Argon loss in experimentally deformed muscovites

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Defects in muscovite are well-documented in naturally deformed rocks. In sufficient concentrations, defects may play an important role in modifying the effective length-scales for argon transport through mineral grains. Recent high spatial resolution $^{40}Ar/^{39}Ar$ studies and combined TEM studies are consistent with defects playing an important role in controlling $^{40}Ar/^{39}Ar$ ages for specific geologic histories [1]. This work continues previous attempts to examine the significance of experimental deformation on $^{40}Ar/^{39}Ar$ geochronology [2].

Cores from a non-deformed two-mica granite of upper Carboniferous age have been experimentally deformed at 600-650°C, 10 kbar, a strain rate of $10^{-6}s^{-1}$. These experiments result in shortening of 10 to 20% and muscovites exhibit folding and kink-bands with densities controlled by the original orientation of the mica. Mica grains have been dated by high spatial resolution UV-laser ablation $^{40}Ar/^{39}Ar$ geochronology and yield ages (+/- 2σ) within individually deformed grains between 262.0 Ma +/- 8.0 to 334.4 Ma +/- 10.0 with a mean age of 300.8 Ma +/- 7.2, and no well-developed mode. The plateau age of non-deformed muscovites obtained by IR-laser step heating is 310.5 Ma +/- 1.8. These results correspond to $^{40}Ar^*$ loss of 0 to 16.9% with a mean $^{40}Ar^*$ loss of 3.4%.

An hydrothermal experimental run of equal run duration, but without deformation is expected to result in less than 0.1% of Ar loss. These initial results are consistent with the hypothesis that high defect densities result in higher apparent diffusivities, which should be manifested in younger ages in naturally deformed versus undeformed samples of a given grain size.

References

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