Abstract

Surface manifestations of hydrothermal fluids such as fumaroles and hot springs provide valuable information about the level of activity of a volcano during quiescent period. Geochemical study of gas and spring waters is useful to elaborate geochemical model for magmatic-hydrothermal system. Furthermore, temporal geochemical monitoring of these fluids with time provides a better understanding in processes occurring inside the volcano and can be useful to detect any changes in the activity of the magmatic-hydrothermal system.

This thesis investigates two hydrothermal systems at Kelud and Papandayan volcanoes that are located at Java Island in Indonesia. Kelud is considered as one of the most dangerous volcanoes of Java because of its frequent eruptions. After the last eruption that occurred in 1990, a new lake rapidly filled the crater of Kelud volcano. Water samples collected since 1993 are near neutral Na-K chloride fluids and are typical of aged hydrothermal system where the acidity has been completely neutralized by fluid-rock interaction and where the emission of acid magmatic gases has stopped. Two sudden increases in lake temperature in 1996 and 2001 were accompanied by rapid changes in lake water compositions and suggest the existence of two hydrothermal systems feeding the lake: a shallow hydrothermal system dominated by Ca-Mg sulfate waters and a deepest aquifer with neutral alkali chloride waters. From 2001 to 2005, measurements of CO_2 emitted by the surface of the lake were performed by using the accumulation chamber method modified in order to work at the surface of a crater lake. Two statistical methods were used to process data: the graphical statistical and stochastic simulation methods. The results of graphical statistical approach showed that two different degassing processes are acting at the lake surface: one corresponding to CO_2 fluxes resulting from rising bubbles and the other corresponding to equilibrium diffusion of dissolved CO_2 at the water-air surface. Total CO_2 emission rate estimated by stochastic simulation ranges from 105 t/day for 2001 to 32 t/day for 2005. Thermal energy released by the lake was also estimated by using an energy balance model with a new constraint using the CO_2 flux. The thermal flux decreased from 200 MW (2001) to 100 MW (2002) and then remained stable.

Correlation between the chemical data of waters, the fluxes of CO_2 and energy show that a constant decrease in the level of activity of the volcano since 1993 occurred although the lake temperature has been stable since 2003.

Since the last magmatic eruption that occurred in 1772, phreatic eruptions occur on Papandayan volcano with the last one in 2002. The volcanic material ejected during this eruption is essentially made of altered rocks from within the hydrothermal system. The interaction of acid waters with the host rocks corresponds to an advanced argilic alteration. The chemical compositions of waters from Papandayan volcano and Kelud lake waters are contrasting. Indeed, the spring waters sampled since 1994 are acid sulfate-chloride waters and acid sulfate waters. The chemical and isotopic ($\delta^{18}O$, D) analyses of gases and waters suggest a significant magmatic contribution in SO_2, HCl and HF to the hydrothermal system. The chemical composition of waters sampled after the 2002 eruption have provided information about origin of this eruption. Decrease in chloride concentration and in $\delta^{34}S$ of dissolved sulfates showed that the magmatic contribution in these fluids are less important and that the waters are likely to be formed by the condensation of steam (H_2O, H_2S) rising from a boiling aquifer.