SOIL GAS EMISSION AT SATSUMA-IWOJIMA VOLCANO, JAPAN.

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Recent geochemical studies in volcanic area have shown that magmatic gas is emitted not only from fumaroles but also through the soil around volcanoes (Chiodini et al., 1998). The amount of diffuse degassing CO_2 is comparable to fumarolic CO_2 in some volcanoes (e.g. Allard et al., 1991). Diffuse output of CO_2 is related to volcanic activity in some area (e.g. Gerlach et al., 1998), soil gas survey can be a useful tool to monitor volcanic activity. Measurement of soil gas emission has been used also to detect active structure, because these structures are permeable zone which can channel deep gases towards the surfaces.

We carried out soil gas survey at Satsuma-Iwojima volcano. The objective is to obtain distribution of the diffuse degassing area, compare with geological feature. Furthermore, we estimate total amount of diffuse CO_2 flux and compare with CO_2 flux from fumaroles.

The soil gas survey was carried out during 18-22 November 1999. We surveyed whole island except upper half of the Iwodake rhyolitic lava dome. In this study, 155 sampling sites (2.5km^2) are selected depending on structural features and accessibility. We measured CO_2 flux, chemical composition, carbon isotope ratio of CO_2 and soil temperature.

Carbon dioxide flux was measured using an open-bottomed accumulation chamber placed on the soil (Chiodini et al., 1996). Soil gas samples were collected with a syringe from a stainless steel probe inserted into the soil at 40-50 cm depth. The chemical composition and carbon isotope ratios of CO_2 were measured by gas chromatograph and mass spectrometry, respectively. Soil temperature at 20 cm depth was also measured by thermocouple sensor.

Soil gas of the studied area is a mixture of CO_2 and air components. The CO_2 concentration varied from 0.03 to 59 vol%. The high CO_2 concentration area is found around Yahazudake area, which is a part of caldera rim of Kikai Caldera. Carbon dioxide in the soil is a mixture of three components, volcanic, biogenic and atmospheric. Figure 1 shows a relationship between CO_2 concentration and $\delta^{13}C(CO_2)$. We calculated each contribution by assuming three end members. Although volcanic contribution is less than 15% at 70% of the sampling site, high volcanic contribution of more than 50% is observed at several selected areas such as Ketsunohama coast, at the foot of Iwodake, and Nagahama hot spring area. The soil temperature is higher than that of background level.

The volcanic CO_2 flux is obtained by the following equation,

$$F(CO_2)obs \times C(vol) = F(CO_2)vol.$$

where $F(CO_2)obs$ is observed CO_2 flux, C(vol) is volcanic CO_2 contribution and $F(CO_2)vol$ is a volcanic CO_2 flux. Statistical graphical analysis (Sinclair, 1974) was used to distinguish different geochemical population. Figure 2 shows distribution of volcanic CO_2 flux together with geological feature. High volcanic CO_2 diffuse degassing of more than 1000g/m^2/day were observed close to

Yahazudake (A), which is a part of the caldera rim. The temperature of the soil is about 80~85℃, and weak steam degassing can be found. Other high flux area is located along the caldera rim of NW side of Iwodake (B), indicating that permeable zone may exist along the rim as a role of channel for emitting deep gas. Around Iwodake volcano (C), high flux is observed in some area, indicating that volcanic gas arises through a crack of lava. Although magmatic contribution is high at Ketsunohama (D), the CO_2 flux is relativity low, probably due to wet sand. Other high flux area is found around Nagahama hotspring (E).

The total volcanic CO_2 flux of the studied area is estimated to be about 20t/day. We did not investigate upper part of Iwodake and Yahazudake, therefore, the total amount of soil CO_2 degassing from Satsuma-Iwojima island is probably higher than 20t/day.

An estimated CO_2 output from Iwodake crater in the range 80~120 t/day has been determined from the measured SO_2 output and CO_2/SO_2 ratio of the fumarolic gas (Shinohara et al., submitted), implying that more than 20 % of the volcanic CO_2 is emitted through the surrounding soil. Diffuse degassing has an important role in Satsuma-Iwojima volcano.

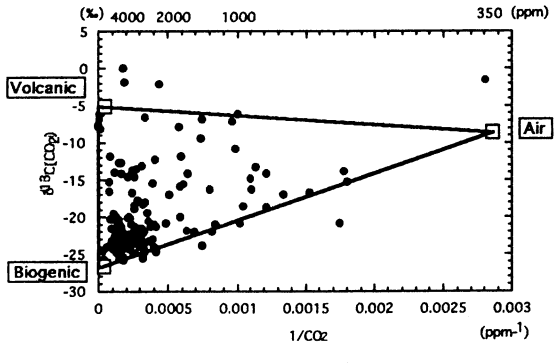

Fig.1 Relationship between CO_2 concentration and $^{13}C(CO_2)$

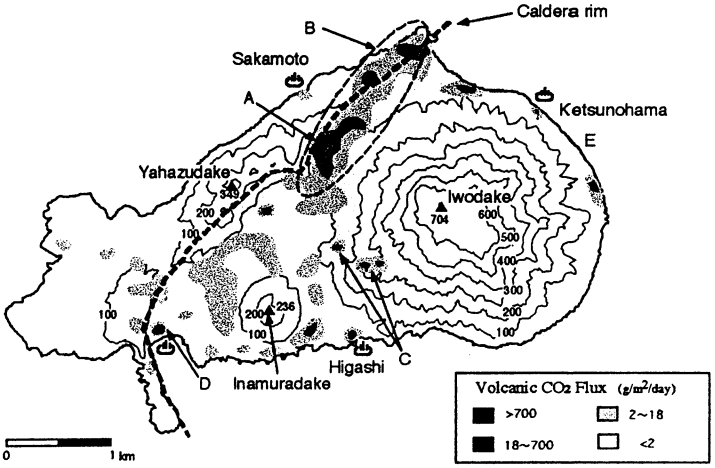

Fig.2 Distribution of volcanic CO_2 flux at Satsuma-Iwojima volcano.

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