

Pyroclastic Flow Hazards

Lecture Objectives

- definition and characteristics
- generation of pyroclastic flows
- impacts and hazards



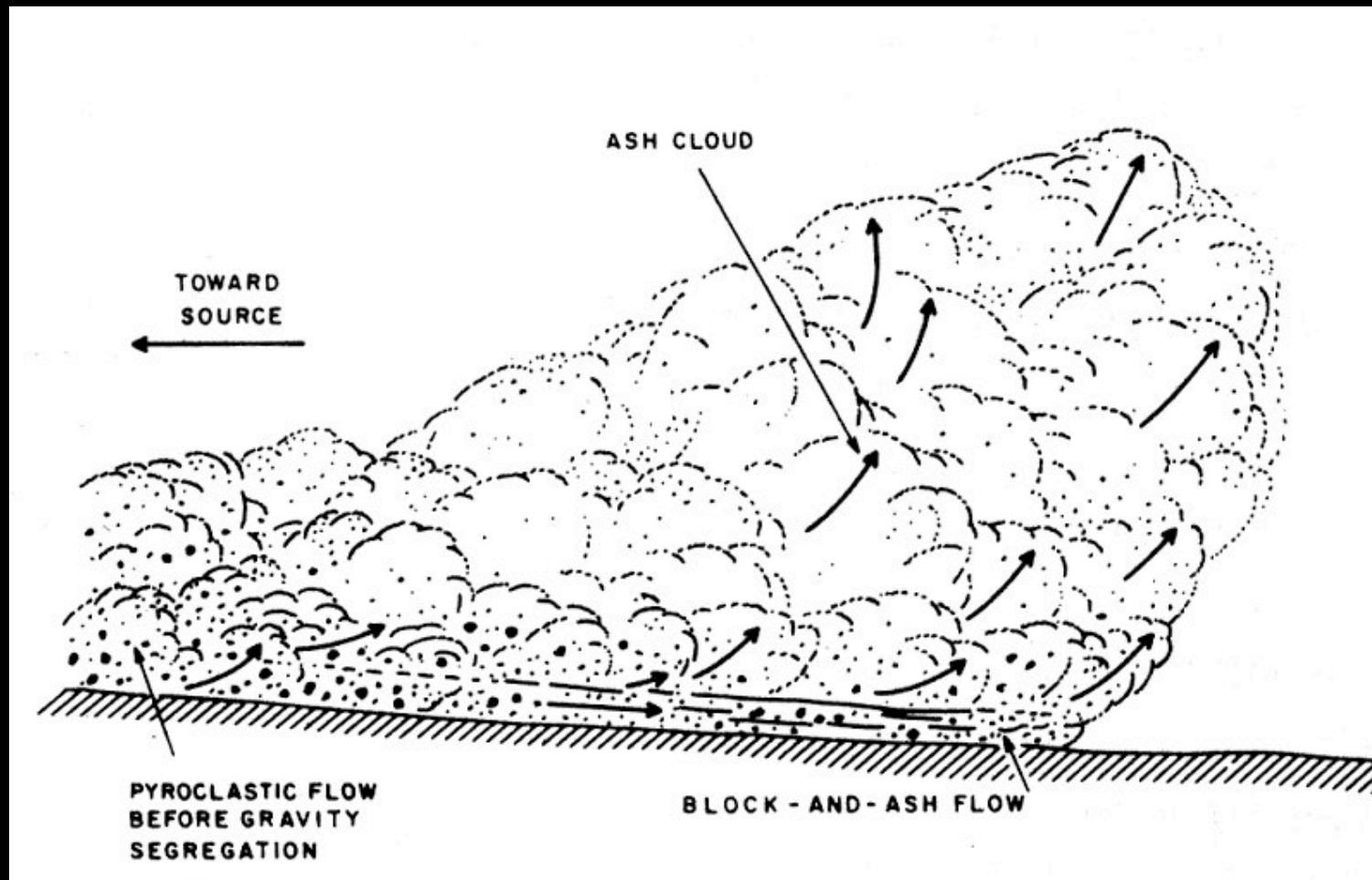
What are pyroclastic flows?

