

Volcanoes: Overview, Seismic Monitoring, and Fuego Example

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Outline

- Basic overview of volcanoes and why/how they form
- Seismic monitoring of volcanoes
- Fuego eruption (compared with the Kilauea eruption and the differences between the two volcanoes)

Where Volcanoes Form:
Subduction Zones (Ring of Fire)
Mid-Ocean Ridges (Iceland)
Hot Spots (Hawaii)

High Temperature and Pressure
Magma forms ~100 km deep
Magma rises due to buoyancy

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"



Topinka, USGS/CVDP, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

Two basic types of eruptions:

1) Effusive (Kilauea)

2) Explosive (Fuego)

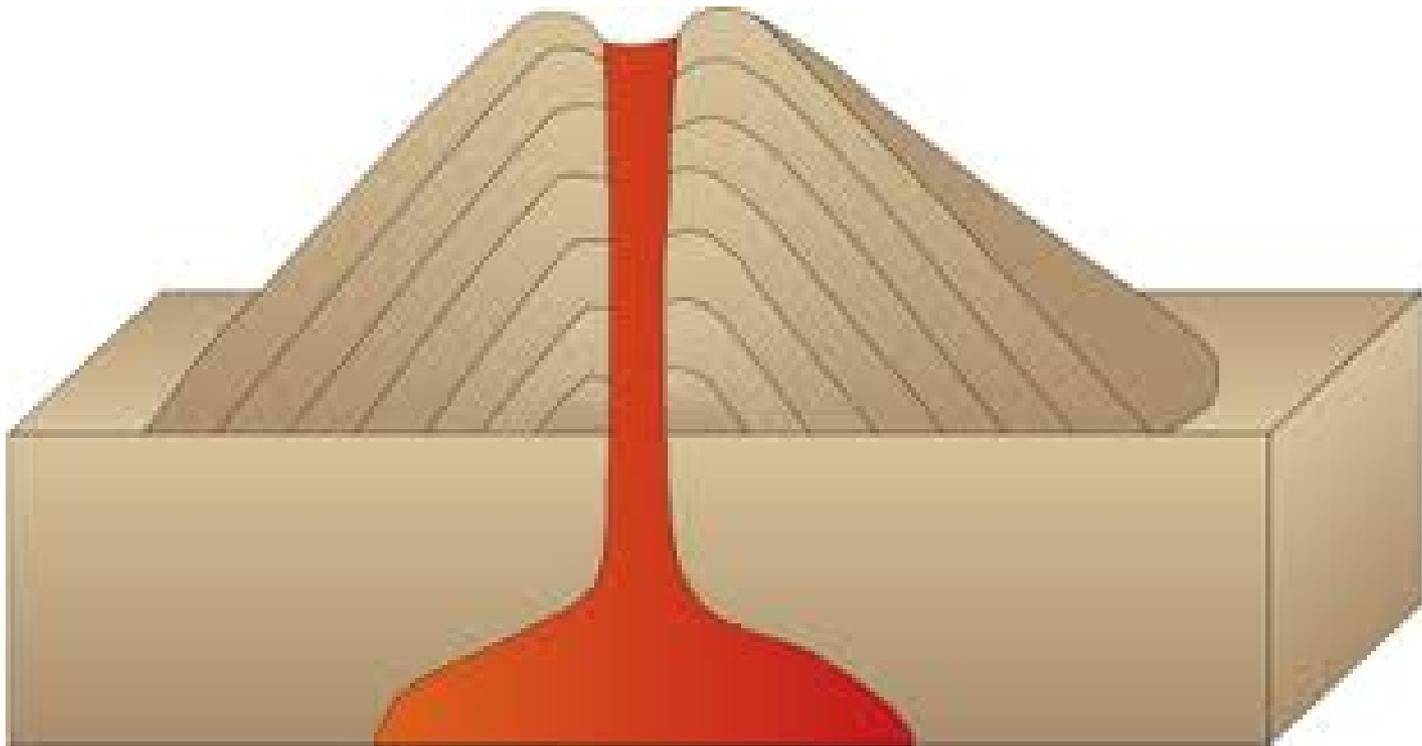
1) Low Silica - Basalt (Kilauea)

Fluid lavas; low gas content

2) High Silica - Andesite-Rhyolite (Fuego)

