Recycling Ar through metamorphic reactions: the record in symplectites

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$^{40}Ar/^{39}Ar$ thermochronology is commonly used to constrain the timing, and rates of cooling in exhumed metamorphic terranes. The $^{40}Ar/^{39}Ar$ age is be linked to temperature via Dodon's closure temperature (T_c) formulation [1], that assumes no initial Ar in the grain, thermally-activated volume diffusion and an 'open' grain boundary network. Elevated Ar ages, compared to e.g. U-Pb ages, in many metamorphic rocks suggest that one or more of these assumptions may commonly be broken, especially in cases where K-bearing minerals recrystallize during exhumation.

Symplectization is an important means by which metamorphic rocks recrystallize during exhumation. Pertinent to $^{40}Ar/^{39}Ar$ thermochronology is the breakdown of HP phengite to biotite-plagioclase symplectites. By analyzing these different minerals we can test which of the T_c assumptions have been broken, during Ar recycling during symplectization.

Laser-ablation $^{40}Ar/^{39}Ar$ analyses of phengite, biotite and biotite-plagioclase symplectites were performed on a symplectic gneiss from the WGR, Norway that reached peak conditions (~650°C, 26 kbar) at 405-400 Ma [2] and decompressed whilst at elevated temperatures soon after. Phengite ages range from 486-385±5 Ma with heterogeneous with-grain age distributions. Biotite yielded a smaller range of ages (396-374±5 Ma) and less inter-grain variation. The biotite-plagioclase symplectite yielded ages of 384-381±6Ma and 698-266±25 Ma for biotite and plagioclase, respectively.

Ar distribution is therefore locally heterogeneous both within and between different minerals. Apparent Ar ages within phengite suggests that despite the elevated temperatures, diffusion of Ar was negligible, while plagioclase shows preferential incorporation of Ar over biotite in the symplectites.

Symplectization is clearly an important process by which Ar is redistributed and simple models of thermally-driven diffusion are insufficient to explain the behavior of Ar in metamorphic terranes, having far-reaching implications for geodynamic modelling of exhumation.

[1] Dodson (1973) *Contrib. Mineral. Pet.* **40**, 259-274 [2] Hacker *et al* (2010) *Tectonophysics* **480**, 149-171