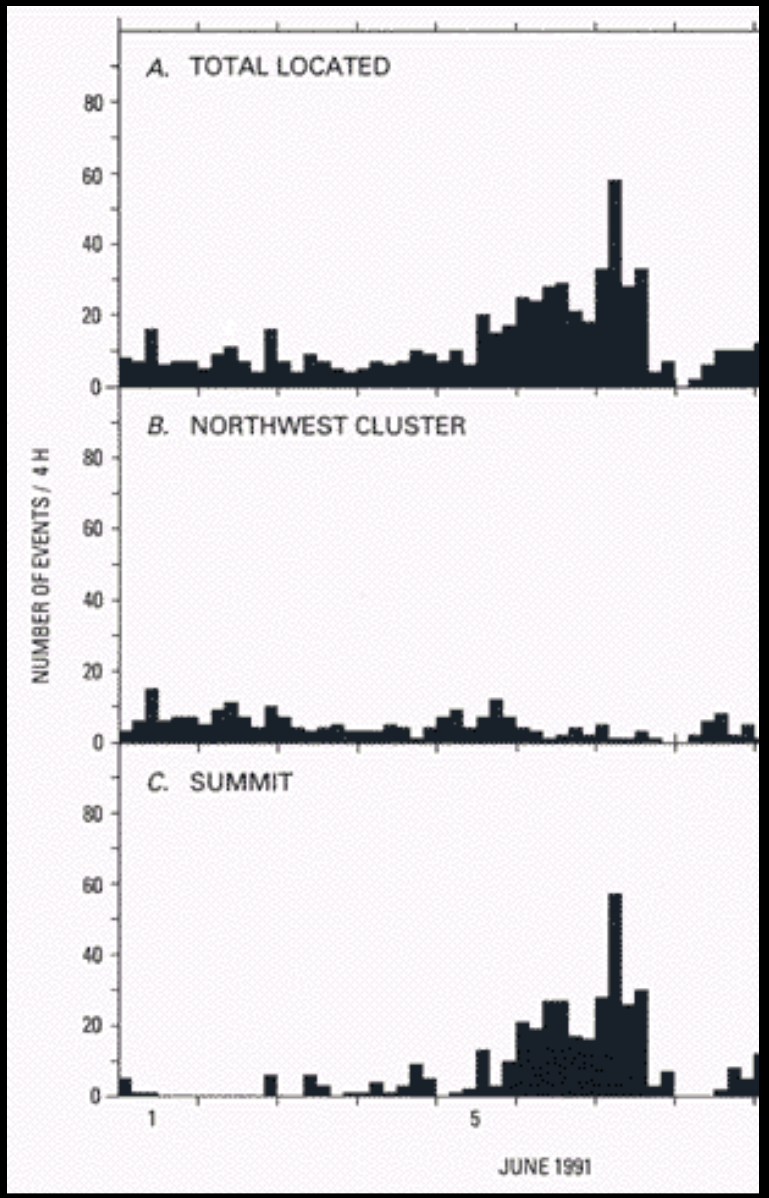
EARTHQUAKES:

DATA SET 1: THRU 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-June 8 at the PIE station.



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.