Stiffer lavas; high gas content

“Balloon and Straw” models – too simple



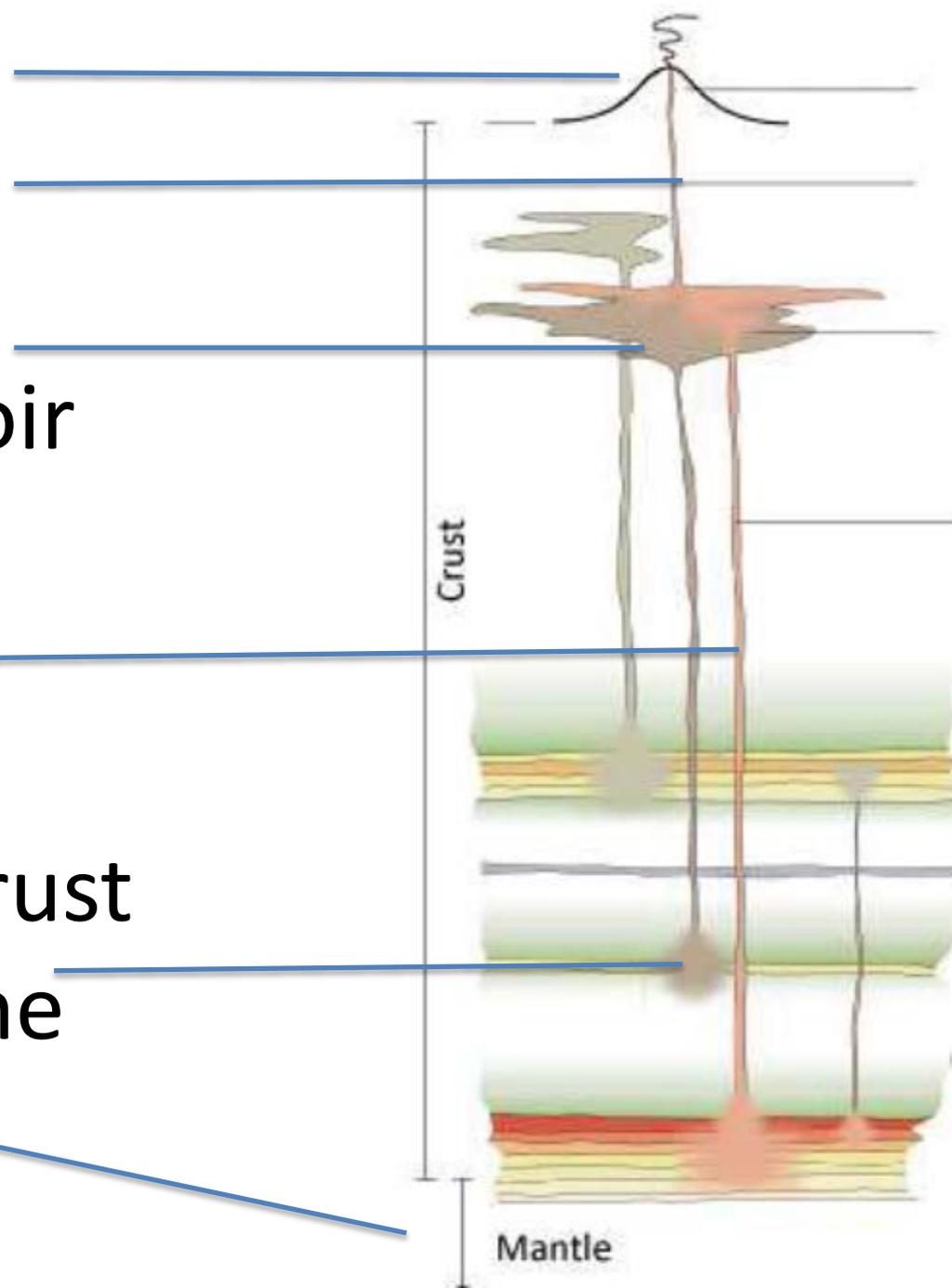
Volcano
Conduit
Magma
Reservoir

Dike

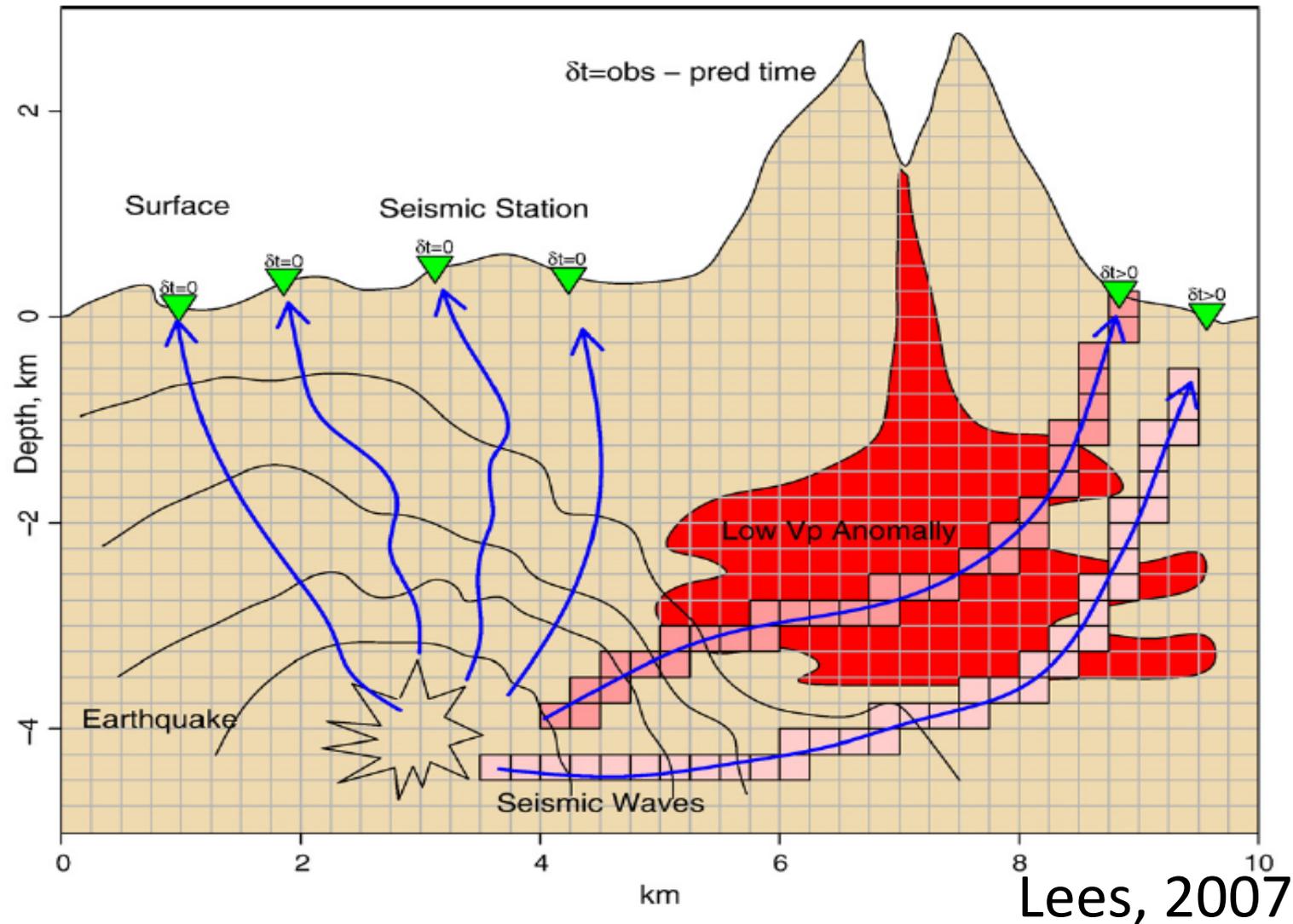
Lower Crust

Hot Zone

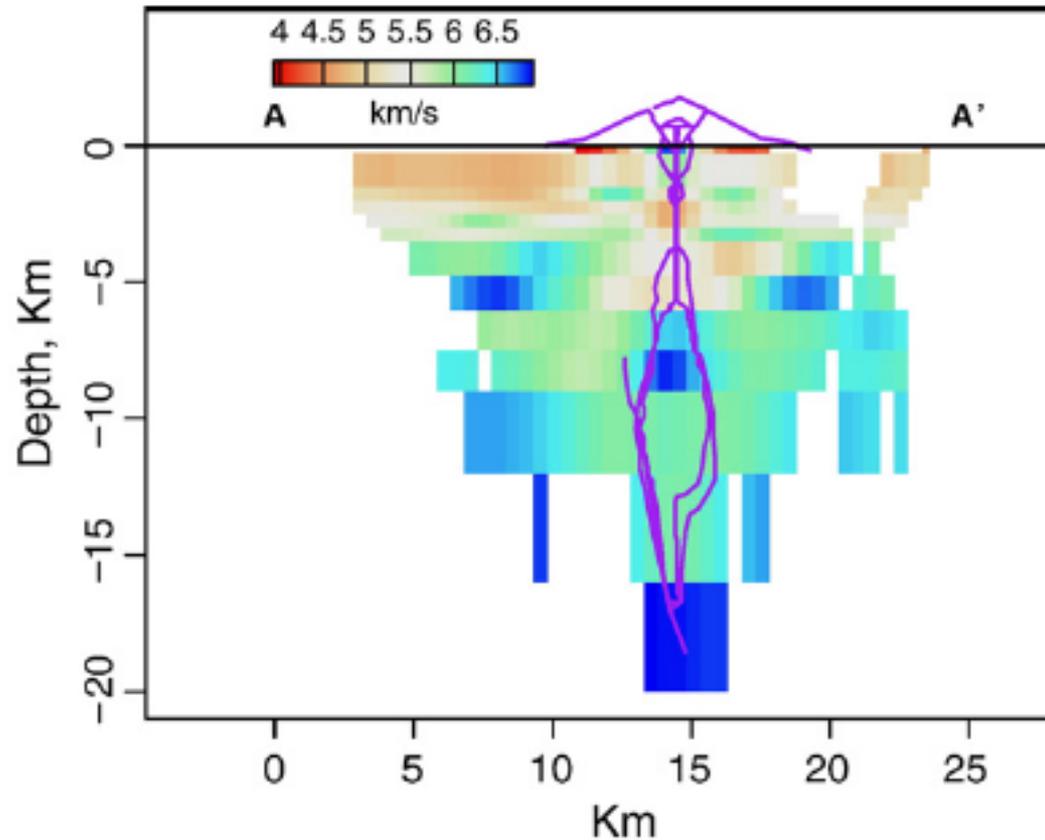
Mantle



Model – blocks and seismic ray paths



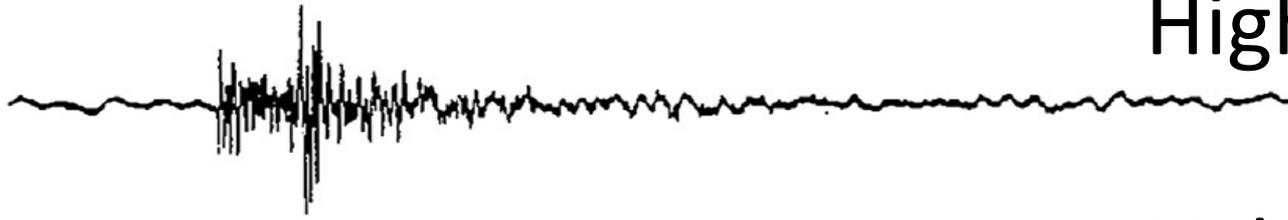
Mount St. Helens – cross section showing seismic velocities



Lees, 2007

The previous figures showed mainly spatial features of volcanoes. Now we look at how magma moves, and earthquake activity evolves in time, before eruptions. There are several different types of earthquakes that occur at volcanoes. These represent different processes.

