

Pinatubo (1991)

Redoubt (1989)

Nevado del Ruiz (1985)



Volcanic Materials and Hazards

- Volcanic Material
- Lava Flows
- Pyroclastic Material
- Volcanic Gases



Lake Nios (1986)

Pinatubo (1991)

Nyiragongo (2002)



Santorini, ~1600 B.C.

Volcanic Hazards and Mitigation

Lava Flows

Pahoehoe lava
>less viscous
>ropey
>fast-flowing

A'A' lava ≻more viscous ≻blocky <u>>slow-flowing</u>



Volcanic Hazards and Mitigation

How fast does lava flow?





Pahoehoe: RUN! ♦ can flow at 100km/h (60 mph) lava flows can travel 10s of km usually don't kill people but destruct!



Lava Flows and Hazard Mitigation

Heimaey, Iceland 1973





Photo: Time Life Books

build blockades hose down (sometimes!)

Lava Flows and Disaster Prevention





FOUR SEASONS RESORT Hualalai at Historic Ka'upulehu



- aggressive development since 1990s
- development in areas of recent activity
- Kona airport runway extended 1994, 2005 second runway considered, 2013 not yet built but still in 2010 master plan

SIO • 2010: 2.6 Mio passengers





Pyroclastic Debris (tephra)

- ash: sharp glassy particles (powder size) lapilli or cinder (marble-to-plum size)
- bombs (basketball-to-house size)

• pumice

MITIGATION
none when happening
monitoring/evacuation
warning air traffic by remote sensing

Volcanic Ash

source: NASA/wikipedia







Eyjafjallajökull, 2010 •extensive volcanic ash •closure of European airspace •impact on global transportation •airlines: \$1.7 billion losses •Kenya farm workers temporarily laid off •Kenya: economic losses at \$4 Mio/day

azards

Ash Clouds

Redoubt, Alaska Dec 15, 1989

Photo: National Geographic

- KLM Flight from Amsterdam to Tokyo
- Boeing 747 at ~10 km altitude
- ~ 250 people on board
- all 4 engines shut down
- steep descent in 12 min to 4km/
 1.5km above mountains
- damage: \$80Mio

• clouds difficult to see or distinguish from weather clouds

REDOUBT VOLCANO

REDOUB

EXTENT OF ASH FALL

NORTH

_oDenali

Talkeetna

Healy

nchorage

40 60 80

- glassy ash melts in hot engines
- engines shut down

Mt. Pinatubo, Jun12, 1991



St. Pierre, Martinique, 1902



- ash with hot air and gases
- extremely destructive
- extremely fast moving (300 km/h) ("volcanic hurricane")

Causes

Pyroclastic Flows

- collapse of eruption column overspilling of crater rim
- dome collapse
- directed blast

MITIGATIONmonitoringevacuation

e.g. 1991 Mt. Pinatubo < 1000 died; could have been 20,000 (1 Mio evacuated)

yles and Hazards

Mt. St. Helens, 1980



Nevado del Ruiz, 1985 (22,000 fatalities in Armero)



Lahars

ash with water fast moving (50 km/h)

Causes

- rain caused by eruption itself
- ash flow intersecting rivers
- drainage of crater lake (e.g. Mt. Kelut)
- melting of ice cap or glaciers
- post-eruption storms (e.g. Pinatubo)

MITIGATION

- monitoring
- evacuation (unpredictable?)
- flood channels
- draining crater lakes by tunnels (e.g. Mt. Kelut)

d Hazards

Volcanic Gases

sudden release of volc. gas (CO₂)
odorless/heavier than air
escape long after eruption
only sign of activity ?



Lake Nyos/Oku Volcanic Field, Cameroon, 1986 1700 fatalities



 $H_2O(50\%),$

• the next disaster?

Volcanic Gases

- Popocatepetl/Mexico
 less than 100km from M. City
 emission of CO₂, SO₂ (+traffic!) (1990s: 100,000 children/yr)
- 9 Mio people but evac. plan for 400,000

Mitigation
unclear
evacuation (unpredictable?)
perhaps monitoring

Mt. Atitlan/Guatemala

- 3535m/11,598 ft

- explosive
- -last known eruption: 1853
- caldera



Oct 8, 2005:

SIO15

- erosion, mudslides after Hurricane Stan
- Panabaj destroyed; 160 killed/250 missing
- people since returned

WHY DO PEOPLE LIVE THERE? fertile soil: coffee, tea, cane sugar, rubber, macadamia, bananas, lumber

EROSION

vegetation slow to come back
 increased erosion risk
 particularly wet climates
 San Pedro Toliman

Panajachel

Photo: NAS

Tsunami

Santorini, Greece ~1600 B.C.

Krakatau, Indonesia

~1600 B.C. (Atlantis?) • no fatalities on Santorini • 70 m tsunami on Crete (120km/75mi) • demise of Minoan culture

1883 Eruption

- 36,000 fatalities
- 10% from volcanic eruption (pyroclastic flow)
- 90% from tsunami



Excavation, Akrotiri (1967)

- no skeleton found

Santorini, ~1600 B.C.

- earthquake might have alarmed residents
- over 1 foot of ash in Turkey (> 200 mi)
 70m high tsunami on Crete (100 mi)
- end of Minoan Civilization
- Atlantis?

SIO15-14: Lecture 8 Volcanic Eruption Styles and Hazards









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