

## **Types and Mechanisms of Basaltic Explosions: Environmental Observations and Experimental Data**

Alexey Ozerov

*Institute of Volcanology and Seismology, PETROPAVLOVSK-KAMCHATSKY, Russian Federation*

During the course of basaltic volcanic eruptions, three types of discontinuous explosive activity are observed: ash, bomb and bomb-ash explosions. In order to investigate the mechanisms of such events, the Complex Apparatus for Modeling Basaltic Eruptions (CAMBE) has been developed. The device stands 18-meters tall, and consists of two major systems, one for modeling and the other for recording. While developing CAMBE, we scaled the geometry of the device to accurately model the volcano feeding system with an inner-conduit diameter to height ratio of 1:1000. For the first time during physical modeling, conditions have been created for the supply of moving model gas-saturated liquid into the conduit, which allowed insight into the processes of bubble nucleation, growth and coalescence, as well as the formation and transformation of gas structures, and kinetic peculiarities of gas phase evolution. Structural barriers and fluctuations of liquid supply rate were eliminated during the course of experiments.

After analysis of flow regimes of the same model liquid (first with dissolved gas, and then with gas separated as a free phase) four gas-hydrodynamic modes have been distinguished: liquid, bubble, cluster and slug regimes, which are regularly sequential and present polymorphic modifications of gas-saturated liquids. Through the CAMBE experiments, a new, never before known, hydrodynamic mode of two-phase flow termed here as the "cluster regime" has been discovered. The cluster regime is characterized by regular alteration of dense gas bubble accumulations (clusters) separated from each other by the gas-free liquid phase.

After comparison of volcanic craters, which are the surface manifestations formed by natural explosions at basaltic volcanoes, with the results of experiments conducted on CAMBE it can be suggested that cluster and slug regimes result in basaltic explosions. By the character of morphological peculiarities of gas structures, four types of explosions can be distinguished: 1) the first phase of the cluster regime produces weak ash explosions 2) the cluster regime itself producing powerful ash explosions 3) the slug regime produces bomb explosions and 4) the slug regime which is also accompanied by a plume of tiny bubbles is found to produce the transitional type bomb-ash explosions.



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