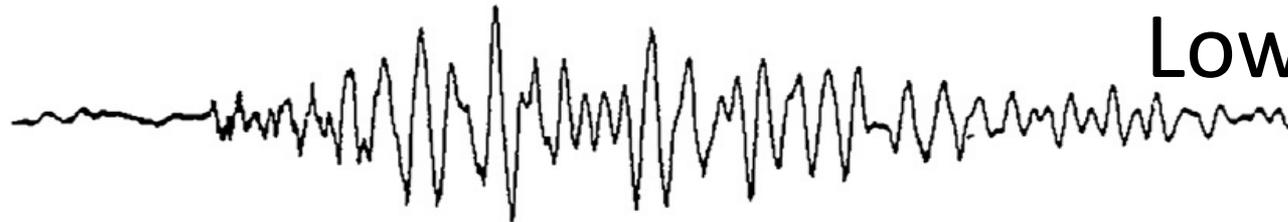
High-Frequency



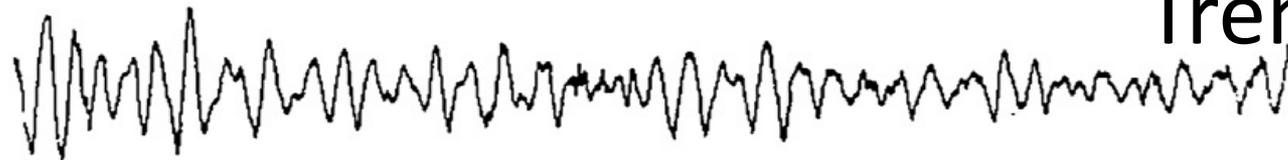
Hybrid



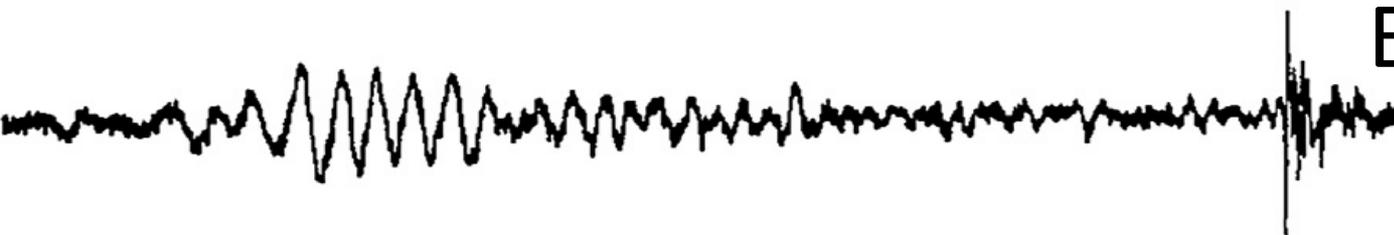
Low-frequency



Tremor

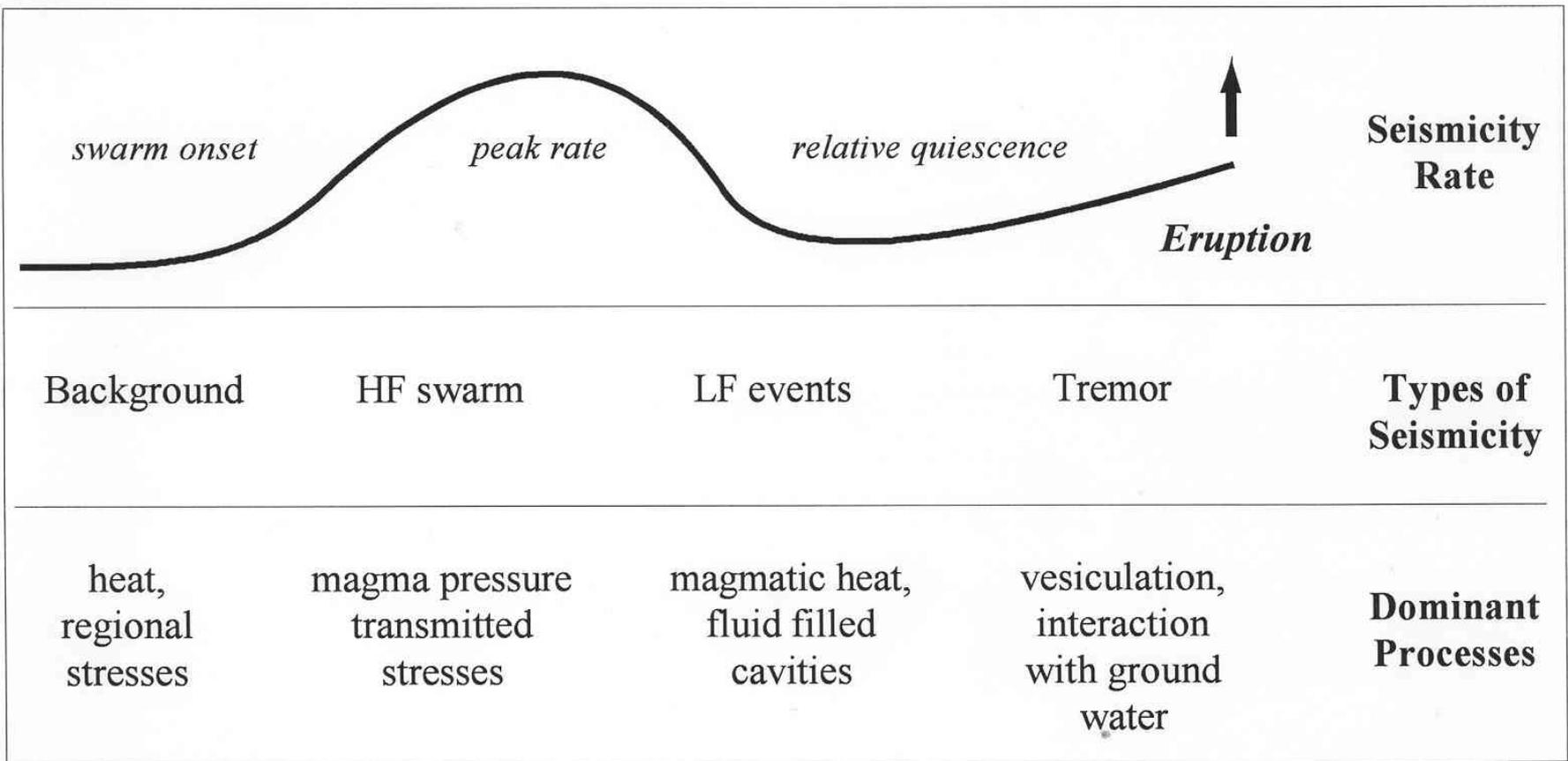


Explosion



10 (s)

Generic Volcanic Earthquake Swarm Model



Time



Cross Section:

