Ar diffusion in K-feldspar: present and absent

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The mechanisms of Ar release from K-feldspar (Kfs) during its geological history and in laboratory experiments are assessed here. Modern petrology clearly established that the chemical and isotopic record of minerals is normally dominated by aqueous recrystallization [1]. Indeed, electron microprobe analyses document Ba-rich Kfs veinlets in many Kfs [2], hard evidence of external fluid ingress.

Understanding the laboratory degassing is trickier, and exporting it to natural conditions leads to paradoxes. The very existence of staircase-shaped age spectra is often misinterpreted. The only attempt so far to stepheat minerals with bona fide concentric age gradients gave plateaus, not staircases [3]. Instead, correlating step ages with Ca/Cl/K fingerprints provided by Ar isotope systematics [4] finds that staircases require heterochemical, diachronous phase mixtures.

Testable geological predictions obtained by extrapolating laboratory degassing rates often overestimate observed geological Ar mobility substantially. Why? Furnace degassing proceeds from structural rearrangements and phase transitions such as observed *in situ* at high *T* in Na and Pb feldspars [5]. These effects violate the mathematics of an inert Fick's Law matrix and preclude downslope extrapolation. The similar upward-concave, non-linear Arrhenius trajectories of many silicates, hydrous and anhydrous, are likely common manifestations of similar effects in other silicate structures. This is made worse by the ubiquitous 1-2% Ar release from non-Kfs intergrowths (sericite, clays) [6], which distort the low-T Arrhenius slope and make extrapolations even less accurate.

Volume diffusion plays a subordinate role both in natural Kfs samples and especially in the laboratory outgassing. The Ar budget of geological Kfs samples is not a unique function of *T*, as recrystallisation promoted by aqueous fluids is the predominant mechanism controlling isotope transport. K-feldspar should therefore be viewed as a hygrochronometer.

[1] *Geochim Cosmochim Acta* **47** (1983) 1681 [2] *Geochim Cosmochim Acta* **101** (2013) 24 [3] *Geology* **22** (1994) 55 [4] *EOS* **46** (1965) 125 [5] *Geochim Cosmochim Acta* **112** (2013) 251 [6] *Geol Soc London Spec Pub* doi: 10.1144/SP378.4.