# Toward an examination of magmatic activation from viscosity-perspective

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Magma viscosity is one of the most important factors controlling activation of volcanic activity, because the timescale of magma motion is essentially controlled by the balance between the viscous resistance and the driving forces inside or outside the magmas. The present study reviews viscosity estimate for erupted magmas and modeling studies on magmatic activation from viscosity-perspective. Finally, some future studies on the evidence-based relationship between preeruptive magma viscosity and magmatic activation are proposed.

The basaltic to rhyolitic magmas have preeruptive viscosities over the range $10^1$ to $10^8$ Pa s (Scaillet et al., 1998, JGR; Takeuchi, 2011, JGR; Andújar and Scaillet, 2012, Lithos). Here, preeruptive magma viscosity means viscosity of phenocryst-bearing magmas in the preeruptive magma reservoirs. The preeruptive magma viscosity can be estimated from petrological data by using melt viscosity models (e.g. Giordano et al., 2008, EPSL) and rheological models of multiphase magmas (e.g. Marsh, 1981, CMP). Increasing bulk SiO2 content, preeruptive magma viscosities roughly increase from $10^1$ to $10^5$ Pa s. Some andesitic to dacitic magmas are estimated to be up to ca. $10^8$ Pa s (Takeuchi, 2011, JGR) due to a large amount of phenocryst content of ca. 50 vol %. The high viscosities arise from high undeformable phenocyrst concentration in magmatic suspension and shifting melt SiO2 content to high silica rhyolitic composition. Andesitic to dacitic magmas, which are most common in arc volcanism, have wide range of preeruptive viscosities from $10^3$ to $10^8$ Pa s. This wide range of preeruptive viscosity may influence timescale for magmatic activation.

There are several modelling studies on activation of magmatic activity from viscosity-perspective. Models of remobilization and convective overturn in crystal mush magmas heated by injecting high temperature magmas (e.g. Burgisser and Bergantz, 2011, Nature) suggest that as a heated magma has higher viscosity, the timescale of convective overturn becomes longer. Models of dike propagation from preeruptive magma chambers at initial stage of eruption (e.g. Rubin, 1995, JGR) suggest that as a magma has higher viscosity, excess pressure required for the dike propagation from the chamber becomes larger.

Several future studies on magmatic activation from viscosity-perspective are proposed; relationship between eruptive history and temporal variation of preeruptive magma viscosity in a volcano (e.g. Gardner et al., 1995, Geology; White et al., 2006, G3); relationship between timescale of magma mixing (e.g. Tomiya et al., 2013, BV) and preeruptive magma viscosity; relationship between geophysically-detected eruption precursor and preeruptive magma viscosity (e.g. Passarelli and Brodsky, 2012, GJI). A melt viscosity scale for preeruptive magmas (Takeuchi, 2015, BV) is useful to easily estimate preeruptive magma viscosity.

Keywords: preeruptive magma viscosity, melt viscosity scale, magmatic activation

 