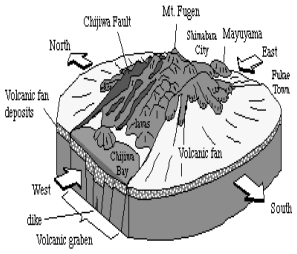
Unzen Volcano

Analysis of the 1990-1995 Eruption
With Emphasis on Pyroclastic Flows
and Edifice Collapse Hazards

Where in the world is Unzendake?

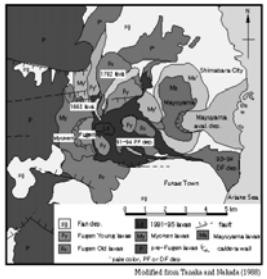
- Unzendake (Unzen Volcano) is located on the Shimabara Peninsula on the island of Kyushu in Southwest Japan
- This is an aerial photo of Unzen looking westward (note the presence of a heavily populated area in the foreground)

Geologic Setting



- Subduction volcanism
  - Philippine plate subducting beneath the Eurasian plate
- Unzen Graben
  - 70 km west of the volcanic front of southwest Japan
  - Extends west to east 30-40 km
  - North and south boundaries obscured by volcanic rocks
  - Vertical offset of 200m
  - Graben still subsiding

Geologic Setting Continued…

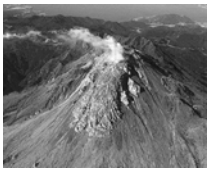


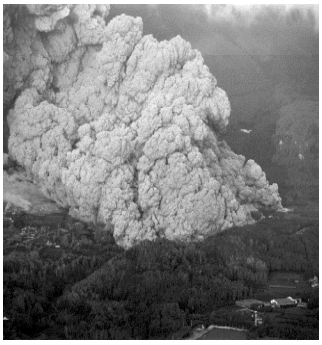
- Unzendake is a general name that includes all of the volcanic features in the area
- Young volcanic features include (in order of decreasing age)
  - Nodake
    - Volcano→Avalanche
  - Myokendake
    - Volcano→Avalanche
  - Fugendake/Mayuyama
    - Mayuyama→Avalanche
    - Fugendake→ACTIVE

Historical Eruptions

- 1663
  - Furuyake lava flows
    - Olivine bearing basaltic andesite
    - Erupted from vent formed in Myokendake scarp
    - Flows reached 1 km from vent
- 1792
  - Activity preceded by earthquakes and fumarole activity
  - Extrusion of Shin'yake (dacitic) lava→2km from vent
  - May 21→Mayuyama lava dome collapses
    - Resulting landslide and tsunami kills 15,000 people

Recent Activity: 1990-1995





1990-1995 Eruption Characteristics

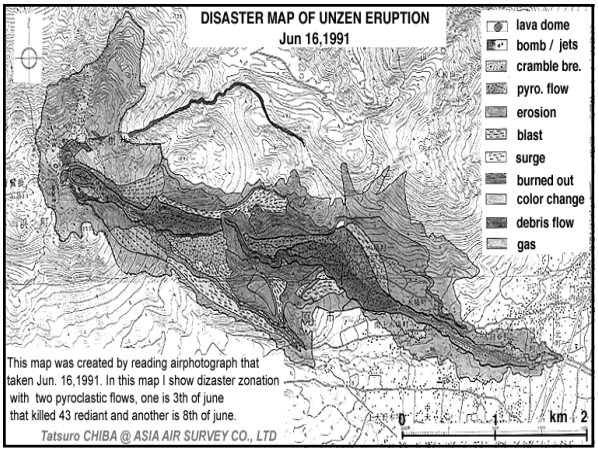
- Early phreatic and phreatomagmatic eruptions—"Mid May Crisis"→starts Nov. 17, 1990
  - Ash eruptions
- Lull in activity between late January 1991 and early February of the same year
- Inflation of summit accompanied by high frequency earthquakes beneath Jigokuato Crater (excavated by a phreatic explosion on Nov 17, 1990)
- Dacite lava emerges from Jigokuato on May 20, 1991
- Lava extruded onto the eastern flank of the volcano—dome collapse along the front of the flow—triggers Merapi type PFs.
  - PFs tended to flow down the Oshigadani and Akamatsu-dani valleys; or would follow the Mizunashi River
  - Most PFs are of this type---10,000 recorded between 1991-1994
    - Distance traveled from summit—1-2 km
  - Powerful PFs recorded on 3rd, 8th June (1991),September 15 (1991) and 23rd June (1993)—were Pelee type PFs (generated by explosions)
    - Explosions triggered landslides—landslides triggered PFs
    - These larger PFs traveled up to 5.5 km from the summit
    - PF on 3rd of June, 1991 killed 43 people, including volcanologists Maurice and Katia Krafft and Harry Glicken

1990-1995 Eruption Characteristics Cont…

- February 1993
  - Formation of lava lobes at summit—more PFs
- February 1995
  - Cessation of pyroclastic flows and dome deformation

Hazards of Living Near an Active Volcano

- Block and ash flows
  - Confined to valleys
  - Generated PFs
- Future edifice collapse
- Lahars
- Earthquakes
- Tsunamis (generated by either edifice collapse or by earthquakes)—Not from the 1990-1995 eruption



Government Response

- Evacuations
  - 12,000 people evacuated in 1991
  - Number of people evacuated dropped to 3,000 by 1993
- Constant Monitoring
  - Seismic
  - Aerial Surveys
  - Photographs/video
  - **Unzen Scientific Drilling Project (USDP)**
    - **Scientists drill into the volcano in an attempt to get samples of magma from the 1990-1995 conduit**
    - **Drilling started in 2003, reached conduit in July 2004**
    - **Discovered hydrothermal cooling of magma**

Lahars

- Heavy rain at the summit can mobilize loose volcanic sediment→lahar
- Serious threat for those living along the Mizunashi River
- In order to combat the problem, government officials oversaw the construction of a discontinuous dike system
  - 3 sedimentary basins
  - Interlocking concrete blocks
  - Keep lahar in the Mizunashi R. valley
  - Allow some material to overflow
    - Lowers inertia of flow→less distruction
  - Excavation of debris→preparation for next lahar

Human Toll

- 44 people killed between 1990-1995
  - Main causes of death
    - Ash inhalation (asphyxiation)
    - Intense heat—burns
- 2000+ houses destroyed
- Loss of life was at a minimum because the area was properly evacuated
  - Early warning system
    - Geo-thermal measurements
    - GPS
    - Tiltmeters
    - Electrical resistivity
- Even though the 1990-1995 eruption is over, the city of Shimabara (population 39,138—2003) is still at risk