# Preface

Satsuma-Iwojima volcano, located 40 km south of Kyushu, Japan, continuously emits high-temperature volcanic gases from the rhyolitic cone of Iwodake (see photograph following). The emission rate of $SO_2$ has been $>300$ ton/day over the past 30 years, and a similar rate of degassing may have continued for more than several hundred years without any appreciable magmatic eruption from the cone having been recorded. The long-term emission of such a huge amount of volcanic gas requires degassing of a large volume of magma, most likely from a deep chamber. Similar continuous and intense degassing has been observed at several basaltic and andesitic volcanoes, including Etna, Stromboli, Izu-Oshima and Sakurajima. The large amount of degassing at basaltic and andesitic volcanoes is thought to be related to convective magma transport between a deep magma chamber and the near-surface site of degassing. The activity of Satsuma-Iwojima volcano is a rare example of continuous degassing from a rhyolitic cone. Satsuma-Iwojima has attracted many geochemists and geophysicists because of the relatively safe accessibility to its high-temperature fumaroles. This has enabled a variety of observations and measurements to be made near the intense degassing source. This special issue is a collection of sixteen articles from many disciplines, and summarizes the results of a variety of research efforts that have been conducted recently to better understand the volcanic and magmatic processes of Satsuma-Iwojima volcano.

The recent activity of the volcano is summarized by Shinohara *et al*. Although the intense degassing occurred continuously over the period of observation, some changes in surface manifestations were observed at the summit area in the 1990s. These included formation of a new vent, ash emission and ground deformation. Iguchi *et al.* monitored the seismic activity during this vent formation and showed that the rate of energy release is comparable to that in the late 1970s. Volcanic earthquakes occurred largely near the surface, just below the summit crater, in the 1990s. Iguchi *et al.* and Uchida and Sakai show that characteristic volcanic earthquakes during this period were generated by volume expansion, most likely caused by bubbling in a volcanic conduit. In addition to the on-site observation, Urai showed that variation in heat discharge and distribution of hot areas at the summit was detectable by satellite-based remote sensing.

Photo. Aerial photo of Satsuma-Iwojima volcano, looking west-northwest. Pre-caldera andesitic and rhyolitic lavas can be seen on the far side of the island as the elongate ridge; they define the northwest margin of the Kikai caldera. The rhyolitic cone of Iwodake (right) and the basaltic cone of Inamuradake (left) lie inside the caldera. Fumaroles with temperatures up to 880°C discharge from the summit crater of Iwodake. Condensation of these volcanic gases has caused large areas of alteration, clearly visible in gullies on the east slope, closest to the viewer, prior to the condensates discharging as hot springs along the shoreline. The discolored seawater shows the degree of acidic outflow, with red Fe hydroxides forming offshore of Inamuradake, and whitish Al hydroxides forming along the shore below Iwodake. (Photo by Kawanabe Y.)

The acid volcanic gases condense to form acid waters, which alter and leach the volcanic rocks around the cone of Iwodake prior to discharging as hot springs on the beach . Hamasaki examined the distribution of the acid-leached rocks in the summit area and found evidence for a structural control on the spatial evolution of the hydrothermal system. Self-potential surveys were performed by Kanda and Mori, and they suggest possible flows of gas and liquid phases beneath the volcano, based on the SP anomaly pattern. The distribution of volcanic $CO_2$ emission through soils was surveyed by Shimoike *et al*. They determined that the emission of volcanic $CO_2$ through the soil constitutes at least 25% of the total emission of volcanic $CO_2$ from the volcano. Although these three articles discuss fluid flow through the volcanic edifice, and arrive at a comparable distribution in some cases, the limited overlap of the survey areas means that a direct comparison of the different techniques remains for future study.

The easily accessible high-temperature fumaroles in the summit area provide a unique opportunity to study the geochemistry of high-temperature volcanic gases. Mori *et al.* applied a remote FT-IR technique to the volcanic plume and found a high $SiF_4$/HF ratio of 0.6 in the plume. These results indicate that it is necessary to consider $SiF_4$ as a common F-bearing species in the volcanic gases. Sato *et al.* discuss the origin of CO and $CH_4$ in the fumarolic gases based on the carbon isotope ratio of the gases. They conclude that CO forms by reaction in the high-temperature gases but $CH_4$ is derived from external sources. Snyder *et al.* investigated the origin of the volcanic gases using iodine isotope and halide compositions. They conclude that recycling of subducted marine sediments is the major source of halides in the gases.

In addition to major gas species, the high-temperature fumaroles also discharge various trace metal components, and this source accounts for a significant contribution to the atmospheric budget. Africano *et al.* investigated the deposition processes of trace metals from the gases by analyzing sublimates collected at the high-temperature fumaroles. Because radionuclides in volcanic gases decay with time, their concentrations were measured at various degassing volcanoes such as Etna, Stromboli, Merapi and White Island in order to evaluate the process of degassing. Le Cloarec and Pennisi applied this method to Satsuma-Iwojima and found that a similar process of degassing of the basaltic and andesitic volcanoes also occurs in this rhyolitic system. The variations that they found may be related to the more viscous nature of the silicic magma.

Kawanabe and Saito refined the history of volcanic activity subsequent to caldera formation based on tephra stratigraphy and $^{14}C$ dating. The activity after caldera formation at 6500 yBP has been characterized by bimodal eruption of basaltic and rhyolitic magmas. Although degassing occurs largely from the rhyolitic cone, abundant mafic inclusions in erupted rhyolite suggest that these two magmas co-exist in a deep magma chamber. Study of the mafic inclusions by Saito *et al.* provides evidence for interaction between these two magmas. Kazahaya *et al.* summarize the characteristics of degassing activity at Satsuma-Iwojima. Based on their modeling of the degassing process, they propose that volcanic gases degas from a rhyolitic magma as it convects in a volcanic conduit, and this rhyolitic magma is supplied with volatile components from a basaltic magma that underlies the rhyolitic chamber. Korzhinsky *et al.* report similar activity of vent formation during continuous degassing at Kudriavy volcano, in the southern Kurils, and they discuss its eruption mechanism and compare it with the activity at Satsuma-Iwojima.

All sixteen articles in this volume discuss various aspects of this continuously degassing volcano. Interaction among these different disciplines was initiated during the planning and editing stage of this special issue. However, further integration of these types of studies should proceed, and we hope that this volume will serve as a stepping stone for such integration. In closing, we thank all the reviewers for their constructive comments on the manuscripts. Their efforts have significantly improved this collection of papers.

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