Supplementary Materials.

This document contains the two figures (S1 and S2) and Table M1 referred to in the Methods section.

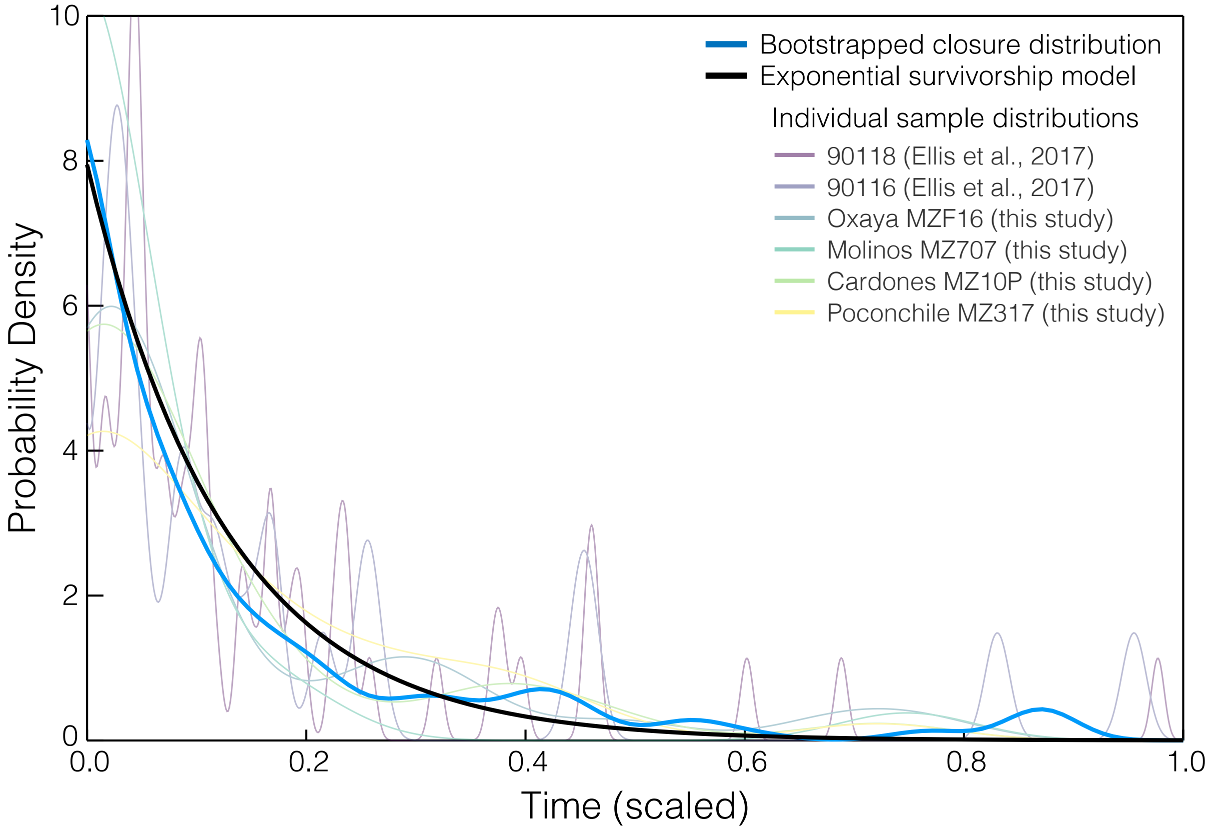

Figure S1: The form of the relative closure distribution, scaled from time of first closure (1.0) to time of eruption (0.0). The empirical ("bootstrapped") estimate of the form of this closure distribution (thick blue line) decreases as a function of time before eruption, following a trend closely resembling that of a similarly scaled exponential distribution (thick black line). This bootstrapped closure distribution is calculated as the kernel density estimate of the union of the sets of scaled single-grain closure ages for each individual sample, the probability density functions of which are each shown as thin colored lines in the background. Both the highly-dispersed single-grain volcanic sanidine Ar-Ar age distributions of the four Central Andean ignimbrites (this study) as well as the similarly dispersed single-grain volcanic sanidine Ar-Ar age distributions of the Mesa Falls Tuff (Ellis et al., 2017)[67] are consistent with an exponential relative closure distribution of this form.