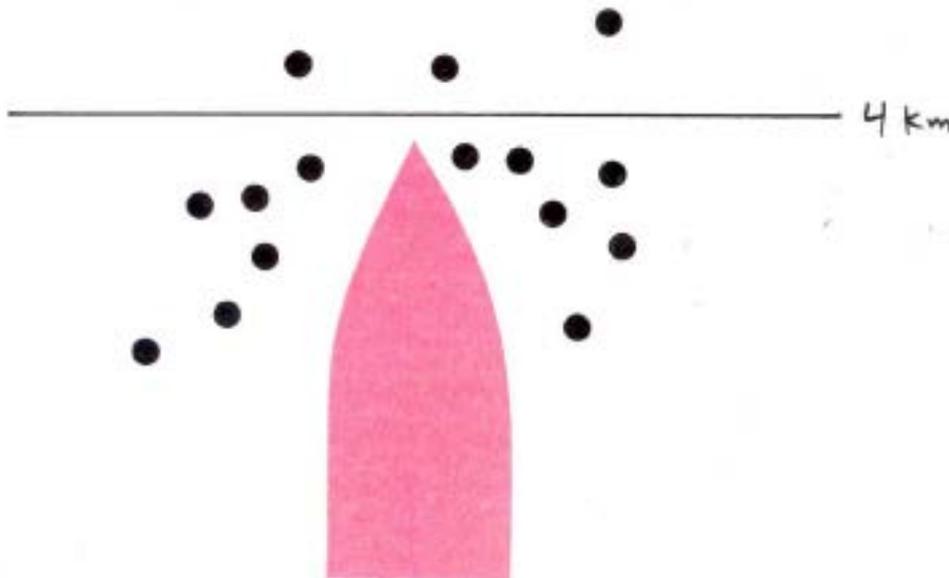
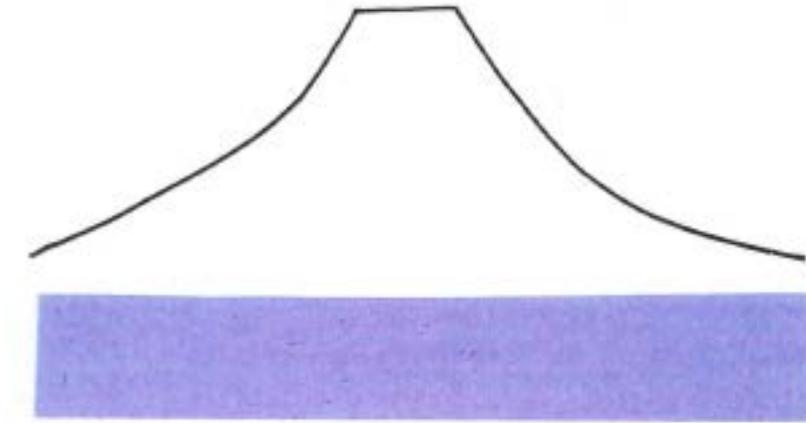
Volcano

