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Anatomy of a volcanic island inferred from a multiphysics approach

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Phreatic and phreatomagmatic eruptions are difficult to predict with accuracy on volcanoes due to complex interactions at depth between heat, water, and magmatic fluids. To better understand such multifaceted interactions, we present here a multidisciplinary geophysical approach performed on Miyakejima, a 10-km wide stratovolcano in the Izu Bonin arc. Its plumbing system was highlighted by combining four geophysical methods: magnetotellurics, seismicity (hypocenters), self-potential, and thermal image (remote sensing). We thus propose the first large-scale interpretation of the volcanic structure in terms of rock properties, temperature, fluid content, and fluid flow. Our findings indicate that hot volatiles released from a *deep* magmatic reservoir (> 350°C, 2.5–4.5 km depth) rise through a narrow permeable path, interact with the conductive hydrothermal system beneath the 2000 A.D. caldera (<250°C, 0–2 km depth). This mixture of fluid is finally released in the fumarolic area in the southern part of the caldera at 181°C. This combined approach allow us to: 1) delineate the water table of the volcano (300–700 m depth), 2) determine the general fluid flow circulation beneath the island, 3) characterize seismic signatures of long-period and volcano-tectonic events, and 4) elucidate the origin of the high water content of fumaroles developed since the last eruption in A.D. 2000.