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U-series ages and Hf-O isotopes of young zircons from active continental volcanoes: Magmatic timescales and processes

HAIBO ZOU

Auburn University

Presenting Author: haibo.zou@gmail.com

Young zircons from active continental volcanoes contain unique information about recent magmatic timescales and processes. Here we report zircon U-Th disequilibrium ages and Hf-O isotopes from active Tengchong volcanoes on southeastern Tibetan Plateau and active Changbaishan (Baitoushan) volcano on the border of China and North Korea.

Active Tengchong volcanic rocks are trachyandesites and trachytes. Zircons from all three active Tengchong volcanoes show two age populations at 55 ka and 90 ka. We infer an earlier and deeper phase of magmatism at 90 ka and a younger and shallower phase of magmatism at 55 ka. Similar zircon ages from all active volcanoes indicate that they share common magma chambers since 90 ka at a lateral scale of 35 km. Magma residence times are 85 kyr for the deeper stage and 50 kyr for the shallower stage. Their zircon oxygen isotope $d^{18}O$ values range from 6.5‰ to 7.9‰, higher than the mantle zircon range. Their zircon Hf-O isotopes display negative correlations, indicating open-system magmatic processes.

The Changbaishan (Baitoushan) Volcano on the border of China and North Korea is well-known for its major caldera-forming Millennium Eruption (ME) of comendites at 946 CE. A pre-caldera commenditic eruption formed the Qixiangzhan (QXZ) lavas on the northern slope of this volcano. Zircons from commenditic pumices of the Millennium Eruption yield a U-series isochron age of 0.7 ka, effectively dating the Millennium Eruption. Zircons from QXZ commenditic lavas give an eruption age of 10 ka. Unlike the case for Tengchong, Changbaishan zircons yield eruption ages with short residence times. Changbaishan zircons have oxygen isotope $d^{18}O$ values ranging from 2.2‰ to 5.5‰ for ME and from 4.5‰ to 5.2‰ for QXZ, mostly lower than the mantle zircon range. Hf-O isotopes in zircons from ME and QXZ do not display significant correlations, arguing against magma assimilations by ancient crustal materials. Low $d^{18}O$ in zircons indicate assimilation of hydrothermally altered juvenile volcanic rocks or addition of surface water to magma chamber. Similar zircon Hf-O isotopes between pre-caldera QXZ comendites and syn-caldera ME comendites indicate tapping of the same portion of a zoned magma chamber or the same shallow magma chamber.