Supplementary material to

Controls on zircon age distributions in volcanic, porphyry and plutonic rocks

C. Nathwani, D. Szymanowski, L. Tavazzani, S. Markovic, A. Virmond and C. Chelle-Michou

Geochronology (GChron)

The supplementary material contents the following:

Figures S1 to S10

Supplement Text 1

Table S1 (separate file)

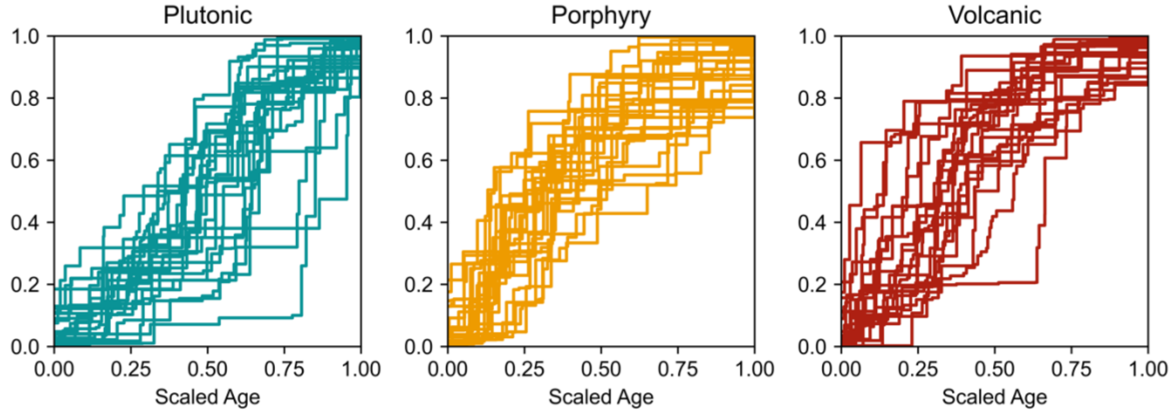

Figure S1: Plots showing weighted ECDFs of filtered natural age distributions combined onto separate plots for plutonic, porphyry and volcanic systems to allow comparison.

