Evolution of magma supply system beneath a submarine lava dome after the 7.3-ka caldera-forming Kikai-Akahoya eruption

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Purpose

Kikai caldera in SW Japan, which is a submarine volcano, has undergone repeated caldera-forming eruptions. After the 7.3-ka caldera-forming Kika-Akahoya eruption, basaltic and rhyolitic subaerial eruptions occurred at Inamura-dake, Iwo-dake and Showa-Iwojima volcanic centers on the caldera rim. Fumarole activity still continues at Iwo-dake. Recent submarine surveys have revealed that a 600 m high central lava dome grew inside the Kikai caldera, with a volume of 32 km^3. In addition, several satellite volcanic cones formed to the east and the west of this central lava dome. These features inside the submarine caldera would postdate the 7.3-ka Akahoya eruption. However, the formation mechanism of these submarine volcanic edifices is yet to be well understood. Here we present the whole-rock and mineral chemistry of dredged rocks from the central lava dome and satellite volcanic cones inside the submarine caldera.

Samples and methods

We conducted 14 dredges from the central lava dome and some of the surrounding satellite volcanic cones. Dredged rock samples are rhyolitic with phenocryst assemblage of plagioclase+clinopyroxene+orthopyroxene+magnetite+ilmenite. Apatite is observed as an accessory mineral. Mineral mode is less than 25 vol.% and vesicularity range from 10 to 40 vol.%. Whole-rock major element composition of each rock was analyzed by XRF. Major element composition of minerals, glasses and melt inclusions was analyzed by EPMA. The results are used to constrain magmatic conditions that formed these submarine volcanic edifices.

Analytical results and discussion

Most rhyolites from the central lava dome and the western satellite volcanic cones are compositionally distinct from those of the Akahoya eruption and the old Iwo-dake volcanic stage (5.2–3.9 ka) rhyolites. Instead, the chemical compositions of these submarine rhyolites overlap with those of the volcanic products of the young Iwo-dake, which is active since 2.2 ka. The compositional similarity suggests that the central lava dome tapped the same magma supplying the young Iwo-dake volcanism. By contrast, the dredge samples from the eastern satellite volcanic cones exhibit binary chemical trends: one group having chemical composition that overlaps with those of the young Iwo-dake rhyolites; the other group being chemically similar to the rhyolites from the old Iwo-dake and the Akahoya eruption. The magma temperature estimated from Fe-Ti oxide thermometry range from 900 to 940 ℃(922 ℃ on average) is almost equal to those estimated for subaerially erupted rhyolites at Iwo-dake during the young Iwo-dake volcanic stage and the Showa-Iwojima eruption in 1934–1935. The oxygen fugacity estimated from Fe-Ti oxygen barometry is 0.8 log unit higher than Ni-NiO buffer (NNO+0.8), on average, which is lower than that estimated for the subaerially erupted rhyolites. A magmatic hygrometer estimated H_2O content of the melt ranging 2.2–3.5 wt%. Polybaric crystallization from H_2O-saturated melts may have occurred beneath the submarine lava dome at depths of 2–4 km. These results suggests that a separate magma supply system with basaltic and rhyolitic magmas may exist beneath the submarine central lava dome and that underlying basaltic magma, such as that beneath Iwo-dake and Showa-Iwojima, may have heated rhyolitic magmas stored at depths of 2–4 km. Additionally, the lack of mafic enclaves, which are by contrast commonly observed in the subaerially erupted rhyolites at Iwo-dake and Showa-Iwojima on the caldera rim, implies that direct interaction between basaltic and rhyolitic magmas is limited beneath the center of the submarine caldera.

Keywords: Kikai caldera, Akahoya eruption, post-caldera volcanism