

Tephra Dispersal Mechanisms and Magmatic Processes of the August 2021 Fukutoku-Oka-no-Ba Eruption, Izu-Bonin Arc: Insights from Rapid Response Seafloor Surveys

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Fukutoku-Oka-no-Ba (FOB) is an active submarine volcano at the southern end of the Izu-Bonin Arc. On August 13, 2021, it erupted for the first time in 11 years, producing an ash plume that reached 16 km in altitude. Satellite images captured a discolored water area immediately after the eruption, followed by floating pumice. The eruption lasted three days, transitioning into phreatomagmatic explosions. Pumice rafts were transported over 1,000 km westward, impacting maritime transport, tourism, and fisheries as they washed ashore on the Ryukyu Islands.

To investigate the eruption processes and tephra dispersal mechanism, we conducted rapid-response seafloor surveys. In 2022, two research cruises (KS-22-5 and KS-22-13) were carried out using the R/V Shinsei Maru. Additionally, in August 2024, a more detailed survey (KK24 cruise) was conducted using the R/V Dai-san Kaiyo Maru.

The KS-22-5 cruise involved 8 grab samplings in the western proximal region to characterize tephra deposits. Volcanic ash and pumice most likely from the 2021 eruption were successfully recovered. The KS-22-13 cruise conducted 4 ROV Hyper-Dolphin dive surveys to investigate the volcanic geology and sample rock, sediment, and benthic organisms. Fine volcanic ash and oxidized red pumice were retrieved from the seafloor 18 km west of the vent, corresponding to the region directly beneath the umbrella cloud formed during the Plinian eruption. The KK24 cruise conducted 20 grab samplings to further characterize the tephra dispersal mechanisms, while also assessing seafloor ecosystem recovery. Bathymetric surveys were performed during all cruises.

Key findings are:

Detection of topographic changes of the edifice from pre- and post-eruption bathymetric data.

Identification of three eruption deposit types: eruption-fed density current deposits, fallout deposits, and abraded pumice raft deposit, corresponding to satellite observations.

Fallout deposits up to 10 cm thick, including oxidized pumice, were found 18 km west of the crater, indicating significant volume of juvenile magmatic material in the Plinian eruption column.

Geochemical analyses indicate the involvement of two compositionally distinct trachytic magmas that mixed shortly before the eruption.

These findings provide critical insights into eruption dynamics, tephra dispersal, and seafloor ecological recovery, emphasizing the importance of rapid-response surveys for understanding shallow-sea explosive volcanism.