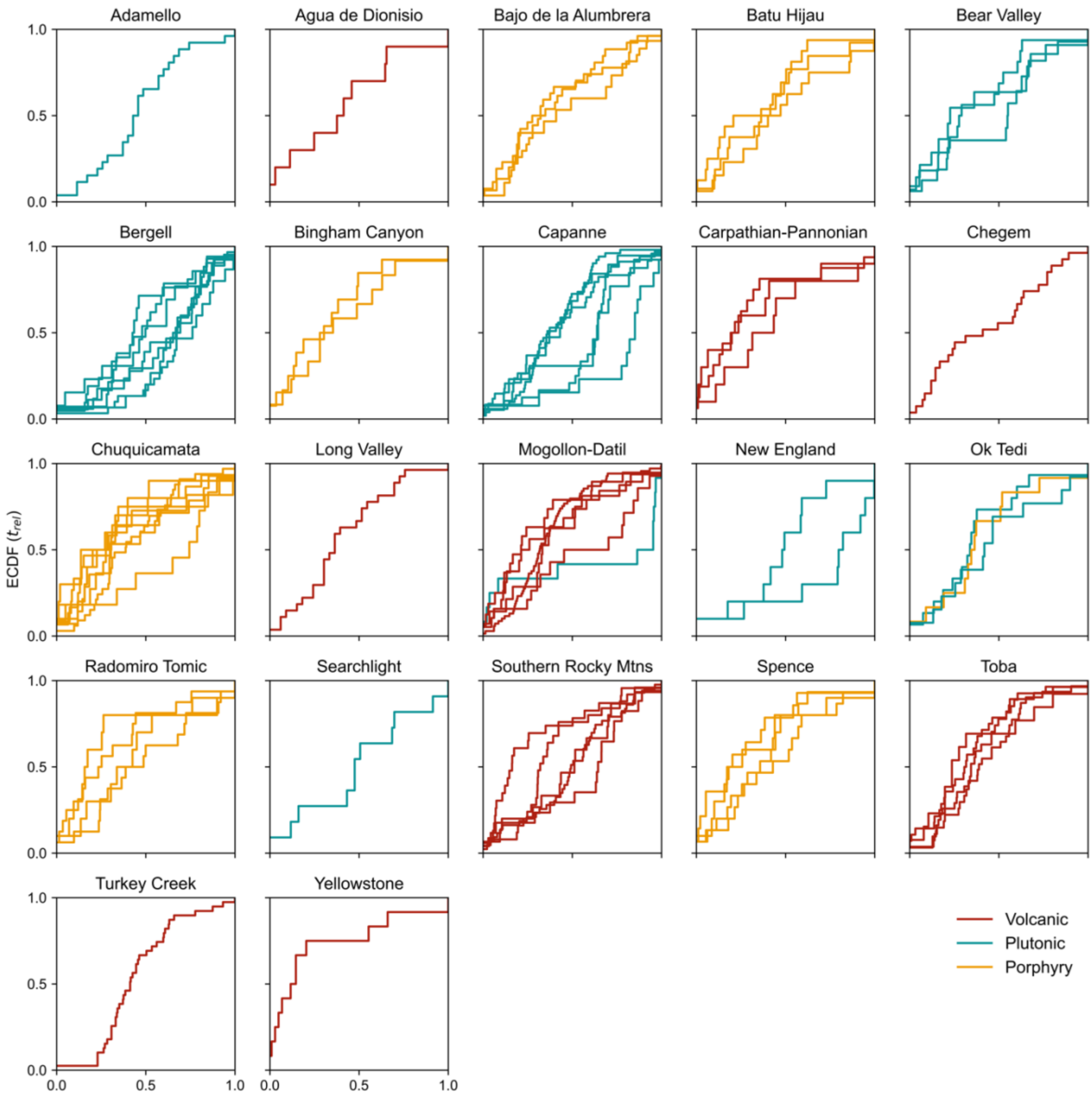

Figure S2: Unweighted ECDFs for all age distributions in the filtered database. The figure is the same as Fig. 3 but the step function increases monotonically rather than by a distance inversely proportional to the analytical uncertainty.

