Preliminary report of the sea floor survey by a remotely operated vehicle (ROV) at the Kikai caldera, SW Japan

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Submarine volcanoes are one of the frontiers in volcanology: many volcanoes are located under the sea and most of them are not well studied. Since 2016, the Kobe Ocean-Bottom Exploration Center (KOBEC) at Kobe University has investigated a submarine volcano (the Kikai caldera) to understand the structure of the caldera and the style of the caldera forming eruption. The Kikai caldera is located about 45 km off southern Kyushu Island, Japan. Except two islands on the northern part of the caldera rim, most of the caldera structure is under the sea. The caldera has double caldera structure: the outer caldera has width of 19 km and length of 24 km and the inner caldera has width of 15 km and length of 17 km. The formation of, at least, the inner caldera must be related with one of the largest eruption of this volcano occurred about 7300 years ago. In the inner caldera, a giant rhyolite lava dome (~32 km^3) was created after the caldera collapse (Tatsumi et al., 2018).

A remotely operated vehicle (ROV) is a tethered underwater robot connected with a support surface vessel by a cable for power supply and signal transmission. To observe and sample sea floor material, we introduced a ROV (SHINDAI-2K) in 2016. In this presentation, we show preliminary results of 9 dives of the ROV at 8 sites in the following 3 areas in the Kikai caldera.

Outer caldera: We investigated two sites at the northeastern rim of the outer caldera. At one of the sites, we found a massive angular outcrop of dense rock in the caldera wall. This result and andesitic gravel sampled at this site confirmed the presence of igneous rock expected by our prior multi-channel seismic reflection survey. Another site had a sandy seafloor. We sampled the sediments with the ROV and identified volcanic glass fragments ejected by the caldera forming eruption.

Inner caldera: We had two dives around the inner caldera. At the northeast caldera wall of the inner caldera, basement rock appeared as a massive and angular upright outcrop of dense mudstone which had several centimeters wide horizontal banded structure. On the other hand, at the southeastern site in the inner caldera, the sea floor was covered by sandy or muddy sediments. Volcanic glass fragments ejected by the caldera forming eruption were also identified from the sediments. Furthermore, some isolated vesiculated lava blocks were observed at this site. Those blocks had fractured surface, suggesting chilling of hot ejecta due to lava/water interaction.

Lava dome: We had four dives at the lava dome. The outline of the results was already reported by Tatsumi et al (2018). The most surface of the lava dome was covered by meter-scale vesiculated lava blocks (pillow lobes; Tatsumi et al., 2018). These blocks also had water-chilled structures. Relatively dense angular chilled blocks were observed at the east flank of the lava dome where gully-like features had been determined with our prior bathymetry analysis. Furthermore, a small amount of gas emission was observed at the northern flank of the lava dome where water column was expected in our prior

side-scan sonar acoustic images.

Visual observation and sediments sampling using ROV provides valuable information to understand the history and eruption style of submarine volcanoes. Our preliminary observations suggests that (1) the amount and size of vesiculated lava blocks decrease with distance from the lava dome, showing that they were provided from the dome, (2) basement rock of the volcano is exposed at the sea floor in, at least, some areas of the Kikai caldera, (3) as well as old volcanic edifices in the two islands, old submarine volcanic edifices were cut by the caldera collapse and some of them are exposed in the outer caldera wall. These results and further ROV survey will provide new insight into the eruption history of submarine volcanoes.

Keywords: Submarine volcanoes, Caldera volcanoes, Kikai caldera, ROV

