

Retention of Trivalent Actinides and Lanthanides by Feldspars

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Motivation

- Possible host rock for deep geological repository for radioactive waste: **crystalline rock**
- Retention of M(III) by feldspars so far only investigated for K- and Na-feldspar^[1,2]
- Trivalent actinides M(III) (M = Am, Cm) and rare earth elements (Eu) as their analogue

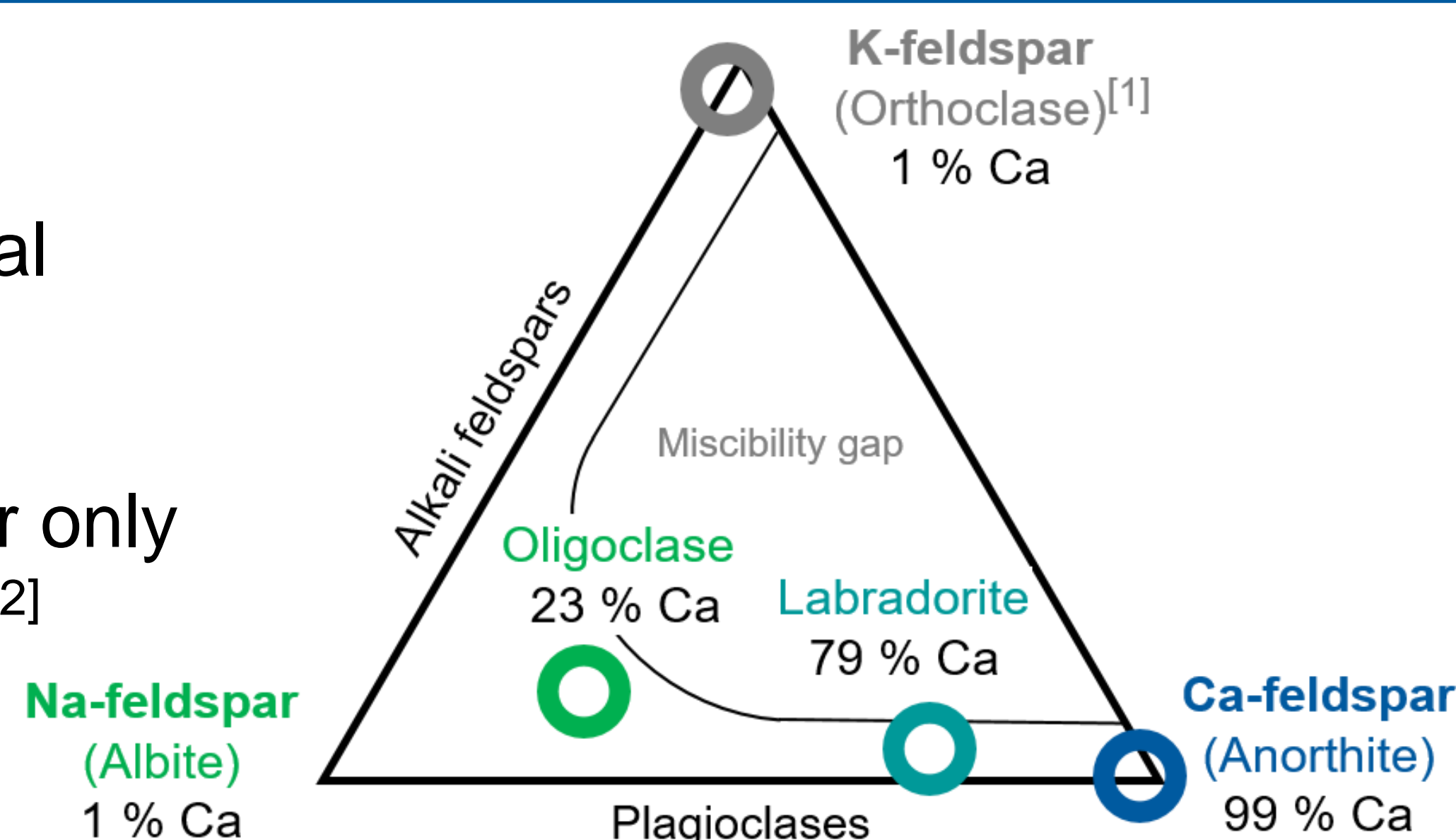


Figure 1. Phase diagram of the feldspar series. Plagioclases (=Ca-feldspars) used in this study are marked in circles.

