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Effect of deformation on 40Ar/39Ar dating in granitic rocks: an experimental approach

Alexane Legeay (1), Stéphane Scaillet (1), Jacques Précigout (1), Romain Augier (1), Holger Stünitz (1,2), and Florian Duval (1)

(1) Institut des Sciences de la Terre d'Orléans (ISTO), UMR7327, CNRS-BRGM, Université d'Orléans, Orléans, France (alexane.legeay@univ-orleans.fr), (2) Department of Geology, University of Tromsø, Dramsveien 201, 9037 Tromsø, Norway

Although the effect of temperature for argon retentivity is a well-known process in the realm of the Dodsonian closure theory, the role of deformation for Ar diffusion remains very elusive. To address this issue, we performed deformation experiments followed by 40Ar/39Ar dating on white mica within a Hercynian microgranite (Carnac, France). A set of 8 mm diameter and 15 mm long cores were first extracted, and then deformed as-is using a solid-medium Griggs-type apparatus at a pressure of 1.2 GPa and a temperature of 650 °C. Coaxial deformation has been applied for different amounts of shortening between 15% and 35%. Each experiment was doubled by a clone experiment performed in the same pressure-temperature-time conditions, but without deformation (hot pressing) to constrain the influence of temperature alone. 40Ar/39Ar dating was then applied on muscovite using in-situ UV laser ablation at the University of Orléans (ISTO). While 40Ar/39Ar ages on the starting material distribute between 285.7 $\pm$ 4.0 to 319.0 $\pm$ 5.6 Ma, a deformed sample shows a younger and more extended distribution from 205.8 $\pm$ 3.59 to 308.3 $\pm$ 5.13 Ma, with a heterogeneous spatial distribution that depends on the size of grains and location of ablation spot (core vs. rim). These observations are reproducible for 20 and 30% shortening. Such an argon loss is also observed with respect to the hot-pressed sample, suggesting that deformation promotes significant rejuvenation of 40Ar/39Ar ages. Although our data acquisition is still ongoing, our findings may have strong implications for the interpretation of geological processes based on mica ages from equivalent natural settings.