Field explosion experiment as an analogue of explosive volcanism

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Explosive volcanism, e.g. 1980 Mt. St. Helens eruption and 2000 Usu eruption, sometimes yielded disaster to the neighboring district. It seems the scales and characters of eruption cloud, topography, eruptive product and of disaster are important parameters to be clear. Especially, the relations among the parameter, explosion energy and explosion depth should be studied from the point of views of mitigation of disaster and the understanding of explosion mechanism.

Some research papers appeared about 30 years ago to understand the volcanic eruption based on the artificial explosion experiments for the engineering and military use. These experiments, however, did not aim the understanding of volcanic eruption, and differed from volcanic explosion in both energy density and power density of explosion source, so remained much questions for volcanological understanding. This means that our volcanologist must make a field explosion experiment by ourselves and must compare the results with natural volcanic eruption.

For this purpose our group has made following three attempts.

1. Field explosion experiment for the establishment of scaling rule that relates the surface phenomena to explosion energy and depth.
2. Comparative study of the experimental results with observed results.
3. Make a reproduction of volcanic explosion using a technique of numerical simulation.

To establish the scaling rule of volcanic explosion, we have made six field explosion experiments using mainly Kiri-dynamite including two underwater explosions at Soubetsu Town. For the observations of physical phenomena we installed some seismometers, visual video recorder, infrared thermoviewer, lead-plate blastmeters, piezo-sensor blastmeter and a low-frequency microphone. After the explosion we made a geological survey on the size of explosion crater, distribution of ballistic fragment and on the distribution of jet deposit. All dimensions (length and time) for explosion phenomenons were scaled by dividing the dimension by cube-root explosion energy. The cube-root scaling law was valid for all relations we examined as a good approximation. This means that if we are given both explosion energy and explosion depth, we can predict the geological parameter such as the crater size, maximum distributions of pyroclastic surge and ballistic fragment and so on.

To confirm the applicability of experimental results to the volcanic explosion, we have made two numerical simulations using a calculation code developed by Saito et al. (2001). One is for the reconstruction of 1980 Mt. ST. Helens explosion, and the other for 2000 Usu phreatic eruption. The results simulated well with real volcanic explosions.