Sequential sodic and potassic alterations through a kinetic controlled fluid-mineral interaction process

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Large-scale fluid-crust interactions during metasomatic and/or hydrothermal processes control element redistribution and are responsible for forming mineral deposits (Sillitoe 2003, 2010), including giant porphyry and IOCG deposits. It is widely accepted that successive mineralization and alteration stages are controlled by evolving (nearly-) equilibrated systems. However, the role of reaction dynamics in non-equilibrated interfacial fluid between mineral and fluid interfaces, especially in impermeable rocks or unconnected dead-end pores, is gaining increasing attention (Plumper et al., 2017).

In this study, we reacted sanidine ($(K,Na)AlSi_3O_8$) with a Na-rich halide fluid (NaCl and/or NaF) at 600 °C and 2 kbar in closed system, isothermal and isobaric experiments. An albite ($NaAlSi_3O_8$) rim formed initially (sodic alteration). However, with increasing reaction time, the initially formed albite and some of the parent sanidine were in-turn back-replaced by a new generation of K-feldspar (potassic alteration). Fluorine accelerated the process significantly, resulting in nearly complete back-replacement of albite to K-feldspar within 1 day. This is the first experimental observation of sequential sodic and potassic alteration from sanidine. Based on in depth characterization of the products, thermodynamic modelling of the fluid-mineral interaction in this system with a miscible solid solution, and a study of the effect of changing reaction kinetics induced by the presence of fluorine on the reaction progress, we propose that the widespread sequential sodic and potassic alteration observed in mineral systems can proceed through a kinetically controlled self-evolving process.

[1] Sillitoe (2003) *Mineralium Deposita* **38**, 787-812. [2] Sillitoe (2010) *Economic geology* **105**, 3-41. [3] Plümper et al. (2017) *Nature Geoscience* **10**, 685-690.