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Thermochemical modelling of zircon age distributions from Nevado de Toluca volcano, Trans Mexican Volcanic Belt

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Understanding the assembly of eruptible magma in volcanic plumbing systems through time is key to the evaluation of hazard scenarios at potentially active volcanoes. In this respect, zircon geochronology provides a temporally resolvable record of the presence of magma. However, which specific processes and associated timescales are captured by zircon age distributions is not well constrained. Here we use zircon geochronology and geochemistry and thermal modelling of pulsed magma injection in the Earth crust to quantitatively invert zircon ages and recalculate magma fluxes and the rate of accumulation of eruptible magma in time. Zircon crystals have been analyzed from 4 late Pleistocene eruptions of Nevado de Toluca, a long-lived currently dormant dacitic stratovolcano in Central Mexico. ^{238}U - ^{230}Th and ^{238}U - ^{206}Pb age distributions show a protracted zircon crystallization history of ~900 ka in the magmatic plumbing system, a large fraction of the 1500 ka record of volcanic activity at the surface for this volcano. The 4 studied eruptions show similar broad age spectra, which are overlapping with each other and comparable peak zircon crystallization ages between 150 and 250 ka. Our dataset suggests that interstitial melt extraction (including zircon crystals) from highly crystallized resident magma and mixing thereof with fresh recharge magma surges is very efficient beneath Nevado de Toluca. Zircon trace element data, together with the geochronology show that the observed temporal trends in zircon geochemistry are consistent with tracking long-term assembly processes beneath the volcano operating over more than 1 million years. The combination of these results and thermal modelling allow us to quantify the rate of magma input, intrusive/extrusive ratio and the rate of accumulation of eruptible magma at Nevado de Toluca, which is essential to estimate the maximum potential size of the next eruption from this system.