Theoretical Behaviour of Radiochronometers Losing Radiogenic Content by Diffusion During Heating

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Since the formalization of the closure temperature concept by Dodson (1973), numerous models have been developed to determine thermal histories using geochronometers. Because, most of the time, the systems lose any memory of the prograde stage, these models focus on the cooling part of the thermal histories. As the closure temperature is a concept that has only been developed for cooling, its use as an indicator of opening and/or resetting during heating is *a priori* abusive. When diffusion is slow, re-equilibration may not be total during the prograde stage, and then complementary models must be developed for the heating part of the thermal history.

We report an analytical model for radiochronological systems losing radiogenic content by thermally activated diffusion during heating. The working assumptions are similar or symmetrical to those of Dodson (1973) for cooling. The obtained formulations for opening (T_{O}, beginning of radiogenic isotope loss) and resetting (T_{R}, total loss of memory) temperatures are formally similar to that of closure temperature (T_{C}). For a given radiochronological system, T_{O}, T_{R}, and T_{C} are significantly different, with $T_{\mathrm{O}} < T_{\mathrm{C}} < T_{\mathrm{R}}$. For instance, T_{O}, T_{C}, and T_{R} are respectively 790, 933 and 1003 $^{\circ}$C for the (U-Th)/Pb system in zircon (for 50 μm spherical grain and 10 $^{\circ}$C/Ma heating or cooling rate). These temperatures are 106, 166 and 197 $^{\circ}$C for the (U-Th)/He system in the same mineral and conditions.

Closure temperature cannot be used neither for opening nor for resetting. Those two temperatures should be calculated using the formulations derived from our model.

References

Dodson M. H. (1973) Closure temperature in cooling geochronological and petrological systems. *Contrib. Mineral. Petrol.* 40:259–274.

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