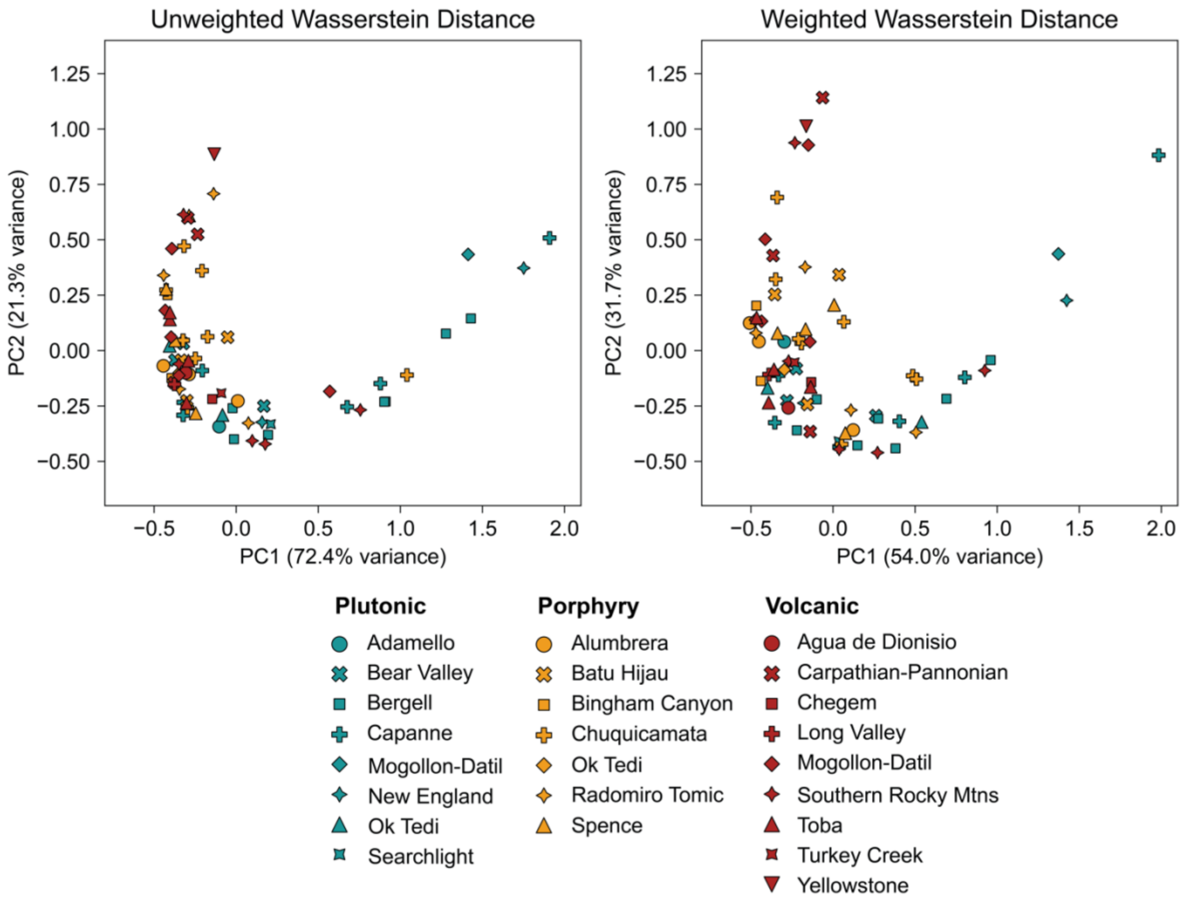

Figure S3: Comparison of PCA of unweighted and weighted W_2 dissimilarity matrix. Implementing the weighted W_2 distance decreases the variance accounted for by PC1 relative to the unweighted W_2 distance.

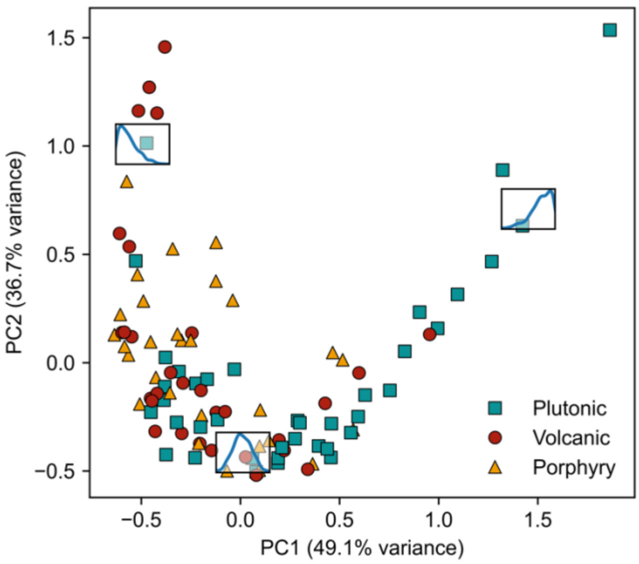

Figure S4: Plot of the PCA on the W_2 ID-TIMS zircon U-Pb dissimilarity matrix where the dataset was filtered using a $\Delta t/\sigma$ of 5 rather than 10. A greater number of age distributions are now available, with a larger proportion plotting with distributions more similar to normal distributions due to a high ratio of analytical versus geological dispersion.