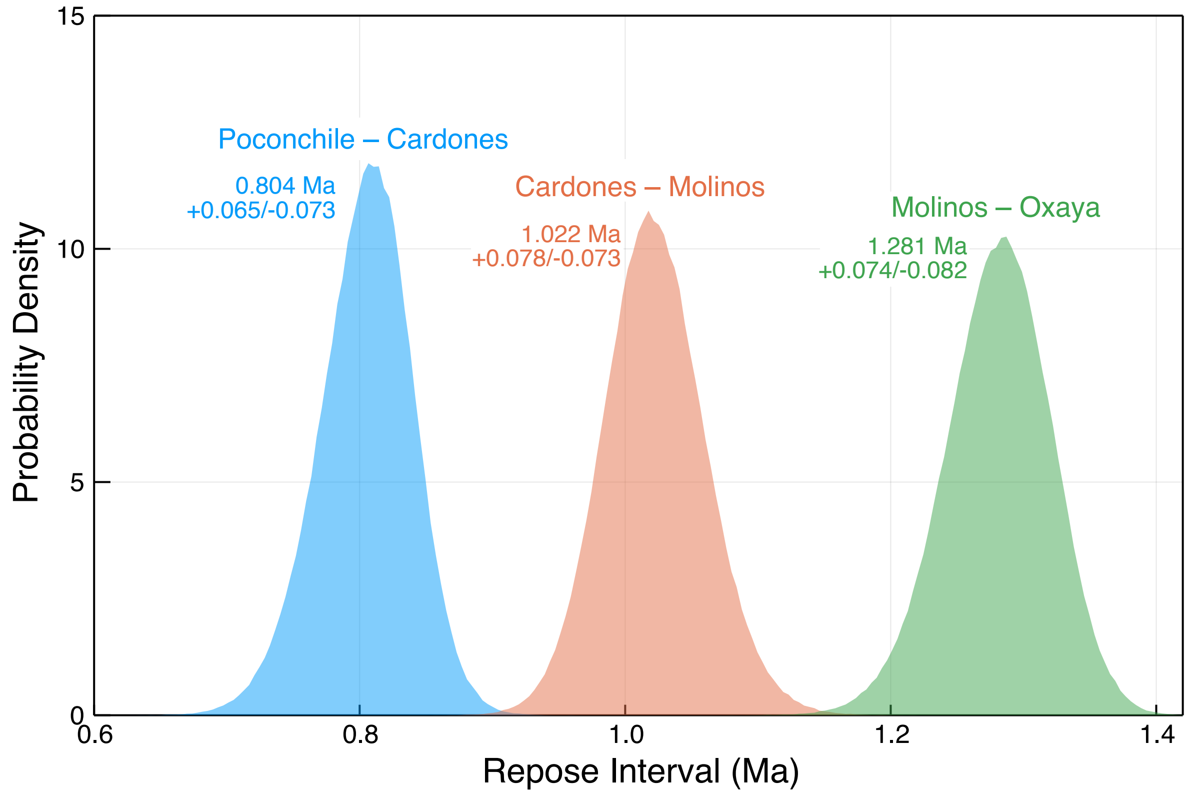

Figure S2: Repose interval durations. The posterior distributions for the durations of the repose intervals of each sequential pair of eruptions (Poconchile to Cardones, Cardones to Molinos, and Molinos to Oxaya), as illustrated for each pair by a normalized histogram of the stationary distribution of a Markov chain Monte Carlo model that integrates the constraints provided by (1) the posterior eruption age distributions for each ignimbrite derived from the Bayesian eruption age models as well as (2) the relative age constraints provided by the stratigraphic superposition of the ignimbrite deposits. While the absolute time uncertainties of the absolute eruption ages shown in Figure 2 are substantially increased by systematic (tracer/standard and decay constant) uncertainties, such systematic uncertainties effectively cancel when calculating the relative durations shown here.

Ignimbrite Sample Location	Description sample	ID-TIMS zircon Byesian eruption age estimate based on data from van Zalinge et al., 2016 (95% confidence, full systematic uncertainty)	$^{40}Ar/^{39}Ar$ Bayesian eruption age estimate (data this study) (95% confidence, full systematic uncertainty)	Range older $^{40}Ar/^{39}Ar$ ages (not included in weighted mean eruption age estimate) (data are 95% confidence, analytical uncertainties)	Eruption age (95% confidence, full systematic uncertainty)
Poconchile Drill hole 2 18°14’15.36” 69°48’39.36” 897 m depth	Bulk rock; lithics carefully removed	22.712 +0.033/-0.05 Ma	22.539 +0.084/-0.098 Ma	23.336 ± 0.172 – 28.269 ± 0.238, n = 19	22.626 +0.053/-0.060 Ma
Cardones Drill hole 1 18°11’11.22” 69°45’46.53” 244 m depth	Large pumice clasts	21.883 +0.028/-0.042 Ma	21.796 +0.072/0.089 Ma	22.307 ± 0.186 – 28.287 ± 0.213, n = 19	21.840 +0.048/-0.054 Ma
Molinos Drill hole 7 18°17’58.75” 69°53’11.79” 153 m depth	Multiple small pumice lapilli carefully separated from the bulk rock.	No data	20.821 +0.057/-0.068 Ma	21.353 ± 0.178 – 27.298 ± 0.237, n = 6	20.821 +0.057/-0.068 Ma
Oxaya Molinos Field section 18°22’00.9” 69°57’13.1”	Welded fiamme-rich bulk rock with no lithics	19.567 +0.067/-0.075 Ma	19.538 +0.053/-0.062 Ma	20.092 ± 0.146 – 21.063 ± 0.174, n = 8	19.553 +0.049/-0.063

Table M1 Geochronological data. Locations of drill holes are shown in Figure 1B.