

Volatile content of magmas of the 2014, 1989, and 1979 eruptions of Naka-dake, Aso volcano based on melt inclusion analyses.

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Volatile content of magma is one of important controlling factors for magma ascent and volcanic eruption. Melt-inclusion analysis is a powerful method for estimating volatile content of melt in magma before eruption. At Naka-dake, Aso volcano, volcanic activity increased September 2013, and minor eruptions occurred January 2014. Since then, eruptions had intermittently occurred up to October 2016, together with intense volcanic gas emission. In this study, we carried out petrological observation and chemical analyses of melt inclusions of the scoria of the 2014, 1989 and 1979 eruptions of Naka-dake to know the eruption and degassing processes.

Whole-rock composition of the scoria was determined by a wave-dispersive X-ray fluorescence analysis (XRF). Observation of the cross sections, chemical analyses of the minerals, determination of major elements and sulfur contents of melt inclusions and groundmass were carried out by electron probe micro analyzer (EPMA). Water and CO₂ contents of the melt inclusions and matrix glass were determined by secondary ion mass spectrometry (SIMS). Analytical errors of the volatile analyses were ±0.2 wt.% for H₂O, ±0.0028 wt.% for CO₂, ±0.007 wt.% for S (Saito et al., 2010).

Five scoria of the 26-27 November 2014 eruptions have andesite composition (SiO₂=54 wt.% and K₂O=2.0 wt.%) and are identical to those of scoria of the November 1979 eruptions (Ono and Watanabe, 1985). The scoria contained 22-31 vol % plagioclase phenocrysts, 5-13 vol % clinopyroxene phenocrysts, a few vol % of olivine and FeTi-oxide phenocrysts. The plagioclase phenocrysts have core of An₆₂₋₉₁ and rim of An₆₀₋₇₉. The clinopyroxene phenocrysts have core of Wo₃₆₋₄₁En₄₃₋₄₇Fs₁₅₋₂₀ and rim of Wo₃₆₋₄₀En₄₂₋₄₆Fs₁₇₋₁₉. The olivine phenocrysts have core of Fo₆₅₋₆₈ and rim of Fo₅₉₋₆₈. Two-pyroxene thermometry (Lindsley, 1983) applied to an orthopyroxene inclusion contained by a clinopyroxene phenocryst gave magma temperature of 1113±51°C. Melt inclusions in plagioclases, clinopyroxenes and olivines have andesite composition (SiO₂=58-62 wt.%, K₂O=3.1-4.7 wt.%), that is similar to chemical composition of the groundmass. The melt inclusions have volatile content of 0.6-0.8 wt.% H₂O, 0.003-0.017wt.% CO₂ and 0.008-0.036 wt.% S. The variation in CO₂ and S contents of the melt inclusions is not related to the K₂O content, suggesting magma degassing with pressure decrease. Gas saturation pressure estimated from the H₂O and CO₂ contents and solubility model (Papale et al., 2006) is 22-78 MPa, corresponding to 1-3km depths. Combining the melt-inclusion analysis with observation of volcanic gas, we can estimate degassed-magma volume. The amount of degassed magma (1-3 km³) was estimated, based on the sulfur contents of the melt inclusions and SO₂ flux during a period of January 2014 to December 2016 (1000-3000 t/d; JMA, 2016), assuming that only SO₂ existing as sulfur component in the volcanic gas and magma density of 2700 kg/m³.

Melt inclusions in plagioclases, clinopyroxenes and olivines from the 1979 and 1989 eruptions have andesite composition (SiO₂=57-62 wt.% and K₂O=2.3-3.8 wt.% for 1979 eruptions, SiO₂=57-63 wt.% and K₂O=3.2-5.4wt.% for 1989 eruptions). The melt inclusions of the 1979 eruptions have volatile content of 0.3-1.6 wt.% H₂O, 0.007-0.034wt.% CO₂ and 0.010-0.035wt.% S. The melt inclusions of the 1989 eruptions have 0.3-0.6 wt.% H₂O, 0.003-0.009wt.% CO₂ and 0.008-0.031wt.% S. Major elements and volatile contents of melt inclusions of the 2014 eruptions are similar to those of the 1979 and 1989 eruptions. The similarity of chemical composition of whole-rocks and melt inclusions among these eruptions suggest petrologic characteristics and volatile content of the magma in the magma chamber had not changed from 1979 to 2014.

Keywords: Aso volcano, Naka-dake, magma, melt inclusion, volatile, degassing