Pyroclastic flows are high-density mixtures of hot, dry rock fragments and hot gases that move away from the vent that erupted them at high speeds.

Generation Mechanisms:

- explosive eruption of molten or solid rock fragments, or both.
- non-explosive eruption of lava when parts of dome or a thick lava flow collapses down a steep slope.





Most pyroclastic flows consist of **two parts**: a basal flow of coarse fragments that moves along the ground, and a turbulent cloud of ash that rises above the basal flow. Ash may fall from this cloud over a wide area downwind from the pyroclastic flow.



Mt. St. Helens



Effects of pyroclastic flows

A pyroclastic flow will destroy nearly everything in its path. With rock fragments ranging in size from ash to boulders traveling across the ground at speeds typically greater than 80 km per hour, pyroclastic flows knock down, shatter, bury or carry away nearly all objects and structures in their way. The extreme temperatures of rocks and gas inside pyroclastic flows, generally between 200°C and 700°C, can cause combustible material to burn, especially petroleum products, wood, vegetation, and houses.

Pyroclastic flows vary considerably in size and speed, but even relatively small flows that move <5 km from a volcano can destroy buildings, forests, and farmland. On the margins of pyroclastic flows, death and serious injury to people and animals may result from burns and inhalation of hot ash and gases.

Pyroclastic flows generally follow valleys or other low-lying areas and, depending on the volume of rock debris carried by the flow, they can deposit layers of loose rock fragments to depths ranging from less than one meter to more than 200 m.

Such loose layers of ash and volcanic rock debris in valleys and on hillslopes can lead to lahars indirectly by: 1, Damming or blocking tributary streams, which may cause water to form a lake behind the blockage, overtop and erode the blockage, and mix with the rock fragments as it rushes downstream; and 2, Increasing the rate of stream runoff and erosion during subsequent rainstorms. Hot pyroclastic flows and surges can also directly generate lahars by eroding and mixing with snow and ice on a volcano's flanks, thereby sending a sudden torrent of water surging down adjacent valleys.



Remnant of a building in Francisco Leon that was destroyed by pyroclastic flows and surges during the eruption of **El Chichón** volcano in southeastern Mexico between March 29 and April 4, 1982. Francisco Leon was located about 5 km SSE of the volcano. The reinforcement rods in the concrete wall are bent in the direction of flow. Several pyroclastic surges swept down all sides of the volcano, reaching as far as 2 to 8 km from the volcano; pyroclastic flows represent only about 30 percent of the total combined mass of surges and flows. In addition to Francisco Leon, eight other villages were destroyed, claiming the lives of up to 2,000 people.



