Geophysical Research Abstracts
Vol. 14, EGU2012-8162, 2012
EGU General Assembly 2012

^{40}Ar/^{39}Ar systematics in an exhumed ultra-high pressure terrane: implications for the timing of exhumation

C.J. Warren (1), S.P. Kelley (2), S.C. Sherlock (1), and C.S. McDonald (1)

(1) The Open University, Department of Environment, Earth and Ecosystems, Milton Keynes, United Kingdom (c.warren@open.ac.uk), (2) The Open University, Department of Physical Sciences, Milton Keynes, United Kingdom

^{40}Ar/^{39}Ar dating of white mica is commonly used to elucidate the timing of cooling of metamorphic rocks. Single grain fusion and spot muscovite and/or phengite data from mafic eclogites and their host gneisses in the Nordfjord region of the Western Gneiss Complex, Norway, show that apparent ages may vary significantly both between and within grains from within the same sample.

Calculated ^{40}Ar/^{39}Ar phengite ages of 440-750 Ma from mafic eclogites are significantly older than previously reported U-Pb zircon constraints on the timing of peak pressure metamorphism in the region (ca. 400-405 Ma). These apparent "old" ages are readily attributable to excess argon contamination and metamorphic evolution of the white mica in an environment in which efficient removal of Ar from the grain boundary is hindered by a lack of fluid and/or suitable permeability.

The calculated ^{40}Ar/^{39}Ar age range in phengites and muscovites from the felsic host gneisses is from ca. 385 to 420 Ma, spanning the timing of peak metamorphism. Numerical modeling of Ar diffusion in an open system, constrained by previously reported pressure-temperature-time data for the Nordfjord region, suggests that a 2-4 Ma age range should be expected for the measured grain size distribution (0.5-2mm diameter) and expected uncertainties on the cooling rate (10-50°C Ma^{-1}). The 15-35 Ma range of calculated ages in each sample is instead most readily reconciled with a model of limited within-sample permeability during exhumation, causing heterogeneously distributed Ar grain boundary concentrations and differences in apparent ^{40}Ar/^{39}Ar age on a <cm scale. Most of the host gneiss samples yield similar "youngest" apparent ^{40}Ar/^{39}Ar ages of 387-385 Ma. These apparently youngest grains may be those that contain the least excess Ar and hence may represent the most likely timing corresponding to the "true" open system cooling age.

The entire dataset suggests a 15-10 Ma timescale for exhumation of the Western Gneiss Complex in Nordfjord from mantle to mid-crustal depths. The combination of high spatial resolution ^{40}Ar/^{39}Ar data and numerical modeling based on independent pressure-temperature-time data provides great potential for unraveling the complexities of metamorphic exhumation. In contrast, step-heating experiments may only yield an average apparent age, potentially leading to an over-estimation of the timing of cooling and hence cooling rates.