

Rheological changes of aphyric basaltic andesite magma based on laboratory experiments of 1986 Izu-Oshima lava

*黒川 愛香¹、三輪 学央¹、石橋 秀巳²

*Aika K Kurokawa¹, Takahiro Miwa¹, Hidemi Ishibashi²

1. 国立研究開発法人防災科学技術研究所、2. 静岡大学理学部地球科学専攻

1. National Research Institute for Earth Science and Disaster Resilience, 2. Faculty of Science, Shizuoka University

Magma rheology is a fundamental factor to control many volcanic phenomena such as conduit flow, formation/collapse of lava dome, and lava flow. For that reason, a considerable number of studies have been made on it by experimental and numerical approaches (Costa, 2002; Mader et al., 2013; Pistone et al., 2016). The previous studies revealed that one-phase magma behaves as a Newtonian fluid and dependences of the viscosity on chemical composition and temperature were convincingly formulated (Giordano et al., 2008; Takeuchi, 2015), whereas magma contained crystals shows more complex rheology acting as a non-Newtonian fluid because of interactions between crystals, and between crystals and melt (Mader et al., 2013). It is known that the crystal-bearing magma shows nonlinear rheology including thixotropy and shear thinning above the critical crystal fraction at which the yield stress first appears (Ishibashi et al., 2010; Vona et al., 2017). However, only few attempts have been made to understand the nonlinear rheology at unsteady state and how temporal changes in rheology are affected by the presence of crystals is still unclear, although these may be dominant when it comes to describe realistic behavior of magma.

The purpose of this study is to unveil nonlinear rheology at unsteady state toward comprehensive modeling of magma rheology. As an initial step, in this presentation, we show our new experimental system and primary results of rheological experiments using volcanic product of lava flowed during 1986 Izu-Oshima fissure eruption B. The experimental system that consists of an electric furnace, a rheometer, and alumina parts, is simplified as much as possible with a view to reducing background noise. By experiments using the Izu-Oshima sample, it was revealed that the relation between the shear stress and the shear rate shows hysteresis and the viscosity depends on the shear rate with decreasing the temperature. We also go a step further and show other characteristics at unsteady state together with microstructures of quenched samples. The results suggest that not only steady state but also unsteady state should be taken into account to capture the entire picture of behavior of magma.

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