Water table

4 km ref depth

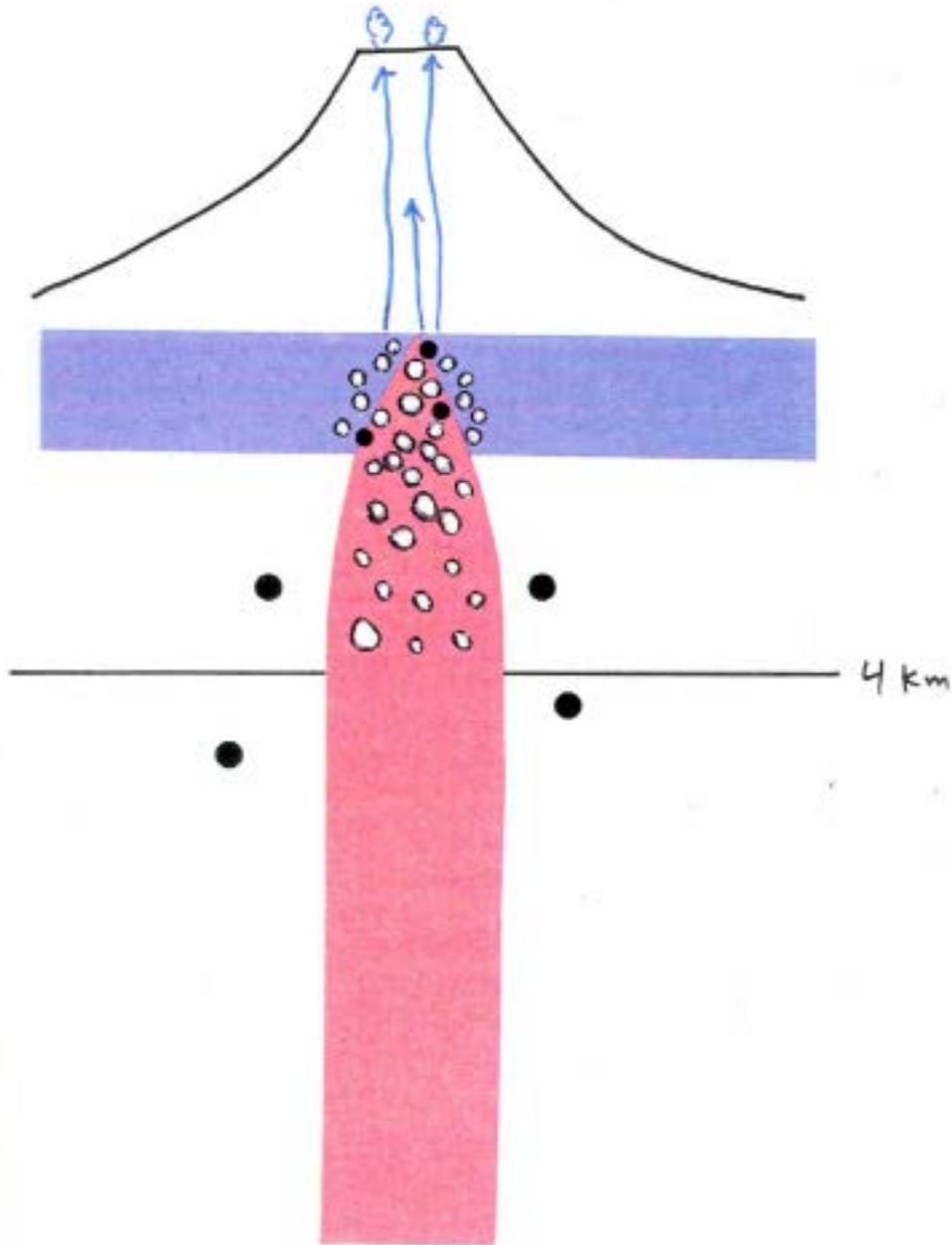
Earthquakes

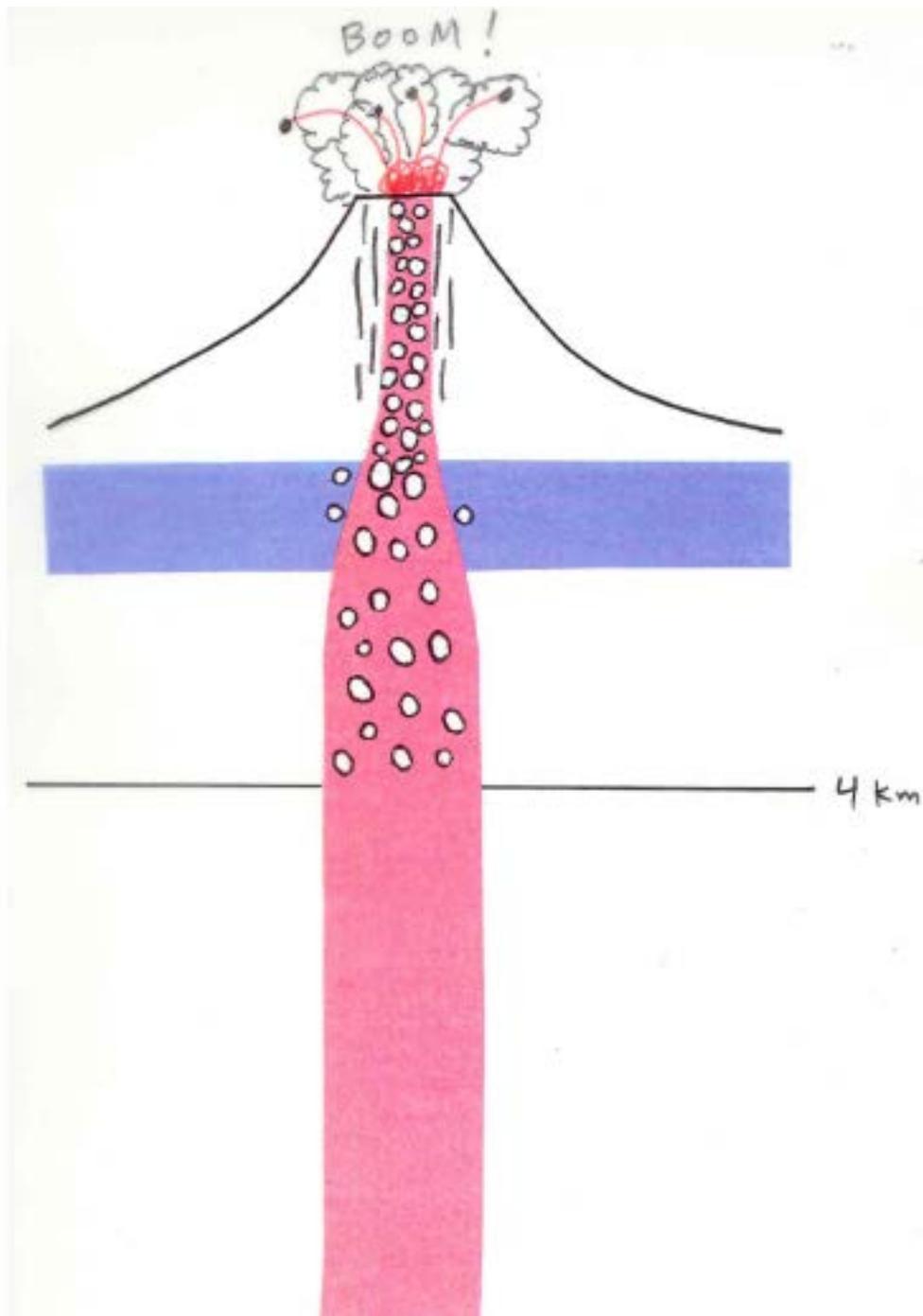
