RECYCLING OF THE CHALUPAS PLUTON AT COTOPAXI VOLCANO, NVZ, ECUADOR: EVIDENCE FROM 238U-230TH DISEQUILIBRIA

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Cotopaxi Volcano is located in the Northern Volcanic Zone (NVZ) of the S. American Andes. It is constructed near the rim of the Chalupas Caldera, which erupted the Chalupas ignimbrite approximately 230 ka ago. An ignimbrite with chemistry identical to the Chalupas ignimbrite was erupted from Cotopaxi at 4.5 ka, and is called the Colorado Canyon ignimbrite. Recently acquired U-series data from rhyolite and andesite at Cotopaxi suggests that recycling of previously emplaced and cooled Chalupas magma may be an important process in the generation of rhyolite at this volcano. This is an important observation, since the formation of rhyolite in the upper crust is usually attributed to pure fractionation or AFC processes involving old continental crust. This research also illustrates that high degrees of U-Th fractionation took place during crustal recycling, which is important when considering the significance of linear arrays on U-series equiline diagrams. Whole rocks and mineral separates were analyzed for (238U)/(230Th) disequilibria using ICP-MS. The Cotopaxi andesites have (238U)/(230Th) from 0.96-0.99, and (230Th)/(232Th) from 1.11-1.18. Rhyolite whole rocks have (230Th)/(232Th) of 1.22-1.43, and (238U/230Th) of 1.03-1.18. Apparent isochron ages from the rhyolite mineral separates and whole rocks range from ca. 90-130 ka; eruption ages range from 7.2 - 6.3 ka. Rhyolite from the Chalupas caldera have whole rock (238U)/(230Th) from 1.05-1.1, and (230Th)/(232Th) of 1.43. Zircon grains were separated from the rhyolite and analyzed for U-series isotopes using the ion probe at UCLA, and yield an isochron age of 219 ± 30 ka. Three notable observations based on the data are: 1) The rhyolite whole rocks and mineral separates form a linear array between the andesite whole rocks and the Colorado Canyon glass, 2) Apparent isochrons from the mineral separate yield ages that are much older than the eruption ages, indicating ageing or mixing, and 3) The Colorado Canyon glass is
more U-enriched than the whole rock. Trace element modeling rules out simple fractional crystallization as a way to explain the linear array of data, and assimilation of old crust can ruled out by Sr and Nd isotopes. Alternatively, we interpret the U-Th isotopic data as a mixing line and suggest that rhyolites from Cotopaxi volcano are the result of partial melting of residual solidified Chalupas caldera magma. Partial melting of the residual pluton was triggered by ponding of andesite; the partial melts then mixed with the andesite to form the array of rhyolite compositions. The zircon U-series data support this model. It is significant that the partial melting process fractionated U from Th such that the melt, approximated by the glass composition of the Colorado Canyon rhyolite, has a higher (238Th)/(232Th) (1.68) than the whole rock (1.45), indicating that the partial melting process causes U-Th disequilibrium that is maintained throughout melting process.