To blast, or not to blast? – That is the Question

Alexander Belousov¹, Barry Voight² and Marina Belousova¹

¹- Institute of Marine Geology & Geophysics, Yuzno-Sakhalinsk, Russia; Institute of Volcanology & Seismology, Petropavlovsk-Kamchatsky, Russia. 2. Penn State University, University Park, USA
• Active volcanoes frequently collapse
• 5 sector collapses of volcanoes in the 20th century
Collapse of an active volcano commonly provokes strong explosive eruption

Mount St. Helens 1980

Bezymianny 1956
QUESTIONS

• What are the main scenarios of failure-related eruptions?
• What factors determine the scenario?
• What factors lead to directed blast?
Sources of information

- Observational data
- Stratigraphy
Pre-failure activity

Intensive seismicity, and in some cases deformations and volcanic activity indicate intrusion of magma into the edifice
Common trigger of collapse: intrusion of viscous magma
Climactic stage

1. Edifice failure
2. Strong explosive magmatic eruption

Bezymianny 1956

Shiveluch 1964
First type of stratigraphy
deposits of failure-related eruptions

- Pyroclastic flow and fallout deposits
- Debris avalanche deposit

*Examples*: Harimkotan 2000 C14 and 1933
Shiveluch 1964

1. Failure
2. Phreatic explosion
3. Plinian eruption
4. Deposition of PFs
Shiveluch 1964

Time gap between failure and onset of magmatic eruption was large (13 min).

Air-wave and volcanic tremor energy during November 12, 1964 eruption of Shiveluch (with modifications after Tokarev 1967)
Harimkotan

1933

2000 BP
Second type of stratigraphy
deposits of failure-related eruptions

- Pyroclastic flow and fallout deposits
- Directed blast deposit
- Debris avalanche deposit
- Pre-climactic ash

Examples: Bezymianny 1956; Mount St.Helens 1980; Soufriere Hills Montserrat 1996
Bezymianny 1956

1. Sector collapse

2. Directed blast

3. Vertical eruption (Deposition of PFs)
Bezymianny 1956

Stratigraphic relations and character of contact between debris avalanche and blast deposits indicate that their deposition was closely spaced in time.
Time gap between failure and magmatic eruption was short

Soufriere Hills, Montserrat

Mount St. Helens

Pre-1956
Two types of stratigraphy
deposits of failure-related eruptions

1
Pyroclastic flow and fallout deposits
Debris avalanche deposit

Examples: Harimkotan 1933, Shiveluch 1964

2
Pyroclastic flow and fallout deposits
Directed blast deposit
Debris avalanche deposit
Pre-climactic ash

Basic scenarios
failure-related eruptions

1
1. Sector collapse
2. Vertical eruption (Plinian/Vulcanian)

Examples: Harimkotan 1933, Shiveluch 1964

2
1. Pre-climactic (pre-failure) volcanic activity
2. Sector collapse
3. Directed blast
4. Vertical eruption (Plinian/Vulcanian)

Differences

Scenario 1
1. **No** pre-collapse volcanic activity.
2. **No** blast.
3. **Long** time span between failure and magmatic eruption.

Scenario 2
1. **Pre**-collapse volcanic activity
2. **Blast**.
3. **Short** time span between failure and magmatic eruption.

Shiveluch 1964
Mount St. Helens 1980
Position of magma in the moment of failure

Blast

Bezymianny 1956

Mount St. Helens 1980

Soufriere Hills, Montserrat 1997

No blast

Harimkotan 1933
Shiveluch 1964

Legend:
- Edifice
- Magma body
- "Bulging" of slope
- Rupture surface
- Direction of collapse
Conclusions

- Two basic scenarios of failure-related eruptions: Shiveluch type (no blast) and Bezymianny type (blast).
- To blast or not to blast depends on a level of magma in the moment of failure: shallow – blast, deep – no blast.
- Interplay between edifice stability and destabilizing effect of the intruding magma determine the scenario.