Experimental study of deformation effect on $^{40}Ar/^{39}Ar$ dating in muscovite

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The effect of temperature for argon retentivity is a well-known process, while the role of deformation for argon diffusion remains very elusive. To address this issue, we performed deformation experiments followed by $^{40}Ar/^{39}Ar$ dating on white mica within a Hercynian granite (Carnac, France). A set of cores were deformed using a solid-medium, Griggs-type apparatus at a pressure of 1.2 GPa and a temperature of 650 °C. These conditions have been chosen so that muscovite can deform viscously in nominally open-system conditions for argon, but without any melting. Coaxial deformation has been applied for different amounts of shortening between 15% and 30%. Each experiment was backed by a control experiment performed in the same pressure-temperature-time conditions, but without deformation (hot pressing) to constrain the influence of temperature alone. While a first set of experiments was performed as-is (no water added), a second set of experiments has been performed in the same conditions, with 0.2 wt.% water added. *In-situ* UV laser ablation $^{40}Ar/^{39}Ar$ dating was then applied on muscovite. While $^{40}Ar/^{39}Ar$ ages on the starting material are homogeneously close to 305.5 ± 0.4 Ma, the control experiments show a slight rejuvenation with a very homogeneous spatial distribution (295.2 ± 0.2 Ma for the hot pressing without water added). In contrast, deformed samples – with or without water added – display more scattered ages with pronounced rejuvenation and heterogeneous spatial distribution controlled by grain size and location of ablation spot (core-rim gradients). Local rejuvenation can amount to up of 45% ^{40}Ar loss. Such argon loss is spatially correlated with deformation features.

Key words: experimental deformation, muscovite, $^{40}Ar/^{39}Ar$ dating, argon retention