Close relationship between earthquakes and volcanoes
760 active volcanoes; one million earthquakes a year
LARGE HISTORICAL ERUPTIONS

- **Vesuvius, Italy**, 79 AD – Destroyed Pompeii and Herculaneum. Killed **16,000 people**. 2 Cities were buried and rediscovered in 1595 (1748?).

- **Tambora, Indonesia** 1815- **92,000 dead**, largest historically.

- **Krakatau, Indonesia** 1883- **36,447 dead**, island destroyed, Tsunami.

- **Mt. St. Helens USA** 1980- Lateral blast & mudflows killed **54 people**, destroyed 100 homes
Volcano watch (Mexico, 1943)
Most famous volcanic eruption

- August of 79 AD (Christian era – birth of Jesus)
  - Prophet Mohamed S.A.W (570AD)

- Buried 1,700 years

- Vesuvius, a huge volcano which had been mostly dormant the previous few centuries, roar into action sending a volcanic cloud into the atmosphere (this cloud probably reached at least 30 km in height).

- Dropped a thick blanket of red hot volcanic ash fell on the cities (Pompeii & Herculaneum).
The Vesuvius eruption

A map of the Bay of Naples. Pompeii was destroyed by ash fall, while Herc. was destroyed by a large mudflow triggered by heavy rains on the recent ash fall.
Classification of Volcanoes

- **Shape** - Morphology of Cone
  - Shield Volcano (Perisai)
  - Strato or Composite Volcano (Komposit)
  - Volcanic dome

- **Eruptive Style** - Kind of eruption (e.g. explosive or not)

- **Tectonic Environment** - Tectonic Setting of the volcano
  - Mid-Ocean Ridges
  - Convergent Margins – Indonesia
  - Hotspots – Hawaii; batuan basalt

http://www.answers.com/topic/lava-dome
Shield volcano (perisai)
SHAPE (Stratovolcano)

Consider as armed and dangerous!!
Mt. Lasen, California
(exremely dangerous!!)
Non-Explosive

Explosive
Figure 4-34 The worldwide distribution of volcanoes, illustrating the relationship between plate tectonics and volcanism. Note the coincidence of volcanic activity with plate boundaries, forming an alignment of the volcanoes surrounding the Pacific Ocean basin, the "ring of fire."

Tectonic Environment

- Shield volcano
- Composite volcano
- Volcanic domes
VOLCANIC HAZARDS

- Lava flows (aliran lava)
- Dome eruptions (letusan dome)
- Ejected material (bahan terlantun)
- *Nuees Ardentes – debu panas* (ash flow)
- Poisonous gases (gas beracun)
- Volcanic mudflows (Lahars)
- Tsunamis
LAVA FLOWS (1)

- Three major groups of lava
  - Basaltic (most abundant); andesitic; rhyolitic

- Rate of flow varies
  - Basalt (1m/hour – m/day) -- slow

- Flow hundred of Kms

- Deaths rare: “most lava flows are slow enough that people can easily move out of the way as they approach”

- High property damage
LAVA FLOWS (2)

- Control methods: (employ to deflect lava flows away from populated/high-priority areas)
  - Bombing
  - Hydraulic chilling
  - Constructing walls (eg. Gunung Merapi)
DOME ERUPTION

- Explosive eruptions of rocks and gases
- Pressure builds up under viscous & solidifying lava
1. Strong lateral Blast

2. Full vertical Blast

Mt St Helens, Washington, US (May 18, 1980)

Exceeding the speed of sound!!

343 meters per second
Figure 5.25 Mount St. Helens. (a) A blast erupted from the volcano on Sunday morning, 18 May 1980, and culminated with a powerful pyroclastic flow. (b) The force of the pyroclastic flow was evidenced by the downed trees stripped of their bark in the "blow-down" area. This is the area where most of the fatalities occurred.
Controls on Eruptive Style

• **Composition** -- kandungan
  – **Silica Content** - Amount of SiO$_2$ that lava contains
    • The higher the amount of SiO$_2$ the more explosive the eruption
  – **Gas & Water Content** - Amount of volatiles (CO$_2$, Water, Sulfur, etc)
    • The higher the amount of volatiles dissolved in magma the more explosive the eruption

• **Viscosity** -- kelikatan
  – How easily material can flow; Low viscosity, lava flows easily; high viscosity, it does not
  – The more viscous the lava the more explosive the eruption: silica rich; higher resistance to flow (water vs milk shake)
  – **Temperature**: Higher Temperature = Lower Viscosity
  – **Composition**: Higher Silica Content = Higher Viscosity
  – **Water Content**: Higher Water Content = Lower Viscosity
EJECTED MATERIAL (pyroclastic hazards)

• Explosive volcanism – pyroclastic activity
• Tephra: batu terbang !!
• Debris
• Ash
TEPHRA

Tephra consists of a wide range of rock particles, including combinations of pumice, glass shards, crystals from different types of minerals, and shattered rocks of all types.

