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Tracking the evolution of Late Mesozoic arc-related magmatic systems in Hong Kong using in-situ U-Pb dating and trace element analyses in zircon

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Abstract

The links between large-scale silicic volcanism and plutonism offer insights into the dynamics of crustal magmatic systems and growth of continental crust. In Hong Kong, voluminous silicic ignimbrites and linked plutons record a ~26 Myr period of magmatism from ~164 to 138 Ma. We present data from these linked volcanic-plutonic assemblages at the Lantau and High Island caldera complexes, with an emphasis on the ~143–138 Ma activity from the latter. To track the evolution of these magmatic systems, U-Pb dating and trace element analyses using secondary-ion mass spectrometry (SIMS) were carried out on zircons from 21 samples from both volcanic and plutonic samples. The SIMS age data sets divide into two groups across volcanic and plutonic origins: (1) seven samples with unimodal age spectra [five of which have the same mean value as the published Isotope Dilution Thermal Ionization Mass Spectrometry (ID-TIMS) age from the same sample]; and (2) 14 samples yielding multiple age components. Age patterns from both groups suggest that the previously separated ~143 Ma Repulse Bay (RBVG) and ~141–140 Ma Kau Sai Chau volcanic groups (KSCVG) instead represent activities over a single ~5 Myr period. Direct linkages previously proposed between some volcanic and plutonic units for this period (e.g., High Island Tuff, Kowloon Granite) are no longer supported, and magmatism represented by exposed plutons continued until 137.8 ± 0.8 Ma (Mount Butler Granite). Under CL imagery, a wide range of zircon textures identified in both volcanic and plutonic samples is indicative of complex processes, some of which are identified through trace element data coupled with textural characteristics. Overall, intra-grain (cores vs. rims; sector-zonation) and intra-sample variations in trace element abundances and ratios are larger than those between samples. Zircon chemistries in both volcanic and plutonic samples fall into two groups during the ~5 Myr history of the High Island caldera magmatic system. One group (RBVG and "cold" granites) includes inherited grains back to 164 Ma and wider ranges in Hf, Y, total trivalent elements, Th and U concentrations and Th/U, Yb/Gd, and U/Yb ratios than the other (KSCVG and "hot" granites). Two possible evolutionary models of the High Island caldera magmatic system are: (1) the system randomly tapped a single crustal domain that fluctuated in temperature as a result of varying interactions of hotter melts, or (2) the volcanic and plutonic records reflect the interplay of two crustal domains with contrasting "low-" and "high-temperature" characteristics. In Hong Kong, some plutonic bodies were comagmatic with large-scale volcanism, while others were emplaced at shallow crustal levels independently of volcanism, matching the current two end-member views of the volcanic-plutonic relationship.

Keywords: Volcanism, plutonism, granite, rhyolite, Hong Kong, Mesozoic, caldera, zircon