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Magmatic evolution leading to multiple calderagenic eruptions at Kikai volcano, Southwest Japan

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The Kikai volcano offshore SW Japan could be one of the deadliest volcanoes in the world for producing three calderagenic eruptions at 140 ka (Koabi, KKb), 95 ka (Tozurahara, KTz) and 7.3 ka (Akahoya, KAh). This volcano is largely submarine, making future explosive eruptions potentially devastating. However, information about its long-term behavior and magmatic evolution is limited because it is largely underwater. We conducted a geochemical survey of subaerial and submarine volcanic ejecta across the different stages of the volcano to understand its evolution and gain knowledge about potential patterns for its caldera-forming events. ^{40}Ar-^{39}Ar age dating of samples from previously unexplored outer caldera rim yielded 205 ka and 235 ka plateau ages, suggesting that the volcano formed a pre-caldera edifice by ~235 ka. Statistical and comparative analyses of the chemical and isotopic variation among the Kikai volcanic ejecta point to the existence of up to three magmatic trends, namely, pre-KKb, KKb-KTz, and KAh from oldest to youngest, consistent with at least three magmatic cycles. Each magmatic cycle is marked by a distinct shift in Pb-Nd-Sr isotopic composition. The first magmatic cycle could represent the ~700 ka initiation and formation of the Kikai volcano or the pre-KKb stage volcanism, based on their distinctive isotopic signatures. The second magmatic cycle built the 235-205 ka andesitic edifice and led to two calderagenic eruptions at ~140 and ~95 ka. The third and present magmatic cycle may have started with the bimodal eruption of andesitic and rhyolitic lava flows that formed small cones that are now preserved on the islands of Satsuma Iwojima and Takeshima along the inner caldera rim and led to the 7.3 Akahoya calderagenic eruption. Post-caldera magmatism shares the isotopic signatures of KAh volcanic products, suggesting that it is still part of the same magmatic cycle. In Pb-Pb isotope space, the data for KKb-KTz and KAh magmatic cycles define distinct subparallel compositional arrays. One of the possible interpretations is that the shifts in isotopic composition between magmatic cycles reflect changes in crustal and subducting slab inputs into the source of Kikai volcano with time.