Both figures from Harlow et al., 1996

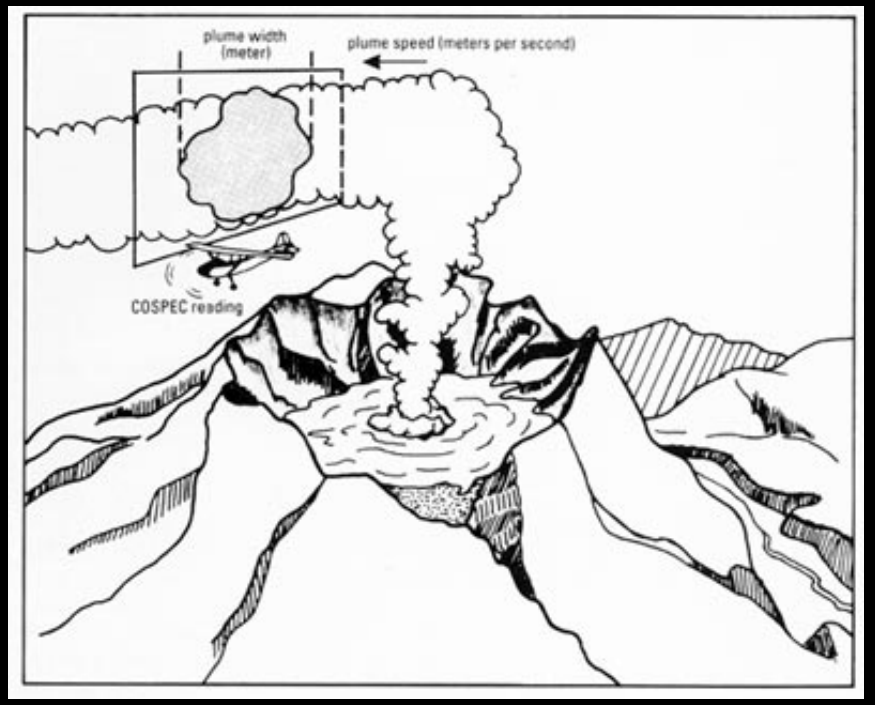
GAS & ASH DATA SET 1: THROUGH JUNE 8

GAS & FUMAROLES

DATA SET 1: THRU JUNE 8

Above and above 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 at right shows north arrow).

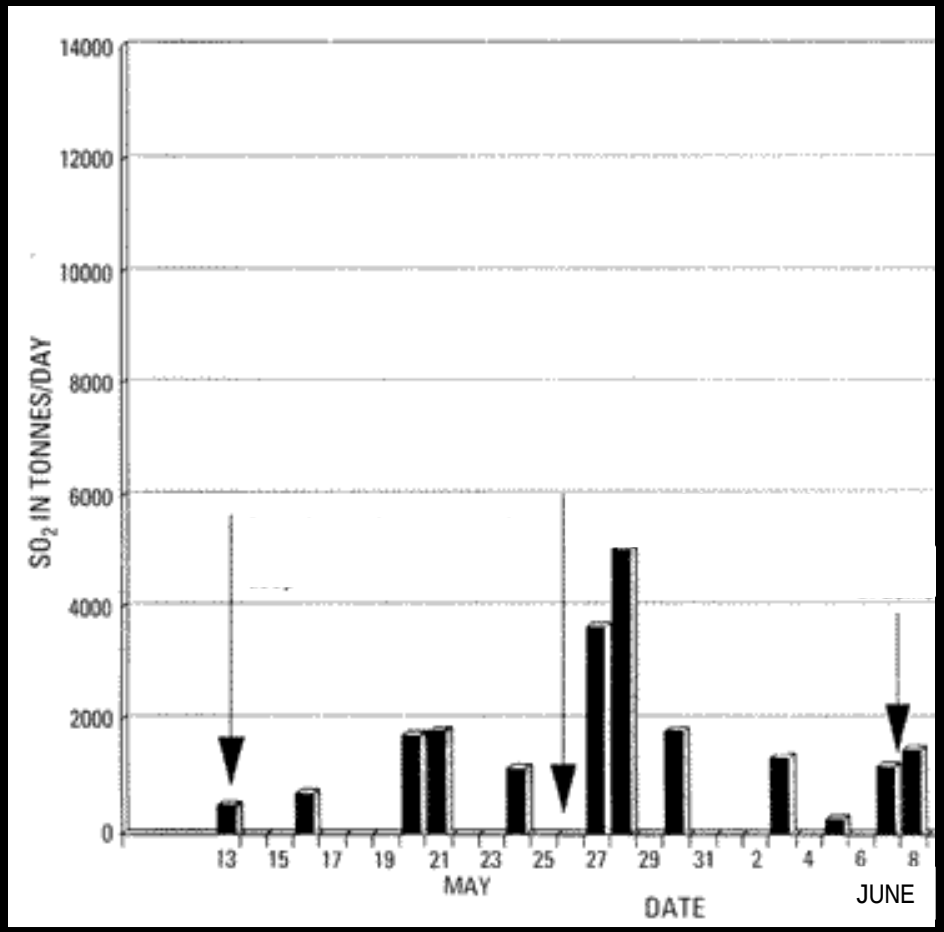
To collect SO_2 flux data, an aircraft carrying the COSPEC instrument flies the plume to measure the concentration of SO_2, which is integrated over the width of the plume and multiplied by the wind speed to get the rate of SO_2 emission.