magma



Steam

Interaction
with
groundwater

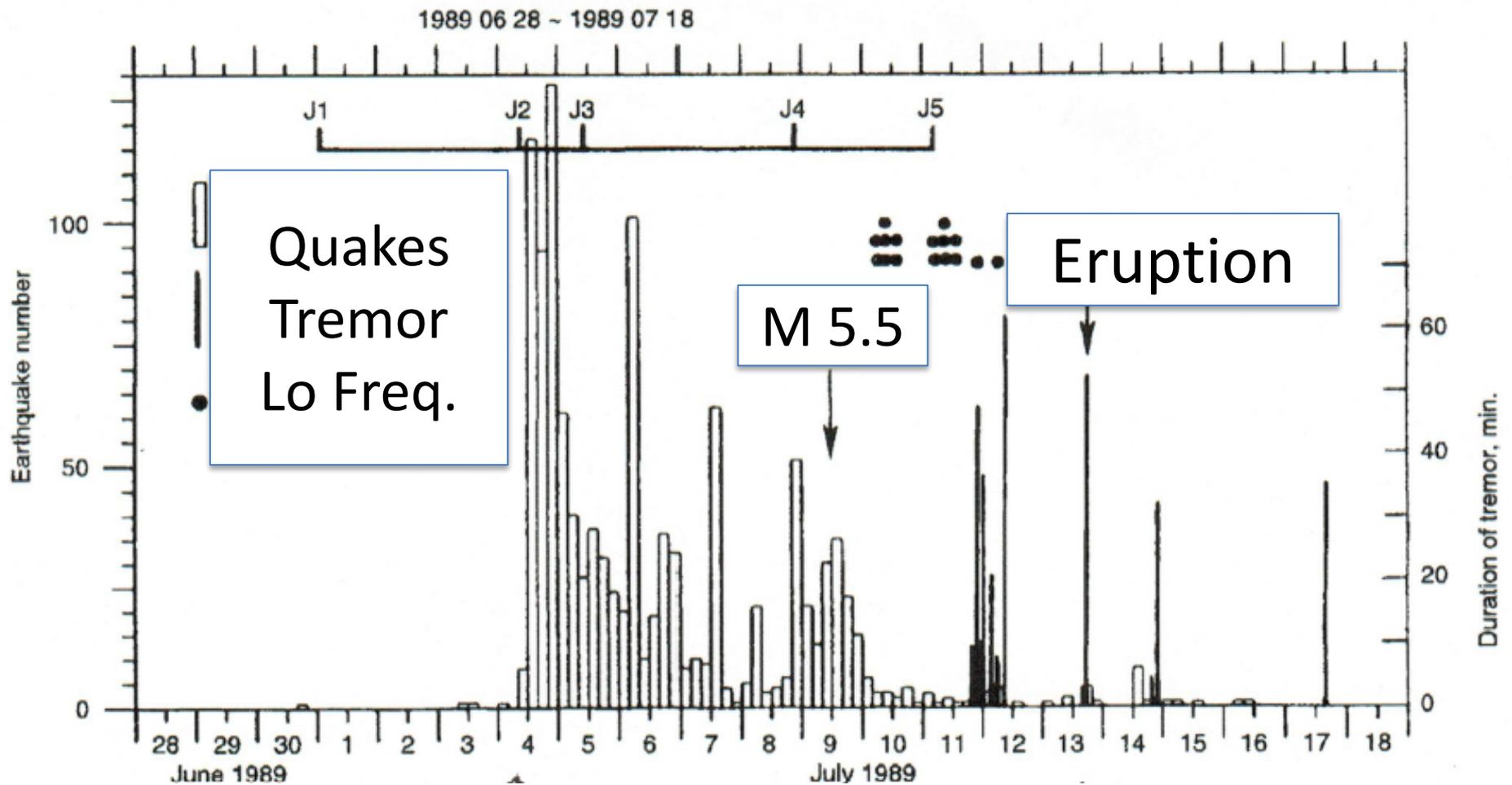




Eruption!

