

Hydrovolcanism

- Definition
 - The explosive interaction of external water and magma
- Generally occurs in the subsurface environment
 - aquifer system/volcanic feeding system
- Sometimes occurs at the surface
 - lakes and ocean interface with vent system

Surtsey Example

- Emerged for the sea south of Iceland
- Along the mid-Atlantic Ridge
- Began in February of 1964

Initial Phase

- Surtseyan explosions
 - Surge clouds
 - Tuff cone
 - Low plume
 - Abundant ballistic fragments



Later Eruptions

- After April of 1964 eruptions became mild
- Tuff cone protected the vent and lava emission was above sea level
- Lava flowing into the sea was not explosive
- Crater lava lake and gentle flow was in final phase

Fuel-coolant Interaction (FCI)

- Caused by the sudden contact of a hot molten fuel and a cold fluid that is volatile
- Typical fuels are lava/magma, molten steel, nuclear core
- Typical coolants are water, combustible liquids like petroleum products

Mechanism

- Steam forms a film along the surface between fuel and coolant
- Shock waves cause steam envelope to suddenly collapse, then it rapidly expands
- This causes bits of the fuel to be torn apart
- The process then cascades with growing intensity

Examples

- Chernobyl
 - Nuclear plant meltdown
- Many volcanic eruptions
 - Final phase of Vesuvius AD 79 eruption
 - Initial phases of MSH 1980 eruption

LANL Experiments

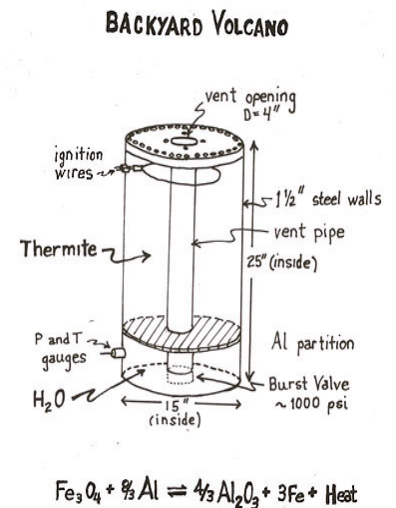
- Backyard volcano
- Experiment configuration
- Water cell
- Aluminum partition
- Thermite cell

Measurements

- Thermal energy release of thermite ignition
- Kinetic energy of plume
- Size distribution of products

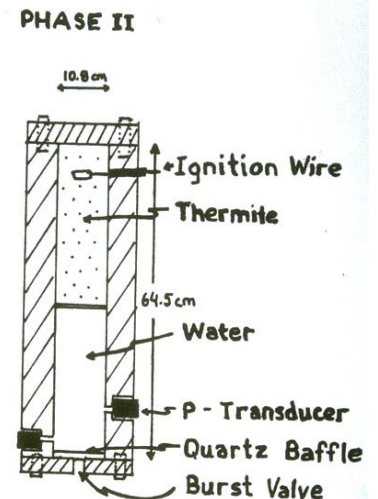
Phase I model

- Large cylinder
- Vent oriented upward



Phase II model

- Smaller cylinder
- Vent oriented downward



Phase II Shot

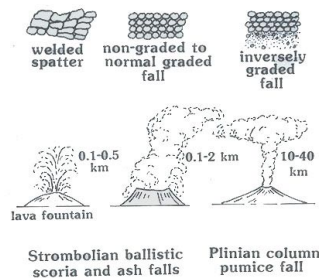
- Fired from a platform
- K.E. measured by cylinder take-off
- Particles collected from platform



Results

- There is an optimum ration of water to melt for energetics
- Too much water cools the system
- Too little water does not provide enough energy for an explosion
- Optimum ratio is at about 0.4

Low Water/melt Ratios

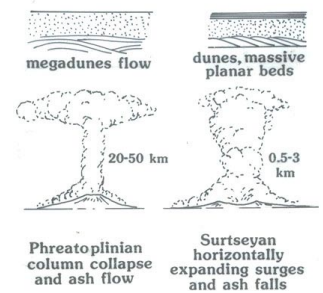


- Strombolian
- Plinian

cm-size fragments
minor steam generation



Optimum Water/melt Ratios

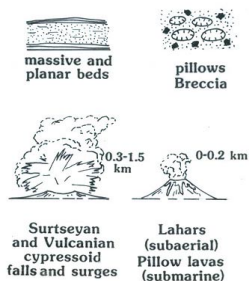


- Phreatoplinian
- Vulcanian

mm and μ m -size fragments,
super-heated (dry) steam



High Water/melt Ratios



- Surtseyan
- Pillow lavas

mm to m-size fragments,
condensing (wet steam)