Upper left from Wolfe & Hoblitt, 1996, Upper right: Ewert et al., 1996, lower right: Daag et al., 1996

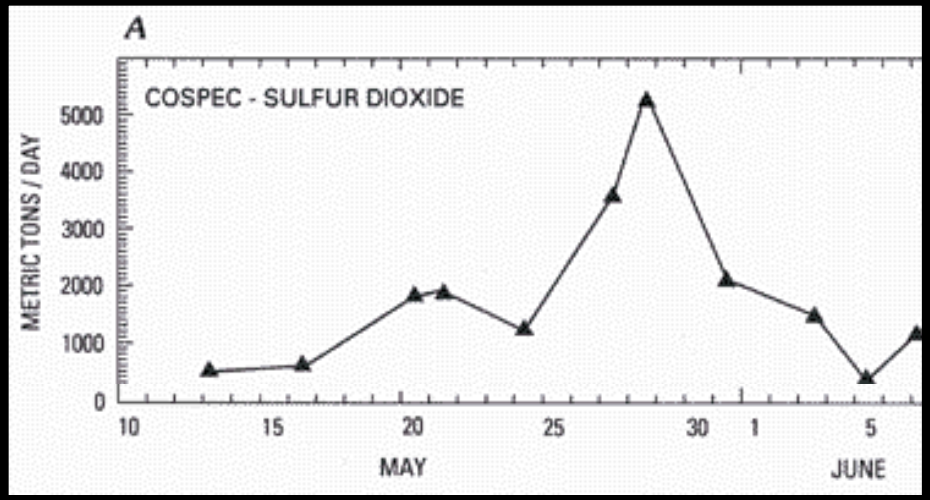
GAS & FUMAROLES

DATA SET 1: THRU JUNE 8



SO_2 emission from May 13 to June 10

On April 2, people in the vicinity smelled hydrogen sulfide (H_2S). 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.



Plot of SO_2 volumes from **May 10 to June 8**, estimated from COSPEC measurements

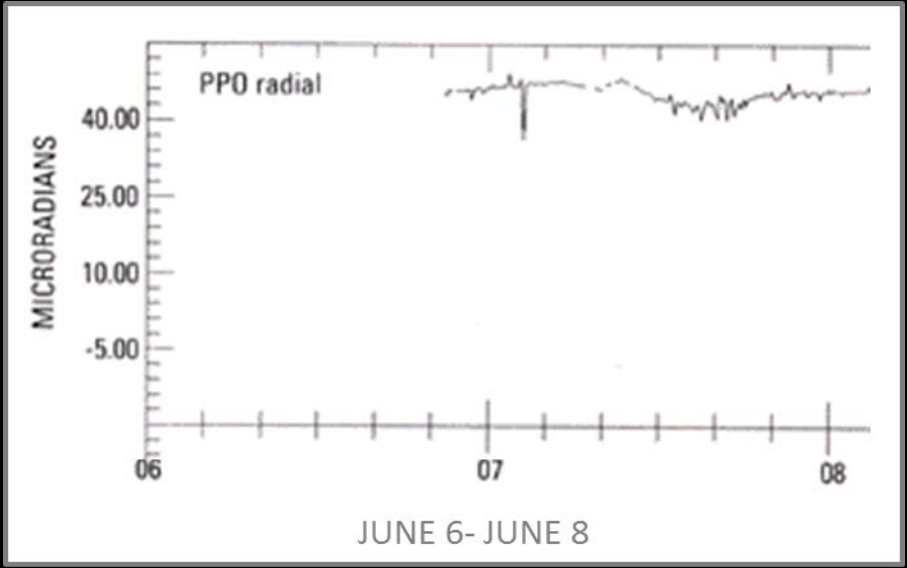
Figures: Left: Daag et al., 1996; Right: Wolfe & Hoblitt, 1996