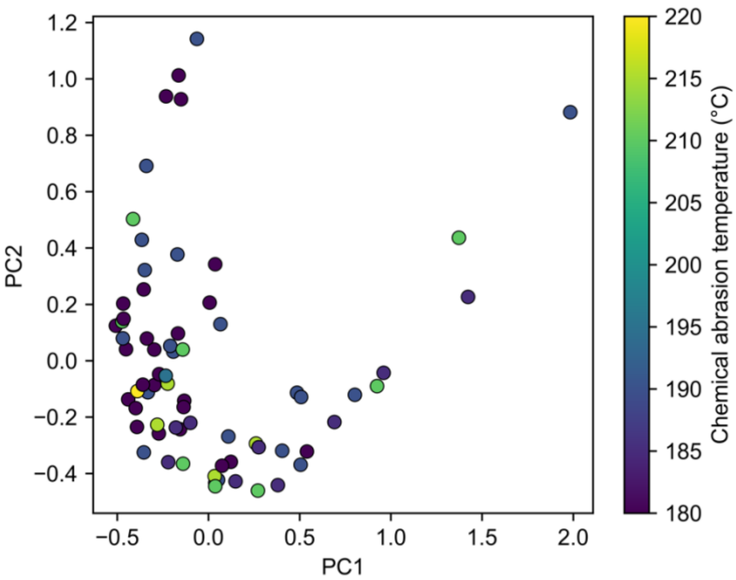

Figure S5: Plot of the PCA on the W_2 ID-TIMS zircon U-Pb dissimilarity matrix coloured by the chemical abrasion temperature reported in the study

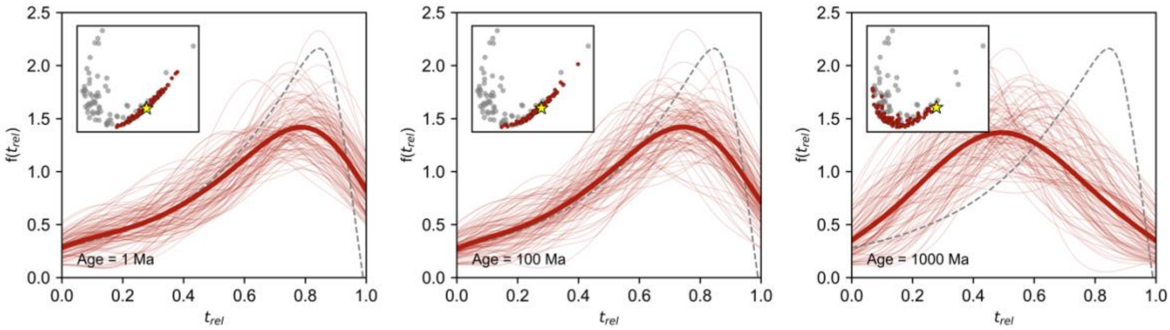

Figure S6: The effect of sampling an underlying distribution of different ages (1, 100 and 1000 Ma) demonstrating the loss of the ability to capture an age distribution with increasing absolute age. The sampled underlying distribution (grey dashed line) is the monotonic cooling distribution (Keller et al. 2018). Thirty zircons are sampled for each of the 100 synthetic distribution (faint red) and the average of 100 simulations is shown (dark red). Inset plots show the location of these distributions (red symbols) in the PCA plot of the W_2 dissimilarity matrix of natural zircon U-Pb distributions (grey symbols).

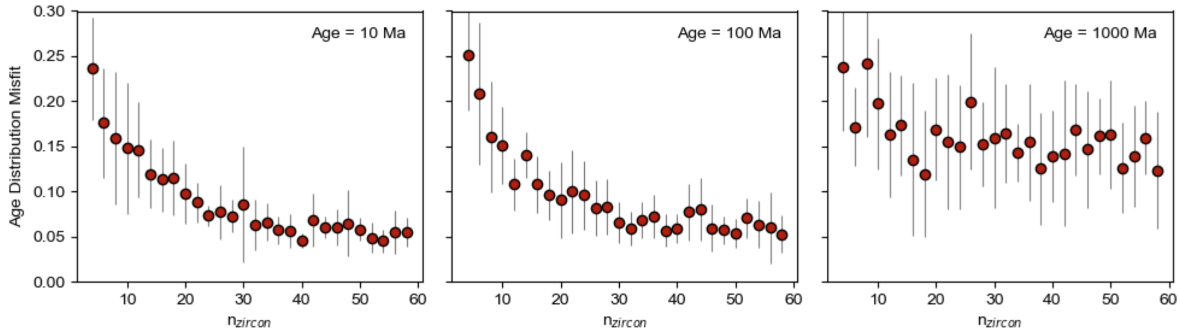

Figure S7: Bootstrap sampling analysis of the effect of n_{zircon} on the age distribution misfit for 10, 100 and 1000 Ma. Bootstrap sampling was repeated 10 times for each n_{zircon} and the symbol indicates the mean misfit and the error bar indicates the standard deviation.

