Investigation of subaerial and submarine deposits of pyroclastic density currents: A case study at Kikai volcano, SW Japan

*Koji Kiyosugi[1], Syota Deguchi[2], Katsuya Kaneko[3], Keiko Suzuki-Kamata[1], Reina NAKAOKA[1], Satoshi Shimizu[1], Nobukazu Seama[3], Yoshiyuki Tatsumi[1], Takeshi Hanyu[4]

1. Kobe Ocean-Bottom Exploration Center, Kobe University, 2. Department of Planetology, Faculty of Science, Kobe University, 3. Department of Planetology, Graduate School of Science, Kobe University, 4. Japan Agency for Marine-Earth Science and Technology

The behavior of pyroclastic density currents becomes much more complicated when it reaches the sea area. The lower, denser flow parts may enter the sea and form submarine ignimbrite. The upper, more dilute flow component may travel over the sea surface for tens of kilometers and reach distal coastlines. Due to limited observations, these currents' flow and depositional mechanisms are not clear. This study investigated the changes in grain size distribution and component abundance of subaerial and submarine ignimbrite deposits at Kikai volcano.

Kikai volcano (Kikai caldera) is located about 45 km off southern Kyushu Island, Japan. Except for two islands (Satsuma Iwo-Jima Island and Take-Shima Island) on the northern part of the caldera rim, most of the caldera structure is under the sea. At Kikai volcano, At least two large pyroclastic eruptions occurred; the 95 ka Kikai-Tozurahara eruption and the 7.3 ka Kikai-Akahoya eruption. In the Kikai-Tozurahara eruption, an ignimbrite called the Nagase pyroclastic flow occurred. It traveled over the sea surface and reached surrounding islands at least 55 km away. Proximal and distal subaerial deposits of this pyroclastic flow were sampled at Take-Shima (ca 0.1 km from the caldera rim) and Kuro-Shima islands (ca 33 km from the caldera rim), respectively. In the Kikai-Akahoya eruption, initial Plinian phase was followed by the occurrence of intra-Plinian and climactic ignimbrites. The deposits of these eruption phases are called the Funakura pumice-fall deposit, Funakura pyroclastic-flow deposit, and Koya pyroclastic-flow deposit, respectively. The climatic Koya pyroclastic flow traveled over the sea surface and reached at least 80 km away. High-resolution marine seismic reflection surveys and glass composition analyses revealed that the submarine counterpart of the Koya pyroclastic flow propagated as seafloor-hugging pyroclastic density current and reached at least 40 km away. Proximal subaerial deposits of the Koya pyroclastic flow and Funakura pumice fall were sampled at Take-Shima island (ca 0.5 and 0.7 km from the caldera rim, respectively). Proximal submarine deposits equivalent to these pyroclastic flows were recovered from 5 sites about 4.3 km off the northeastern side of Take-Shima Island (ca 5.5 km from the caldera rim) with Hydraulic Piston Coring System (HPCS) and Short HPCS (S-HPCS) of D/V Chikyu on January 11–14, 2020. Each drilling site was separated by 10–20 m from any other site. The sediment was not consolidated. Bioturbation was not observed. The sediment sequence, from the top of the cores, consists of gravel unit, ill-sorted lapilli unit (Koya upper), reddish tephra unit, sandy silt unit (Koya lower), and white tephra unit. Glass composition and a ^{14}C date suggest that the ill-sorted lapilli unit and reddish tephra unit originate from Kikai-Akahoya eruption and the white tephra unit originates from Kikai-Tozurahara eruption.

Comparisons of the subaerial and submarine deposits show the sorting effect of submarine deposition. In the case of the Kikai-Tozurahara eruption deposits, the median diameter and the sorting coefficient of subaerial deposits decrease with distance from the volcano. Proximal deposits sometimes show sorting coefficients as small as the distal subaerial deposit when they are deposited under the sea. In the case of the Kikai-Akahoya eruption deposits, the proximal submarine deposits have a wide range of median diameter and sorting coefficient. Due to submarine deposition, the minimum sorting coefficient is smaller

than the sorting coefficient of the proximal subaerial deposits of the Funakura pumice fall and Koya pyroclastic flow.

The sorting features suggest the importance of investigating both subaerial and submarine deposits to understand the entire behavior of pyroclastic flow traveled over the sea surface.

Keywords: Catastrophic caldera-forming eruption, Offshore drilling, Sedimentary facies