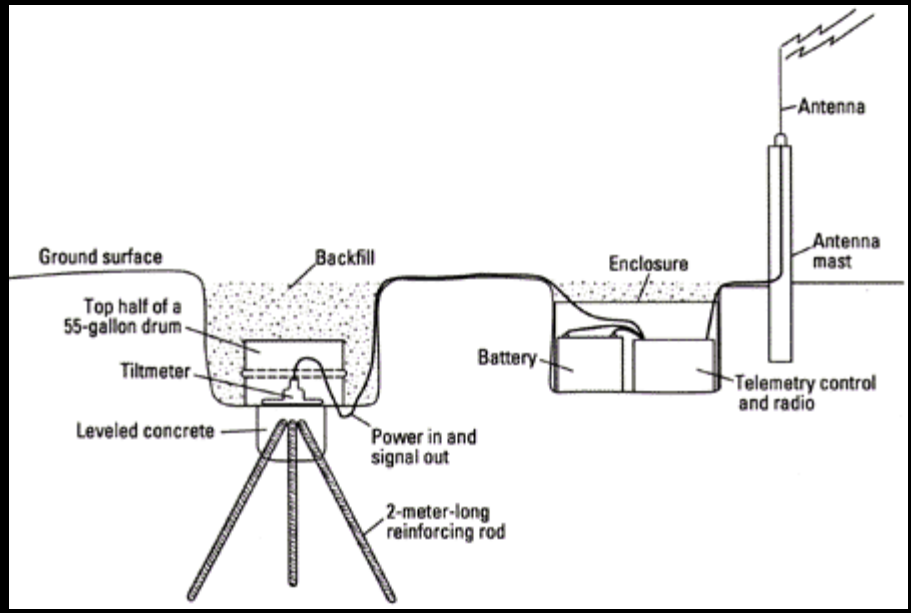
TILT DATA SET 1: THROUGH JUNE 8

DATA SET 1: THRU JUNE 8

The PPO Tilt station was installed 4 km north of 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.



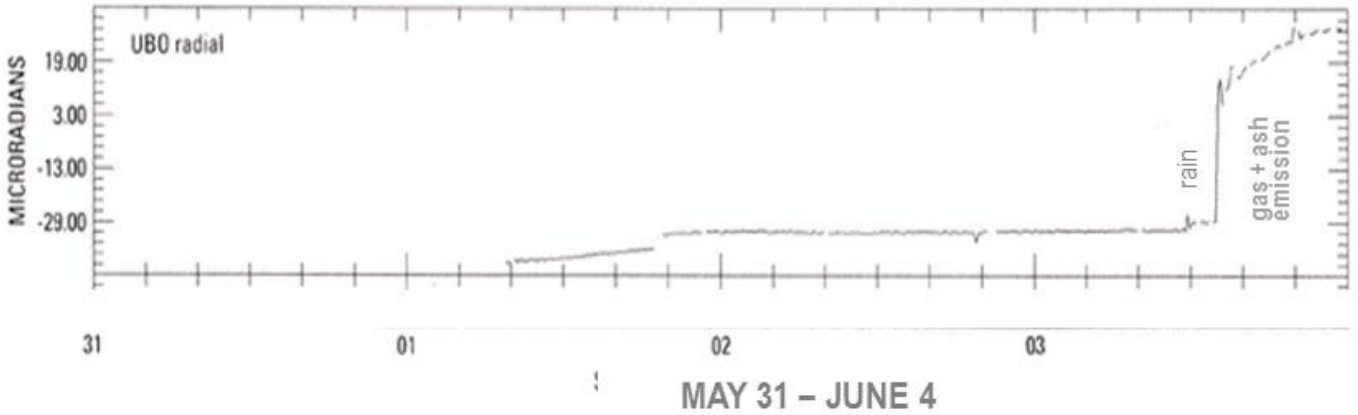


PPO tiltmeter, north side of volcano. Tiltmeters are sensitive to even slight changes in temperature, so burial 1 to 2 m deep is necessary in order to isolate the instrument from diurnal temperature changes .