Ash
Tephra less than 2 millimeters in diameter.

Lapilli
Tephra between 2 and 64 millimeters in diameter.

Blocks/bombs
Tephra greater than 64 millimeters in diameter.

A sample of tephra erupted by Mount St. Helens on May 18, 1980.
Pyroclastic (broken rock); volcanic bombs
Greek : pyro "fire" & clastos "broken"

Tephra – generic name
Pyroclastic flow @ Nuee Ardentes

- Glowing avalanches (most deadly!!)
  - ignimbrites, and *nuee ardentes* “glowing/burning cloud in french” @ hot avalanches @ ash flow

- Hot cloud (>600°C) rock, ash, dust and gas travels at great speed (100km/h) for distances upto 10 kms

- Eg. Mt Pelee (1902-03)
  - Killed 30,000 people
  - Destroyed town

Mount Pelee eruption of May 8, 1902
Pyroclastic flow on Unzen Volcano, Japan, on March 23, 1993

$V = 100 \text{ km/hr}$

$T = 600 \degree \text{C}$
Pyroclastic flow

Pyroclastic flows are an extreme form of hazard.

Nuée Ardente (the glowing cloud)
Pyroclastic Flows typically move at speeds of over 60 mph (100 km/hr) and reach temperatures of over 800 °F (400 °C).

USGS geologist examines pumice blocks at edges of pyroclastic flow deposit.

Mount St. Helens

August 7, 1980

Mount St. Helens

October 17, 1980

USGS Photos by P.W. Lipman (inset) and T.A. Leighley
Poisonous gases (1)

- Various gases; water vapor, $\text{CO}_2$, CO, $\text{H}_2\text{S}$, $\text{SO}_2$
- Water + $\text{CO}_2$ – 90% of emitted gases
- $\text{SO}_2$ – acid rain (sulphuric acid)
- $\text{CO}_2$ – asphyxiation ($\text{sesak nafas}$)
- **EG**: Japan
  - volcanoes are monitored to detect releases of poisonous gas ($\text{H}_2\text{S}$)
  - Use Siren to warn people (run to high ground)
Poisonous gases (2)

- Travel for tens of kms downwind
- Poisonous to humans, animals & plants
- **EG: Lake Nyos:** Aug 21, 1986
  - Volcanic lake in Cameroon, Africa
  - Poisonous gases (mostly CO$_2$)
  - 1700 people + 3000 cattle died by asphyxiation
Lake Nyos

Nyos degassing project
Volcanic mudflows (Lahars)

• Collectively known as Lahars (Indonesian word !!!)

• Large volume of loose volcanic ash becomes saturated and unstable and moves suddenly downslope.

• **EG: 1985: A lahar in Armero, Colombia (South America). Killed 22,000 people**
VOLCANIC MUDFLOWS or LAHARS

Mencari barang berharga !!
Tsunami

• Giant sea waves produced by volcanic eruptions

• **EG**: 1883 Krakatoa eruption in Indonesia
  – Destroyed 300 coastal settlements
  – Killed 36,000 people
Tsunami krakatao vs Acheh Tsunami

12-Feb-10

wzwy :: 2010
• **Lava & Pyroclastic Flows**
  – Hot, destroy everything in their path

• **Ash Falls (volcanic ash – pulverized rock)**
  – Danger of suffocation; clogging of engines, etc.

• **Mudflows**
  – Like large landslides will sweep the foundations of houses, flood towns.

• **Gas Emissions**
  – \( \text{SO}_2 + \text{H}_2\text{O} \)-sulfuric acid

• **Tsunami**
  - Underwater Eruptions or Major Eruptions on Islands
Monitoring volcanoes

Perubahan kandungan gas, CO2 dan SO2.

Melihat takungan air, glasier yang boleh menjadi punca lahar

Perubahan permukaan volcano (sudut cerun) mengambarkan aktiviti di dalam volkano

Gegaran bertambah sebelum letusan berlaku