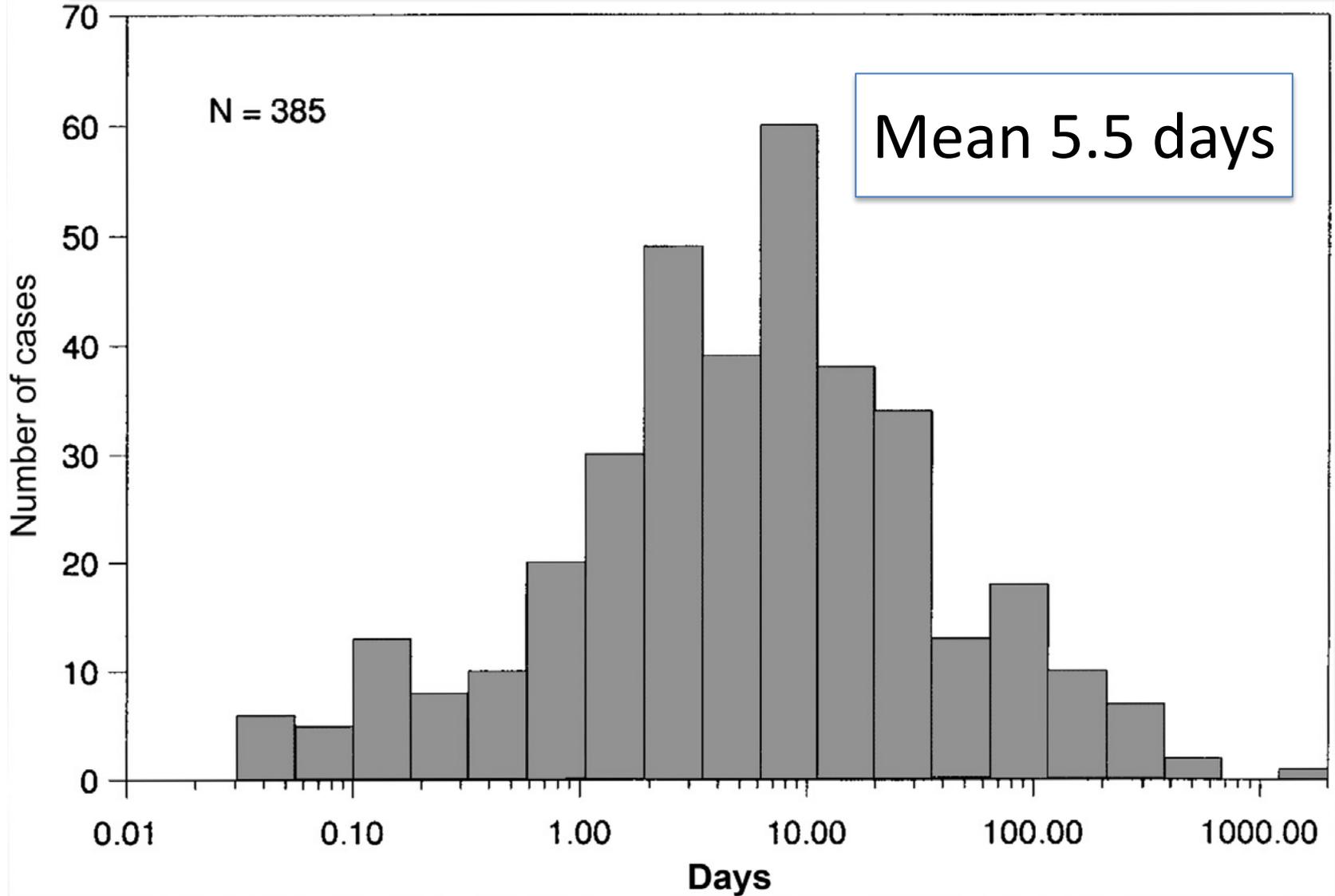
note: few earthquakes

Off-Ito, Japan, July 1989



Time – 3 weeks

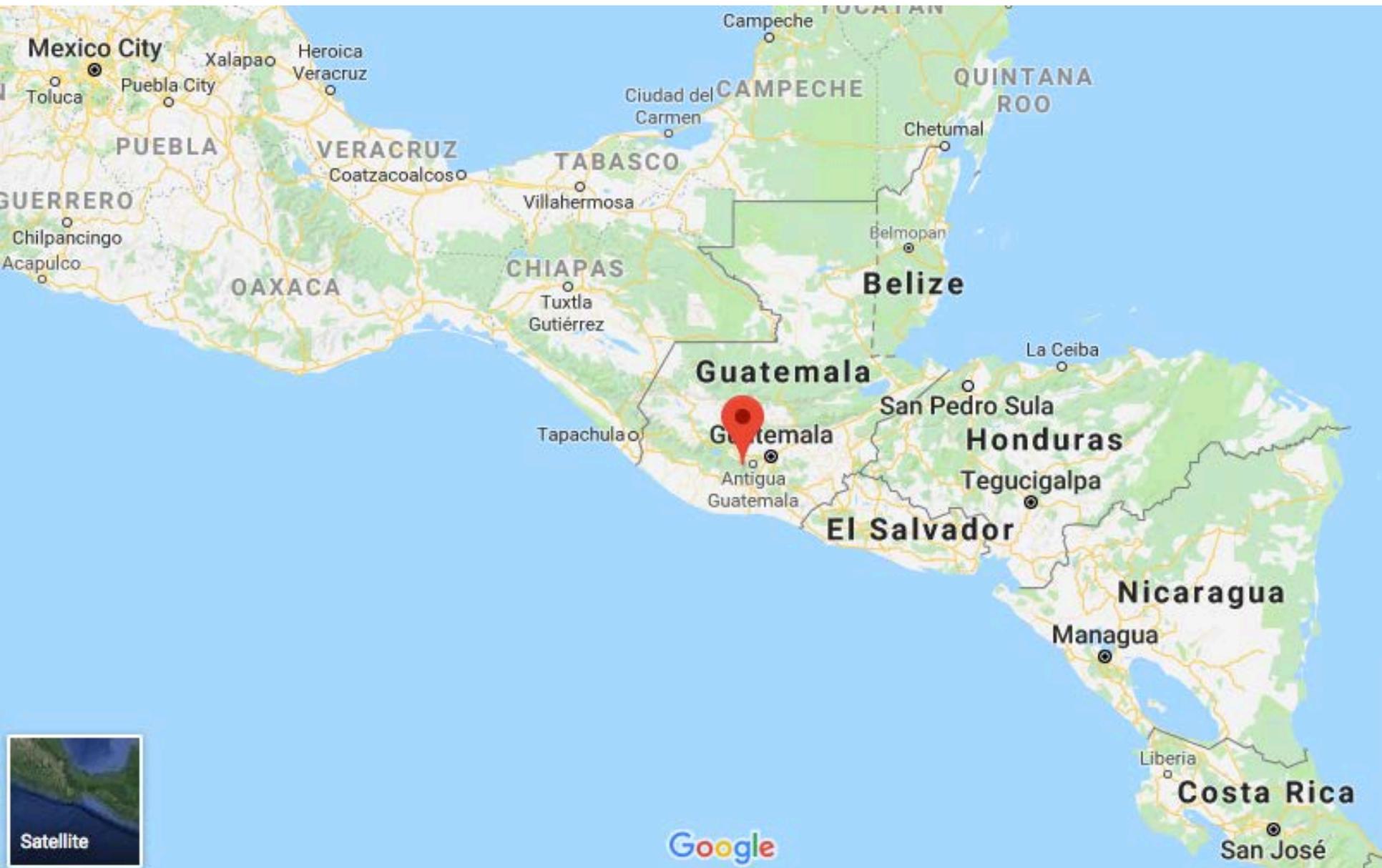
How long do earthquake swarms last?



Fuego and Acatenango Volcanoes, Guatemala



Location of Fuego Volcano in Guatemala





1974 eruption - Wikipedia

Explosive eruption
Sunday, 3 June 2018
Recent smaller eruptions

Ash clouds to 15 km
Pyroclastic flows
Lahars

>100 people killed
Several towns destroyed
Similar to Vesuvius 79 A.D.

Fuego pyroclastic deposits destroyed this town



Conclusions

- 1) Volcanoes/eruptions are of two main types:
Effusive and Explosive
- 2) Seismology is used to determine where the
magma is stored.
- 3) Seismology is one of the main tools used for
eruption forecasting.
- 4) Time frames are usually days to weeks, occasionally
shorter or longer.
- 5) There is significant uncertainty; better
instrumentation helps.