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Timing and distribution of the Los Chocoyos supereruption from Atitlán caldera (Guatemala) by zircon 238U-230Th and (U-Th)/He double-dating

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The climactic Los Chocoyos (LCY) rhyolitic eruption from Atitlán caldera (Guatemala) is a key chronostratigraphic marker for the Late Quaternary period that has been widely used for relative dating of paleoenvironmental, paleoclimate, and volcanic events throughout Central America and adjacent marine basins in the Pacific Ocean, the Caribbean Sea, and the Gulf of Mexico. Despite LCY tephra being an important marker horizon, a radioisotopic age for this eruption has remained elusive. LCY tephra has been dated at ca. 84 ka BP based on its occurrence in marine sediments with model $\delta^{18}O$ ages, but this inferred age has not been independently confirmed through radioisotopic methods. This is due to the inherent limitations of radiocarbon dating (which is practically limited to □50 ka) and a lack of suitable materials for $^{40}Ar/^{39}Ar$ analysis in LCY tephra. To overcome this limitation, we applied ^{238}U-^{230}Th and (U-Th)/He zircon double-dating (ZDD). Due to zircon being alteration-resistant this method establishes absolute chronologies for and correlations between silicic tephra deposits, which are unaffected by glass alteration or complex compositional signatures within a single eruption. ^{238}U-^{230}Th zircon crystallization rim ages were obtained from LCY proximal tephras (~17 km from Atitlán caldera) including sub-units that may bear distinct glass compositions (e.g., fallout, ignimbrite, surge) as well as ultra-distal fallout tephra samples (~300 km from source) collected from drill cores at Petén Itzá Lake (ICDP) and the Pacific Ocean (IODP). All samples yielded zircon with statistically indistinguishable ^{238}U-^{230}Th zircon rim age spectra. These reveal continuous zircon crystallization from ca. 160 ka to ca. 74 ka, with peaks in zircon crystallization between 90-100 ka. ZDD eruption ages from two LCY fallout and one ignimbrite deposit are indistinguishable with error-weighted averages of 75.1 ± 3.2 ka (1σ; n = 16; MSWD = 4.1), 76.0 ± 2.5 ka (n = 16; MSWD = 2.5), and 72.8 ± 3.5 ka (n = 16; MSWD = 3.7). Considering all individual zircon results as a single population, a weighted average ZDD age of 74.8 ± 1.7 (1σ; n = 48; MSWD = 3.3) is obtained and considered as the best estimate for LCY eruption age. GIS-based reassessment of LCY eruptive volume uses thickness information from new 113

outcrops including 6–10 m thick pyroclastic density currents in Chiapas, Mexico (>130 km from the source) and suggests a minimum estimate volume of ~1200 km^3, confirming the LCY eruption as the first ever recognized supereruption in Central America. The new ZDD age of 74.8 ± 1.7 ka for the LCY eruption is significantly younger than the commonly cited O-isotope stratigraphic age of 84 ± 5 ka. This age is close to the voluminous (2,800-5,600 km^3) Young Toba Tuff (YTT) supereruption at ca. 73.8 ± 0.3 ka from Toba Caldera, Indonesia. Both YTT and LCY eruptions have been previously linked to prominent Quaternary climate excursions. Based on the new LCY eruption age, climate-forcing effects that are usually attributed to YTT may in fact be exacerbated by another supereruption occurring within a short time window of the YTT event.