Alpha-recoil tracks in natural dark mica: Dating geological samples by optical and scanning force microscopy

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Alpha-recoil tracks (ART) are lattice defects caused by the α-decay of ^{238}U, ^{235}U, ^{232}Th, and daughter products. Visualization of etched ARTs in dark mica by phase-contrast microscopy allows dating of Quaternary geological as well as archaeological materials. Visualization of etched ARTs by Nomarski-differential-interference-contrast microscopy (NDICM) and scanning force microscopy (SFM) enables the access to areal densities (ρ_a) of ART etch pits beyond 10^4 mm^{-2} and thus the extension of the new ART-dating technique to an age range >1 Ma. The successful application of SFM as a new tool in geochronology could open the way to a field to be characterized as nanogeochronology. In order to visualize ARTs by NDICM and SFM, dark mica was etched with 4% HF at 21°C for 5–107 min. A linear relationship between ρa and etching time (t_e) was observed for phlogopites from the Kerguelen Islands (French territory, Indian Ocean), and the Kovdor magmatic complex (Russia). The volume density (ρ_v) of ART is a function of etching speed (v_{eff}) and slope of the ρ_a-growth curve. The ART-age equation allows the calculation of an individual ρ_v-growth curve for the phlogopite analysed by us using the uranium and thorium content. The ART-ages were determined by combining the experimentally obtained volume density with the individual ρ_v-growth curve.