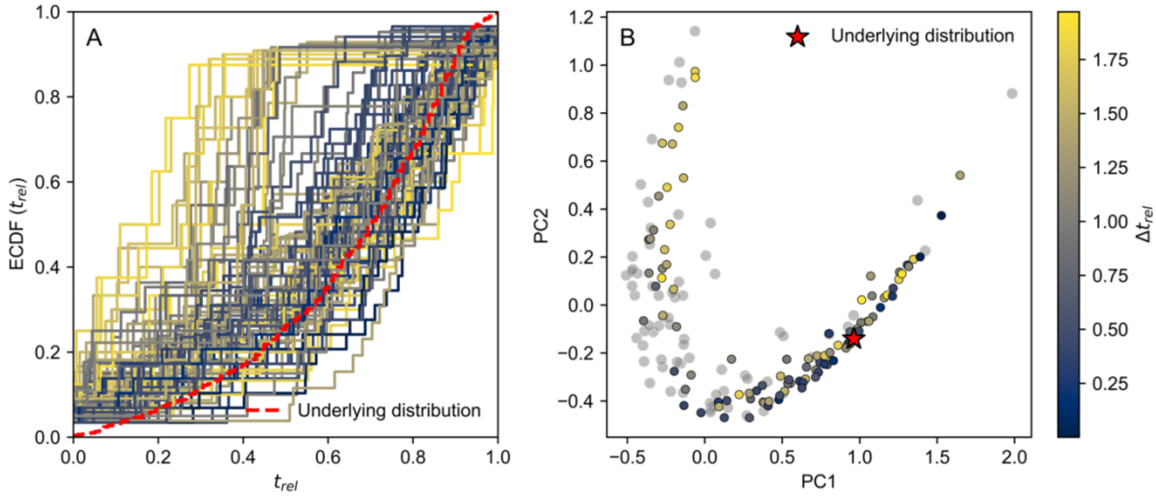

Figure S8: Results of the antecryst modelling presented in Fig. 10 where old outliers were filtered according to the filtering method described in the text using identical parameters ($\nabla_M = 0.3$, $t_{flatmax} = 0.25$) to those used to filter natural ID-TIMS age distributions.

