Geochemical survey at Rabaul caldera, PNG

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INTRODUCTION

Rabaul caldera situated on the east end of New Britain Island, PNG holds eight volcanic cones or lava vent, of which Vulcan crater and Mt.Tavurvur have discharged a large amount of ash and destroyed the eastern half of Rabaul town in 1994. Rabalanakaia crater continues a geothermal activity being neighbored by hot springs. Before the eruption in 1994, Mt.Tavurvur had a non-eruptive period lasting 51 years. In 1990, six local peoples were killed by a volcanic CO2 gas accumulated in the summit crater of Tavurvur (BGVN, 1990). In 1997 a lava flow have issued on the south flank of Tavurvur. At present (Nov. 2003) Tavurvur is continuously discharging ash, occasionally affecting an airport 10 km northeast of Tavurvur.

In order to investigate a shallow structure of magma-hydrothermal system in Rabaul caldera, a geochemical survey was carried out. On 17th to 26th Nov. 2002, a measurement of CO2 flux from ground surface, a direct sampling of fumarolic gas and a sampling of hot spring waters were carried out.

MAGMA HYDROTHERMAL SYSTEM

During the sampling of fumarolic gas, explosive eruptions occurred every eight minutes. The following features were found in the fumarolic gases from Tavurvur volcano. 1) The stable isotope ratios of water vapor is located in a triangle region the apexes of which are identical to local meteoric water, magmatic water and sea water. 2) The fumarolic gases contained CO2 gas with high concentration. The 13C/12C ratio of the CO2 was magmatic. 3) The concentration of acidic gases such as HCl and SO2 were very low. The above features could be explained by the following model. A high temperature gas originated in a degassing magma is mixed with sea water. A vapor phase and a liquid phase are created from the mixture. The vapor phase is discharged as fumarolic gas. The liquid phase is mixed with a hot sea water and discharged as hot springs. The CO2/H2O molar ratio of the high temperature gas is evaluated to be 0.035 based on the model. Roggensach et al.(1996) analyzed the melt inclusions contained in the lava from Mt.Tavurvur. The concentration of H2O and CO2 in melt inclusions were 3.5wt.% and 500-1000wt.ppm, respectively. If a magma with the above concentrations is degassed at 3.3 to 4 km of depth, a gas with 0.035 for CO2/H2O ratio will be created. The fumarolic gas on the foot of Tavurvur volcano can be generated from a magmatic gas and sea water. The magmatic gas is not identical to a gas discharged with volcanic ash from summit. Sea water is necessary for the formation of fumarolic gas. The acidic gases in the magmatic gas would be transformed to a liquid phase.

DIFFUSIVE CO2 DISCHARGE

The CO2 discharge from ground surface was measured at 65 points surrounding Simpson harbor by use of the accumulation chamber method (Chiodini et al., 1998). The flux of CO2 gas from ground surface was 0 to 820 (g m-2 day-1). Maximum flux was observed at the point closest to Rabalanakaia crater. The number of high CO2 flux points was 13 where the flux was more than 36 (g m-2 day-1). The points with high flux were mainly located near the abandoned airport and the west side of Vulcan. The airport area overlaps the area of seismic energy release during the Crisis period (Mori et al., 1989). As already suggested by Pérez et al. (1996), the CO2 anomaly around the airport indicates the establishment of a channel through which magmatic gas or fluid can easily raise from a deep source.