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Closure temperature of biotite and thermal history

Hironobu Hyodo[1*]

[1]RINS, Okayama Univ. of Sci

In previous report, closure temperature of biotite in K-Ar system has been estimated from the results in laser step heating $^{40}Ar/^{39}Ar$ experiment on a single grain. In the estimate, the cooling rate was assumed to be 1 K/1000 yr, and the data was taken from fraction less than 800 degrees steps where little effect of dehydration is expected. The closure temperature calculated were distributed from less than 0 degrees to over 300 degrees. The average was approximately 250 degrees, being slightly less than the estimate from bulk experiments, whereas the average of activation energy was not much different from the previous value, indicating that the closure temperature obtained from laser step heating experiments is good enough for a rough estimate.

In this paper, increasing the number of data and distinguishing slow (1K/1000 yr) and rapid cooling (1K/1yr) between ”intrusives” (including metamorphics) and igneous ”extrusives” (including tuffs), respectively, closure temperature and activation energy was compared. No significant difference was found in the activation energy, but the closure temperature estimates differed; 270 degrees in intrusives and 330 degrees in extrusives. The difference seems to reflect the effect of cooling rate in the Dodson’s (1973) closure temperature formula. However, if we assume the cooling rate of the intrusives in extrusives, some of the samples show the closure temperature less than 200 degrees. Thus, the difference does not seem to be an apparent effect from the calculation.

There also were samples with closure temperature less than 100 degrees regardless of rock types. This often correlates with alteration, in particular chloritization of biotite, and reflected in age spectra. In most Arrhenius plots, the change of trend, reflecting the dehydration of biotite in bulk experiment was not found in laser step heating results. The difference is considered in view of heating scheme and slightly the lower estimate of closure temperature than bulk experiment.

Keywords: closure temperature, biotite grain, K-Ar system, $^{40}Ar/^{39}Ar$, laser step heating