Explosion experiments in laboratory for further understanding of explosive volcanism

Akio Goto[1]; Akihiro Sasoh[2]; Mie Ichihara[3]; Hiromitsu Taniguchi[1]

[1] CNEAS, Tohoku Univ; [2] IFS, Tohoku Univ.; [3] ERI, U. Tokyo

To understand the relationship between the explosion condition and the resultant surface phenomena, and to construct a scaling law on volcanic explosion, we had made field explosion experiments using dynamite. Through the series of experiments we concluded that scaled depth, which is the depth divided by cube root of energy, is the main parameter determining the properties of explosive volcanism (Goto et al., 2001; Ohba et al., 2002). By applying this result we also estimated the explosion condition such as depth and energy of explosions on Usu 2000 eruptions (Yokoo et al., 2002).

In these studies we premised a priori that explosions by dynamite can be considered as an analogue of volcanic explosions. However the applicability of the experimental results to natural volcanic explosions is not self-evident. In fact there are large differences in condition between volcanic explosion and dynamite explosion. For example, volcanic explosion pressures are estimated to be several hundreds of bar on Sakura-jima (Iguchi, 1989) and a few bar on Stromboli (Ripepe et al., 2001), which are 2-4 orders lower than the initial pressure induced by dynamite. Without evaluating the influences of these differences on accompanying phenomena, the applicability of our experimental results to volcanic explosions is not clear. If inapplicability of our previous results becomes clear to some types of volcanic explosions we need new experiments to obtain new data which are applicable to such types of volcanic explosions.

To evaluate the influences of explosion conditions such as initial pressure, which are ignored in the past experiments, the usage of high pressure gas release from a chamber seems to be appropriate. However the introduction of these techniques to field explosion experiments becomes large-scale setting. For this reason we are trying relatively small scale explosion experiments in laboratory. The basic idea is to set a high pressure gas chamber instead of an explosive in soil or sand and to release the gas as an analogue of volcanic explosion. In this experiment we mainly focus on the effect of gas pressure and chamber volume on surface phenomena such as crater formation, ballistics distribution and blast pressure. Sometimes the chamber may be connected to a rigid pipe to simulate the influence of conduit on explosion behavior.

In addition to these experiments, we are planning another experiment which focuses on magma behavior in conduit by releasing high pressure gas into a clear narrow pipe filled with liquid. In this experiment the physical properties of the liquid, such as viscosity, are also important parameter. If we set the apparatus in a large high pressure chamber and decompress the chamber pressure with synchronizing gas bubble rise, we may be able to simulate the effect of decompression against depth in a conduit, which has been ignored in the past analogue experiments such those by Jaupart and Vergniolle (1988), for example.