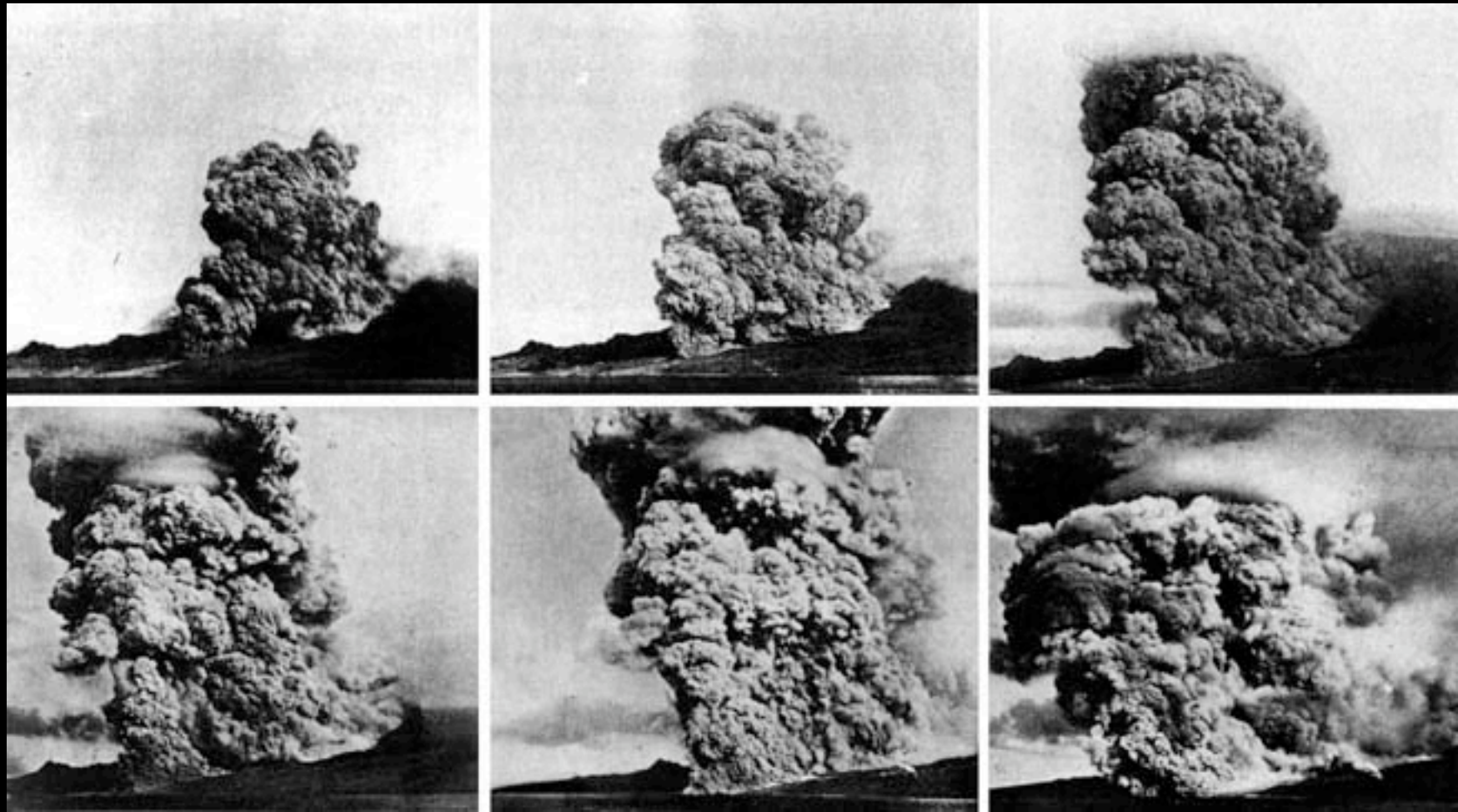
Pyroclastic flows erupted by **Mount Pinatubo** on June 15, 1991, buried the Marella River valley (SW of Pinatubo) with pumice, ash, and other volcanic rocks to depths of between 50 and 200 m. This eruption was one of the largest in the 20th century, depositing about 5.5 km³ of rock debris over nearly 400 km². The pyroclastic flows traveled as far as 12 to 16 km from the volcano in all directions. Unlike river valleys, the steep slopes around the volcano were veneered with very thin, discontinuous pyroclastic-flow deposits.



A series of pyroclastic flows from **Redoubt Volcano**, Alaska between December 1989 and April 1990 rapidly melted snow and ice that generated lahars in Drift River (valley in photo). The lahars swept 40 km to Cook Inlet. Most of the pyroclastic flows were caused by the repeated collapse of a lava dome growing high on the volcano's north flank (right side), but the dome is not visible. As each pyroclastic flow swept down the volcano's snow- and glacier-covered north flank, the hot lava-dome fragments eroded and mixed with the snow and ice to form a torrent of water that eroded loose sediment on the valley floor and transformed into lahars which swept into the Drift River.



A small but highly fluidized pyroclastic flow traveled down the narrow Belham stream channel as far as 5 to 6 km from a lava dome growing at the summit of **Soufriere Hills** volcano in Montserrat. The basal part of the pyroclastic flow was confined to the channel bottom, but the overriding hot ash cloud **burned and killed vegetation along the channel**. The pyroclastic flow was triggered by a partial collapse of the dome. With initial temperatures higher than 900°C , the rock debris and gas carried by a pyroclastic flow or surge easily remain hot enough to burn/singe combustible material even when they travel more than 20 km from a vent.



Mont Pelee pyroclastic flow