The dehydration and color change rates of volcanic materials and time scales for Plinian volcanic eruptions

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The dehydration and color change rates of volcanic eruptive materials have been investigated to evaluate quantitatively time scales for volcanic eruptions. The dehydration rates of volcanic glasses have been primarily controlled by diffusion of molecular water (H2O). Based on the H2O diffusivity in rhyolitic glasses, rough time scales for diffusion-limited dehydration of the magma for some Plinian eruptions are estimated to be in the order of a few hundreds of seconds. This can be considered as a minimum time scale for magma ascent from the magma chamber to the fragmentation level during volcanic eruptions.

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 cation diffusion, and is 2 to 4 orders of magnitude slower than the dehydration rate. This diffusion-limited oxidation model was applied to colors of 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 1 to 100 minutes for 2 typical plinian deposits.

Besides the rhyolitic glasses, the dehydration and color change rates for some mineral phases are being studied in order to evaluate time scale ranges for volcanic eruptions based on various volcanic materials.