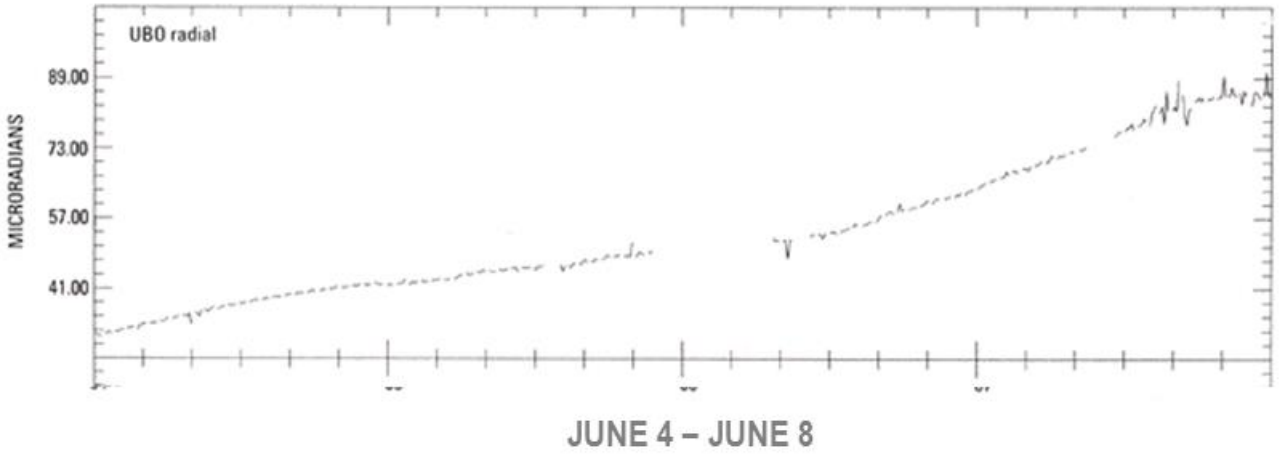
From Ewert et al., 1996

DATA SET 1: THRU JUNE 8

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).

From Ewert et al., 1996

References

Daag AS, Tubianosa BS, Newhall CG, Tungol NM, Javier D, Dolan MT, DelosReyes PJ, Arboleda RA, Martinez, MML, Regalado MTM; 1996, Monitoring Sulfur Dioxide Emission at Mount Pinatubo, *In* Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines; CG Newhall, RS Punongbayan (Editors); Philipine Institute of Volcanology and Seismology, Quezon City and University of Washington Press, Seattle and London

Ewert JW, Lockhart AB, Marcial S, Ambubuyog G, 1996, Ground Deformation Prior to the 1991 Eruptions of Mount Pinatubo; *In* Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines; CG Newhall, RS Punongbayan (Editors); Philipine Institute of Volcanology and Seismology, Quezon City and University of Washington Press, Seattle and London

Harlow, DH, Power JA, Laguerta EP, Ambubuyog G, White RA, Hoblitt RP, 1996, Precursory Seismicity and Forecasting of the June 15, 1991, Eruption of Mount Pinatubo; *In* Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines; CG Newhall, RS Punongbayan (Editors); Philipine Institute of Volcanology and Seismology, Quezon City and University of Washington Press, Seattle and London

Ramos, E, Laguerta, EP, Hamburger, MW, 1996, Seismicity and Magmatic Resurgence at Mount Pinatubo in 1992; *In* Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines; CG Newhall, RS Punongbayan (Editors); Philipine Institute of Volcanology and Seismology, Quezon City and University of Washington Press, Seattle and London

Wolfe EW and Hoblitt RP, 1996, Overview of the Eruptions, *In* Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines; CG Newhall, RS Punongbayan (Editors); Philipine Institute of Volcanology and Seismology, Quezon City and University of Washington Press, Seattle and London

FOR NEXT CLASS:

- Complete “Unit 6 Pre-work” posted on class website (Blackboard”) and bring it to the next class period
- Be sure to find assigned site location (and write that down/bring site name to class)

- Be ready to help your classmates learn about the data you examined today!