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Inversion of argon data implies extreme extension in and below the orogenic lid of the European Alps during Eocene–Oligocene collision

Gordon Lister[1], Marnie Forster[2], Jack Muston[3], Jason Price[4], and Gianreto Manatschal[5]
[1]The Virtual Explorer, Clear Range, 2620, Australia (gordon.lister.001@gmail.com)
[2]Australian National University, Research School of Earth Sciences, Structure Tectonics, Canberra, Australia
[3]AngloGold Ashanti Australia, Perth, Australia
[4]United States Geological Survey, Denver, USA
[5]Institut de Geologie, University of Strasbourg, Strasbourg, France

Here we demonstrate conjoint inversion of data combined from $^{40}Ar/^{39}Ar$ geochronology and ultra-high-vacuum (UHV) ^{39}Ar diffusion experiments using potassium feldspar. The method allows precise definition of diffusion parameters for a collection of domains, using an approximation to a fractal geometry. Using the MacArgon program, we could constrain possible temperature histories followed by individual mineral grains in and below the orogenic lid of the European Alps, during its history of mountain building. Tests of the sensitivity of the obtained fits provides insight into the possible range of allowed temperature-time (T-t) paths, and recognition of 'events' during which microstructural modification may have taken place. The results suggest a sequence of abrupt cooling events, which could reflect, either: i) cycles of crustal shortening followed by detachment faulting; or ii) initial terrane-stacking beneath the orogenic lid followed by repeated rapid crustal stretching events, each event involving upward stepping of the active detachment fault. Substantial movement on low-angle normal faults and shear zones has taken place, consistent with extreme extension of the mountain belt at high-angles to the convergence direction, in front of the advancing Adriatic indentor. The magnitude of the temperature drop implies that a rapid extension event took place at the time of the Eocene—Oligocene transition, and reduced the thickness of the orogenic lid to a few kilometres.