Supplementary Materials

In this study, zircon crystallization age with correction for common Pb, initial disequilibria, and melt disequilibria (i.e., t in Equations 5 and 10) is determined by the bisection method, and 50 iterations of following equations are performed.

$$\begin{cases} when\ F\left[x_{lower}(n-1)\right]\times F\left[x_M(n-1)\right]<0 \\ x_{lower}(n)=x_{lower}(n-1) \\ x_{upper}(n)=x_M(n-1) \end{cases}$$

$$\begin{cases} when\ F\left[x_{lower}(n-1)\right]\times F\left[x_M(n-1)\right]>0 \\ x_{lower}(n)=x_M(n-1) \\ x_{upper}(n)=x_{upper}(n-1) \end{cases}$$

$$(n=2,3,...,50) \quad \text{(S1)}$$

Where F(x) represents the left member of Equations 5 or 10. The x_{lower} and x_{upper} represent lower limit and upper limit of the crystallization age. Initial value (x(1)) and intermediate value (x_M) are defined as following equations:

$$x_{lower}(1)=1$$

$$x_{upper}(1)=100000000$$

$$x_M(n)=\frac{x_{lower}(n)+x_{upper}(n)}{2} \quad \text{(S2).}$$

Where, $x_M(50)$ represents the age with common Pb and disequilibria correction. If the product of $x_{lower}(1)$ and $x_{upper}(1)$ shows positive value, the age approximated by present approach does not converge. It should be noted that presented modified ^{207}Pb method

cannot be applied if a measured pair of isotope ratios ($^{238}U/^{206}Pb$ and $^{207}Pb/^{206}Pb$) plots in the reverse discordant area (i.e., below the modified Tera–Wasserburg concordia curve). This is because the $^{238}U/^{206}Pb$ of zircon that has been contaminated by common Pb must become larger after common ^{206}Pb component has been removed from that of total ^{206}Pb by the modified ^{207}Pb method (i.e., ^{206}Pb becomes smaller). In the case of reverse discordant data, isotopic measurement and/or estimation of factors ($f_{Th/U}$, $f_{Pa/U}$, $f_{Th/U}(p.m.)$, $f_{Pa/U}(p.m.)$, and T) are problematic, or contribution of common Pb is negligible. If the common Pb is insignificant, the crystallization age can be calculated by only Equation 1 or 6.

The overall uncertainty on the final U–Pb age is calculated by an empirical method. The uncertainty of each parameter (i.e., $R^{76}{}_m$, $R^{76}{}_c$, $R^{86}{}_m$, $f_{Th/U}$, $f_{Pa/U}$, $f_{Th/U}(p.m.)$, $f_{Pa/U}(p.m.)$, and T) is estimated from the deviation between two ages (t and t′) calculated with and without the error of the parameters. For example, in the case of $R^{76}{}_m$, the crystallization age t is calculated using all five parameters, while t′ is estimated using $R^{76}{}_m + \sigma R^{76}{}_m$ instead of $R^{76}{}_m$. Here, we define the deviations of the two ages as $\sigma t(R^{76}{}_m)$, $\sigma t(R^{76}{}_c)$, $\sigma t(R^{86}{}_m)$, $\sigma t(f_{Th/U})$, $\sigma t(f_{Pa/U})$, $\sigma t(f_{Th/U}(p.m.))$, $\sigma t(f_{Pa/U}(p.m.))$, and $\sigma t(T)$. The error propagation for the final U–Pb age is calculated as follows:

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$$\sigma^2 t = \sigma^2 t\left(R_m^{76}\right) + \sigma^2 t\left(R_m^{86}\right) + \sigma^2 t\left(R_c^{76}\right) + \sigma^2 t\left(f_{Th/U}\right) + \sigma^2 t\left(f_{Pa/U}\right) + \sigma^2 t\left(f_{Th/U}\left(p.m.\right)\right) + \sigma^2 t\left(f_{Pa/U}\left(p.m.\right)\right) + \sigma^2 t\left(T\right)$$

34 (S3).