^{39}Ar and ^{37}Ar recoil ejection during neutron irradiation of sanidine and plagioclase crystals

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The ^{40}Ar/^{39}Ar dating technique requires the activation of ^{39}Ar via neutron irradiation. The energy produced by the reaction is transfer to the daughter atom as kinetic energy and triggers its displacement, known as the recoil effect. Significant amount of ^{39}Ar and ^{37}Ar can be lost from minerals leading to spurious ages and biased age spectra. Through two experiments, we present direct measurement of the recoil-induced ^{39}Ar and ^{37}Ar losses on Fish Canyon sanidine and plagioclase. We use multi-grain populations with discrete sizes ranging from 210 µm to <5 µm. One population consists of a mixture between sanidine and plagioclase and the other one includes pure sanidine.

We show that ^{39}Ar loss (depletion factor) for sanidine is lower than previously thought with ~3% loss for the smallest fraction. Age spectra of fraction smaller than ~50 µm show departure from flat plateau-age spectrum usually observed for large sanidine. This departure is roughly proportional to the size of the grain but do not show typical ^{39}Ar loss age spectra. The calculated thickness of the total depletion layer (equivalent to the mean thickness of the perturbation layer; d_0(sanidine)) is **0.035 ±0.012** (2σ). This value is lower than the previous value of ~0.08µm obtained by argon implantation experiments and simulation results. We show that it is possible to satisfyingly correct ages from ^{39}Ar ejection loss providing that the d_0-value and the range size of the minerals are sufficiently constrained. As exemplified with similar calculation that we performed on results obtained from a similar study on GA1550 biotite [1], the d_0(biotite) is 0.46 ± 0.06 µm. The significant difference between empirical results on biotite and sanidine along with difference with simulation results suggests that crystal structures and lattice defects of the stopping medium must play an important role in ^{39}Ar ejection.

The second experiment suggests that ^{37}Ar recoil can drastically affect the age via the interference corrections. Our calculations are somehow compromise by the bimodal character of the mixture but our results suggest that up to ~98 % of ^{37}Ar can be ejected of the grain of ~5 µm dimension.
Further investigations on silicates of various compositions and structures are clearly required to better understand (and correct) the recoil effect on both ^{39}Ar and ^{37}Ar and its influence on ^{40}Ar/^{39}Ar dating and its subordinate multi-diffusion domains theory.

[1] Paine et al. *GCA* **70,** 1507-1517