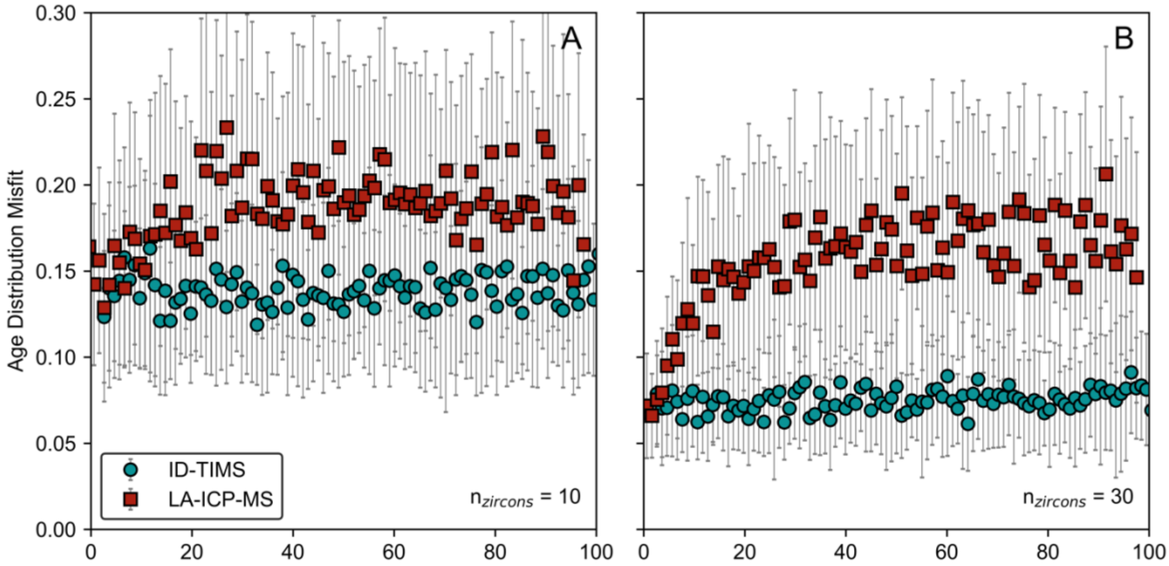

Figure S9: Comparison of ID-TIMS and LA-ICP-MS age distribution misfit as a function of age for $n_{zircon} = 10$ and $n_{zircon} = 30$. Sampling is identical to that shown in Fig. 11 over a younger age range from 0.1 to 100 Ma highlighting that the age distribution misfit for ID-TIMS and LA-ICP-MS only overlaps within a very narrow age range.

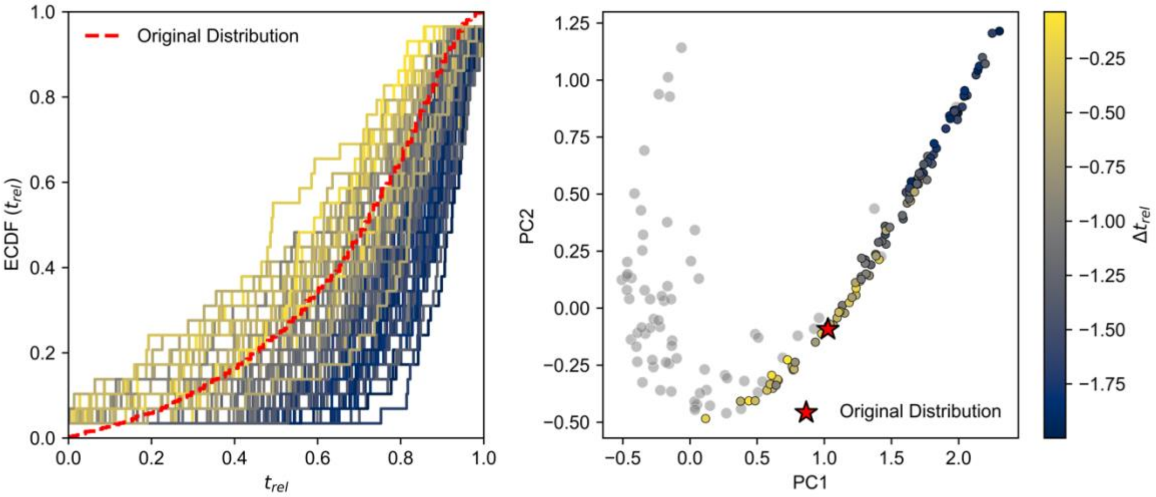

Figure S10: Modelling of the effect of Pb loss on zircon age distributions by adding one age from a younger distribution separated from the main age distributions by variable Δt_{rel}. Left plot shows the ECDF of the Pb loss induced age distribution and right plot shows the position of each distribution on the PCA plot of the W_2 dissimilarity matrix of natural data.

Supplementary Text: Modelling the effect of Pb loss on zircon age distributions

Filtering of the initial database that our analysis was performed on to CA-ID-TIMS datasets younger than 130 Ma should largely exclude the effect of Pb loss on age distributions. Although the chemical abrasion process should mitigate the effect of Pb loss on our age distributions, there is still potential that some unmitigated Pb loss may be present. In the case of our datasets, unmitigated Pb loss would cause a low proportion of younger zircon ages causing a younger tail on an age distribution and thus an older skew. Analogous modelling to that performed for the incorporation of antecrysts into an age distribution, where in this case a zircon from a younger age distribution is added to the main age distribution, indicates that Pb loss would lead to high PC1 and high PC2 scores (Fig. S10). This may provide a method in future to filter dates with unmitigated Pb loss from ID-TIMS datasets. For example, a volcanic age distribution which plots at high PC1 and high PC2 scores would not beconsistent with the general volcanic age distribution shape and filtering young tails from such a distribution may restore the age distribution towards a more acceptable shape for volcanic rocks.