Unclosure Temperature and Relaxation Time

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A diffusion process in a sphere is analytically solved and, well described in a rigorous form. Dodson (1973) defined a closure temperature T_c as a narrow range of temperature where a radiogenic isotope production exceeds the amount of decease by the diffusion process because of its factor dependence on the Arrhenius relation. A step heating experiment used in $^{40}Ar/^{39}Ar$ dating is a reheating process, and diffusion parameters of various minerals have been obtained from the approximation in a simple analytical form in many diffusion studies. Viewing a cooling process as the reversed direction of a reheating process, a fractional loss of 20% is the minimum requirements to hold the original cooling age, which we named unclosure temperature T_{uc}. The other extreme limit (T_{dc}) is a fractional loss of 99% where diffusion exceeds the production rate of radiogenic isotopes. According to Dodson's definition, closure temperature Tc is analogous to the temperature just below Tdc. Using typical diffusion parameters obtained by previous experiments, T_c, T_{uc} and T_{dc} were compared. They are closer in small grain sizes, but the differences grow as grain sizes become large (>100 microns). The agreement is also depends on the cooling rate. The agreement of T_c is closer to T_{uc} rather than T_{dc}. The meaning of this results is discussed.

Keywords: diffusion, sphere, unclosre temperature

