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Magma mixing and mingling processes inferred from the ejecta in the Shinmoedake 2011 eruption: Its implications for the transient behavior of eruption styles

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The Shinmoedake 2011 eruption which started on 26th January 2011 showed a characteristic transition of eruption styles. Two sub-plinian eruptions from 3 p.m. on 26th and from midnight of 27th produced a pumice deposit of 6 cm in thickness at 8 km from the vent. After the sub-plinian phase, the eruption style shifts to the phase of vulcanian eruptions which majorly produced volcanic ash since an eruption at 3 p.m. on 27th Jan.

We obtained samples from the pumice deposit of the 3 times sub-plinian eruptions on 26-27th Jan and the bread-crust bomb (1 m in size) of the vulcanian eruption at 7:54 a.m. on 1st Feb. In the presentation, we discuss the depth of magma chamber and the mechanisms of magma mixing and mingling on the observation and chemical analyses of these ejectas.

Pumices show white, gray, brown and black-colored. Banded pumices (white and gray) can be often found. White pumices (SiO_2= 64 wt%) contain Ca-poor Pl (An_{75-50}), Opx, Cpx and Mag as phenocrysts and the matrix is composed of freshed glass (SiO_2= 76 wt%). Gray pumices (SiO_2= 58.6 wt%) contain Ca-poor (An_{75-50}) and Ca-rich Pl (An_{90}), Opx, Cpx, Mag and Ol as phenocrysts. Ca-poor Pl shows reverse zoning in rim and often has a sieve-texture. Gray pumices contain 2 types of glomerphenocrysts; Ca-poor Pl-Opx-Cpx-Mag and Ca-rich Pl-Ol assemblages. The vesicularity of gray pumices varies about from 50% to 80% and the number density of plagioclase microlite increases with decreasing its vesicularity.

Assemblage and character of phenocrysts in bombs are same as gray pumices. Basaltic inclusion, which contains Ca-rich Pl and Ol phenocrysts, can be found in the bomb.

On the basis of the zoning of phenocrystic plagioclase and the mineral assemblage of glomerphenocryst, it is highly likely that both gray pumices and bombs originate from the mixed magma formed by mixing between dacitic magma and basaltic magma (Hoshide et al., 2011, JpGU Meeting).

We obtained 887-903 ˚C by application of pyroxene geothermometer (Ishibashi and Ikeda, 2005) to rims of two pyroxenes from white pumices. From the temperature, rim composition of phenocrystic plagioclase and matrix bulk composition of white pumices, ca. 5 wt% H_2O in melt (at 1-2 kbar) was estimated (Lange et al., 2009). This value is higher than the H_2O solubility in rhyolitic melt at 3 km depth and comparable to that at 6 km depth (Newman & Lowenstern, 2002). This suggests that dacitic magma has migrated upward from more than 6 km depth.

On the other hand, the time during elemental diffusion between dacitic magma and mixed magma is estimated to be a few days from the line traverse of glass composition across the white-gray boundary in a pumice grain. This suggests that the mingling between dacitic magma and mixed magma occurred only a few days before the sub-plinian eruption on 26th Jan.