Hydrovolcanism

Reverences:
Encyclopedia of Volcanoes, pp. 431-446
Volcanic Successions, pp. 33-57

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

**Backyard Volcano**

\[
\text{Fe}_2\text{O}_3 + \text{Al} \rightarrow 4\text{Al}_2\text{O}_3 + 3\text{Fe} + \text{Heat}
\]
**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

**Optimum Water/melt Ratios**

- Phreaticplinian
- Vulcanian

**High Water/melt Ratios**

- Surtseyan
- Pillow lavas
Landform | Possible Environment | Energy
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A | Cinder Cone | Little or No Water
B | Tuff Ring | Ground Water?
C | Tuff Cone | Shallow Water?
D | Pillow Lava | Deep Water