6. Eruption of Usu volcano

Nakada (2001) and Ui *et al*. (2002a) reported the sequence of Usu 2000 eruption. The eruption started at 1:07 PM, March 31 following 3-and-a-half days precursory activities of earthquakes and ground cracking. Initial explosion took place at the western lower slope of the volcanic edifice discharging ash plume. Ballistics were thrown at least 1.2 km away from the source. The initial vigorous phreatomagmatic explosion moved gradually into phreatic eruption with vertical cock's tail jets in early April. Hot lahars were discharged from some of the craters. The phreatic eruption was replaced by intermittent small explosion in mid-April and by continuous steaming that often included ash emissions. A small-scale and flat-topped cryptodome was formed during this stage. Graben-like fault swarms were formed above the cryptodome. More than 60 explosion craters were formed by late April. Then the eruptive activity concentrated on a few craters and bursting-type explosion with air shock wave frequently occurred at the water-saturated crater floor. Geothermal activity became clear on and around the cryptodome since middle May and then amount of steam decreased with time.

Event of the March 31 phreatomagmatic eruption was analysed in detail correlating video footage and analysis of the proximal deposit (Takarada *et al*., 2002). Totally 11 sandy coarse layers and 9 silty matrix-supported layers were identified 90 m away from the crater rim. These layers are correlated with each eruption event observed from 13:07 to 17:25 on March 31. The deposit consists of fresh juvenile fragments up to 20 mm in diameter, accessory fragments, accidental fragments and aggregate of ash (Tomiya *et al*., 2001; Nagai *et al*., 2002). The deposit is interpreted as a product of dry pyroclastic surge derived from the collapse of low eruption column (Ui *et al*., 2002b). Maximum travel distance was 1-2 km (Yamamoto, 2001). Wet pyroclastic surge deposits was also identified during phreatic eruption stage. Maximum travel distance of wet surge was about 600 m away from the source (Ui *et al*., 2002). Ash sample from the ejecta during March 31 to early April contain Miocene altered felsic volcanic rocks suggesting that the fragmentation by the eruptions occurred at depths below ca. 1000 m and more (Yahata, 2002). Yahata (2002) also suggested that fragmentation occurred shallower than several hundred meters below after middle April.

Takarada *et al*. (2001) estimated total amount of ash discharged by April 4 as 1.24 x 10^8 kg judging from tephra fall data at proximal and medial region. However, Ohno *et al*. (2002) concluded amount of the pyroclastic deposits from the entire Usu 2000 eruption is more than 6.4 x 10^8 kg.

Hirose and Tajika (2002) described three different types of surface ruptures, compressional, tensional and strike-slip regimes. Miura and Niida (2002) suggested by means of aerial photograph interpretation that formation of the cryprodome is due to the two stage growth, consisting of initial dike intrusion and subsequent shallow inflation and lateral extension of magma from the dike tip.

Chemical composition of juvenile fragment is slightly less differentiated than those of 1977-78 eruption (Tomiya *et al*., 2001; Nakagawa *et al*., 2002). This suggests that distinct and/or modified magma system has been active in the 2000 eruption (Nakagawa *et al*., 2002). Tomiya and Miyagi (2002) proposed magma-feeding system for Usu 2000 eruption by petrological and experimental data. The 2000 eruption is inferred to have started by an ascent of magma from 10-km chamber, followed by its injection to the 5-km depth chamber, as well as other historical eruptions. The magma ejected during the 2000 eruption shows no evidence of magma mixing, indicating that this magma was derived from only top layer of the shallower chamber. Suzuki and Nakada (2001, 2002) made bubble size distribution analysis and measurement of water content in groundmass glass. They concluded that magma ascent rate was slow to allow gas escape up to 5-km depth chamber. Then disequilibrium in water exsolution can be caused by acceleration of magma ascent and fragmentation of juvenile material may have been caused by water quenching.

(Tadahide Ui)

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