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Petrological viscosity scale of preeruptive magmas

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Magma viscosity is one of the most important physical properties to model igneous processes, because it controls timescale of magma motion. Especially, preeruptive magma viscosity erupted at active and hazardous volcanoes should be fundamental information to predict future activities and evaluate potential hazards. But, examples of calculating viscosity of natural magmas are scarce, because petrological, precise data required to calculate magma viscosity (melt composition, melt water content, temperature and phenocryst content) is not easy to be acquired.

In order to develop a simple method to approximate preeruptive magma viscosity, petrological data available to calculate viscosity of magmas in preeruptive condition were compiled, and the correlations between petrological data and preeruptive magma viscosity were examined.

Similar compilation was performed by Scaillet et al. (1998), but they compiled silicic magmas only. Besides that, recent experimental studies (Hui and Zhang, 2007; Giordano et al., 2008) have proposed precise viscosity models available for wide range of magma composition from basaltic to rhyolitic systems. In addition to re-calculations for 33 examples of silicic magmas in Scailllet et al. (1998), viscosity calculations were performed for new 37 example of basaltic to rhyolitic magmas by using the model of Hui and Zhang (2007).

Bulk SiO_2 content, which is often used as a measure of preeruptive magma viscosity, is not well correlated with magma viscosity. Especially, andesitic magmas have wide range of magma viscosity from 10^3 to 10^7 Pas due to wide range of phenocryst content from 0 (pure andesitic melt) to ca. 50 vol.% (50 vol.% rhyolitic melt + 50 vol.% phenocryst). In contrast, temperature and melt SiO_2 content are well correlated with melt viscosity. These correlations enable us to empirically approximate melt viscosity for basaltic to rhyolitic composition. Therefore, these empirical relations with correction of phenocryst content (e.g. Caricchi et al. 2007) can be used to approximate preeruptive magma viscosity. However, we should call the approximated magma viscosity *magma viscosity scale*, in order to distinguish them from precise calculation of preeruptive magma viscosity. Since melt SiO_2 content can be estimated from bulk SiO_2 content and phenocryst content, it is possible that we approximate magma viscosity by using bulk SiO_2 content and phenocryst content only.

Although this method is rough approximation of magma viscosity, it has great merit to apply to a lot of petrological data in previous literature for understanding eruptive patterns from the standpoint of magma viscosity.