Late Quaternary U-Pb and Ar-Ar ages of granitic intrusions beneath Medicine Lake Volcano, California, USA

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We report U-Pb crystallization ages for zircon grains and Ar-Ar whole-rock spectra for a hydrothermally altered granodiorite (31-17) at Medicine Lake Volcano, a half-million-year-old shield volcano of basalt through rhyolite composition. The granodiorite was obtained at ~2.5 km depth in a geothermal drillhole sited within Medicine Lake caldera (sample supplied by CalEnergy Corp.). Plagioclase remains a stable phase within the rock, though the mafic minerals have been altered primarily to chlorite + epidote. All phases contain abundant secondary, water-rich fluid inclusions and the whole-rock $\delta^{18}O$ is -1.5 per mil. The Stanford-USGS ion microprobe (SHRIMP-RG) was used to analyze 14 unaltered zircons with U concentrations ranging from 320 to 3080 ppm. The zircon U-Pb data, uncorrected for common Pb, define a crystallization age of 250±25 ka on a Tera-Wasserburg diagram. Accounting for likely initial ^{230}Th deficiency in the zircons results in an age of ~330 ka. Analyses of four additional zircons trend in a direction that suggests variable amounts of ^{206}Pb loss: the minimum bound of this trend would define an age of ~150 ka. A ^{40}Ar-^{39}Ar step-heating experiment on the same granodiorite yielded an irregular plateau with an age of 119±9 ka and isochron and inverse isochron ages of 148±50 and 146±35 ka. We interpret these data to reflect magma crystallization about 330 ka, followed by a hydrothermal event at 150 ka that reset the Ar clock and induced Pb loss in some of the zircons.

We also studied unaltered, incipiently melted granite xenoliths from two silicic lavas, Medicine Dacite (~2000 year old) and Crater Glass Flow (erupted 1065±90 ^{14}C years BP: dates from Donnelly-Nolan et al. 1990; JGR 95: 19,693). These xenoliths (86-3 and 2050M-b) must have been dislodged from intrusions or dikes that underlie the present geothermal system and thus reside greater than 3 km beneath the Medicine Lake caldera. Sr and oxygen isotopic compositions for these samples differ appreciably from their hosts, hinting that they might not be genetically related. However, U-Pb analyses of zircons from these xenoliths indicate crystallization ages of less than 100 ka. A $^{40}Ar/^{39}Ar$ step-heating experiment on a potassium feldspar separate from one of these xenoliths (86-3) yielded an extremely regular plateau age of 9.8± 0.6 ka, consistent with isochron and inverse isochron ages of 7.4±2.7 and 7.5±2.1 ka. Future ion microprobe analyses for ^{230}Th may allow us to determine whether these extremely young ages represent actual crystallization events or a thermal event that reset the Ar clock less than 10,000 years ago.

In neither the sample from drillcore nor the granitic xenoliths did we find any evidence for relict zircons from either Sierran or Klamath terranes that might be expected to underlie the volcano.