The time scale evaluation of volcanic eruptions by dehydration and color change rates and permeabilities of volcanic materials

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In order to evaluate quantitatively time scales for volcanic eruptions, dehydration rates, gas permeabilities and color change rates of volcanic eruptive materials have been experimentally investigated. The dehydration rates of volcanic glasses, measured by in-situ infrared (IR) microspectroscopy with a heating stage, have been found to be primarily controlled by diffusion of molecular water (H2O). Based on the apparent H2O diffusivity in rhyolitic glasses, rough time scales for diffusion-limited dehydration of the magma for typical eruption conditions are estimated to be from 1 second to 1 hour. This can be considered as a minimum time scale for magma ascent from the magma chamber to the fragmentation level during volcanic eruptions.

The permeabilities of volcanic materials have been measured by using a revised gas permeameter for small samples. The gas permeability in vesiculated volcanic materials can be used to evaluate the time scale ranges for degassing through 1 cm to 1m to be from about 8 seconds to about 10 hours.

A series of heating experiments of obsidian was conducted to simulate the color changes during natural oxidation processes of rhyolitic glasses. The color change rate of dry obsidian including ferrous iron might be controlled by a diffusion process, and is 2 to 4 orders of magnitude slower than the dehydration rate. This diffusion-limited oxidation model was applied to colors of some natural plinian pumices to estimate time scale ranges of plinian eruptions. The estimated travel time of magma from the fragmentation level to the lower parts of plinian eruption column ranged from 12 to 207 minutes for one plinian deposits.

All these studies provide quantitative bases for evaluating time scale ranges of some rhyolitic volcanic eruptions and might be useful for determining evacuation periods for people at the active volcanic sites.