

Zircon geochronological and geochemical insights into pluton building and volcanic-hypabyssal-plutonic connections: Oki-Dōzen, Sea of Japan—A complex intraplate alkaline volcano

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ABSTRACT

The relationship between plutonic and volcanic components of magmatic plumbing systems continues to be a question of intense debate. The Oki-Dōzen Islands, Sea of Japan, preserve outcrops of temporally associated plutonic, hypabyssal, and volcanic rocks. Post-intrusion uplift juxtaposed Miocene syenites in inferred faulted contact with volcanic trachytes that are cut by rhyolite hypabyssal dikes. This provides a window deep into the timing and origins of magma storage architecture and dynamics. Zircon is ubiquitous in all samples; our aim is to determine what its age and composition can reveal about the plutonic-volcanic connection. Here we show magma source characteristics are recorded in zircon Hf isotopes; source composition and assimilation of heterogeneous hydrothermally altered crust in zircon O isotopes; and extensive fractional crystallization in zircon trace elements. Combined with new U-Th-Pb SHRIMP zircon ages, 6.4–5.7 Ma, compositional data show pluton formation was by protracted amalgamation of discrete magma pulses. The rhyolite dike preserves an evolved fraction segregated from these discrete magmas. Synchronous with plutonism was a volcanic eruption of trachyte magma derived from the same source, which may have stalled at a relatively shallow depth prior to eruption. Stalling occurred at least above the amphibole stability zone because amphibole-compatible Sc and Ti were not depleted in the trachyte melt resulting in elevated values of these in volcanic compared to plutonic zircon. Identifying smaller episodic magma pulses in a larger magmatic complex places constraints on potential magma fluxes and eruptible volumes. High-flux, large volume, plume-related ocean island magmatic systems may have extensive vertically distributed multi-stage magmatic reservoirs and subduction-related systems transcrustal magma reservoirs. By contrast, Oki-Dōzen was a low-flux system with incremental pluton growth and small- to moderate-scale eruptions.

Keywords: U-Th-Pb dating, zircon trace elements, O isotopes, Hf isotopes, amphibole