Surface structural and quantitative characterization of sorption of M(III) on feldspars

Surface charge characterization

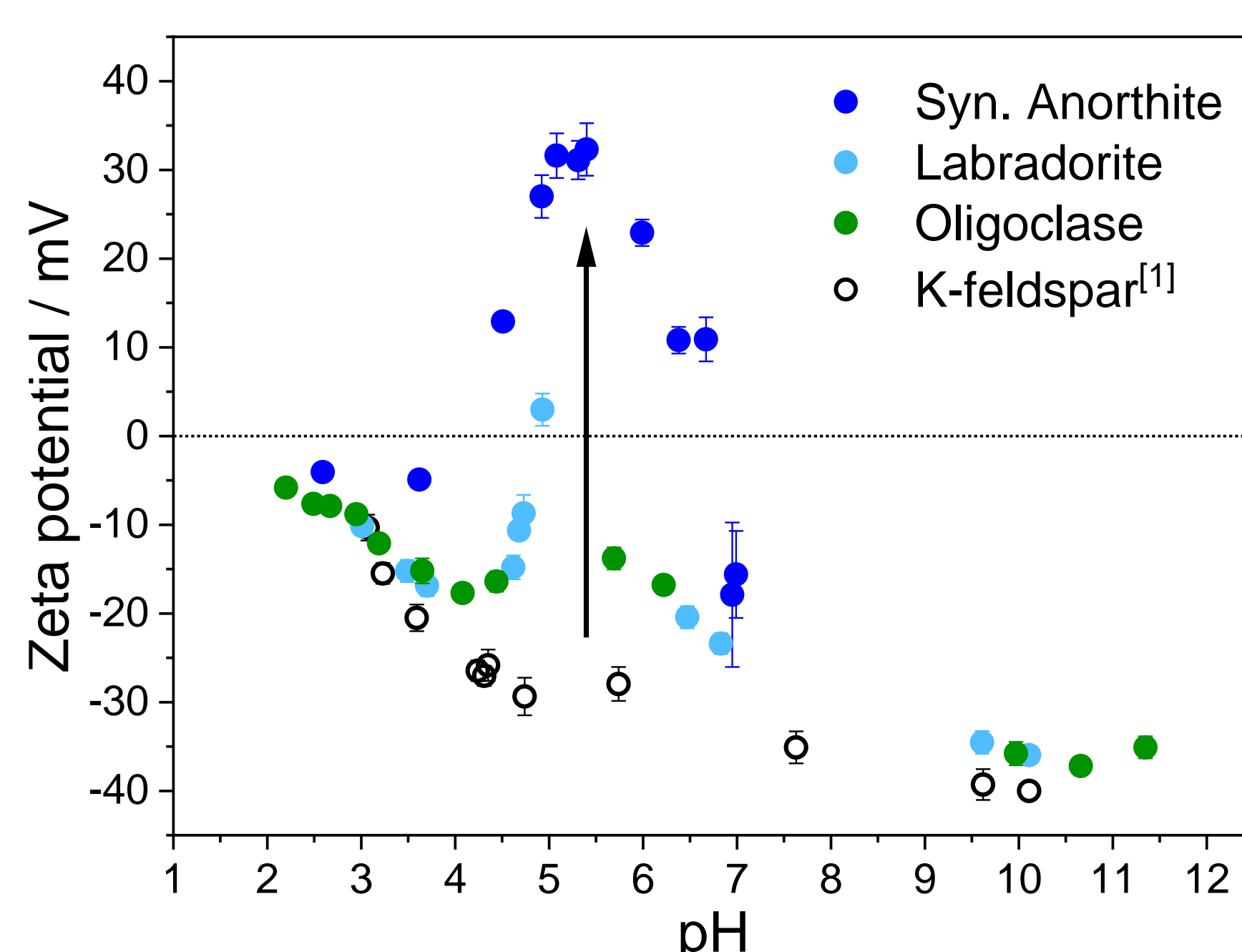


Figure 2. Zeta potential of 0.2 g/L feldspars with varying Ca content.

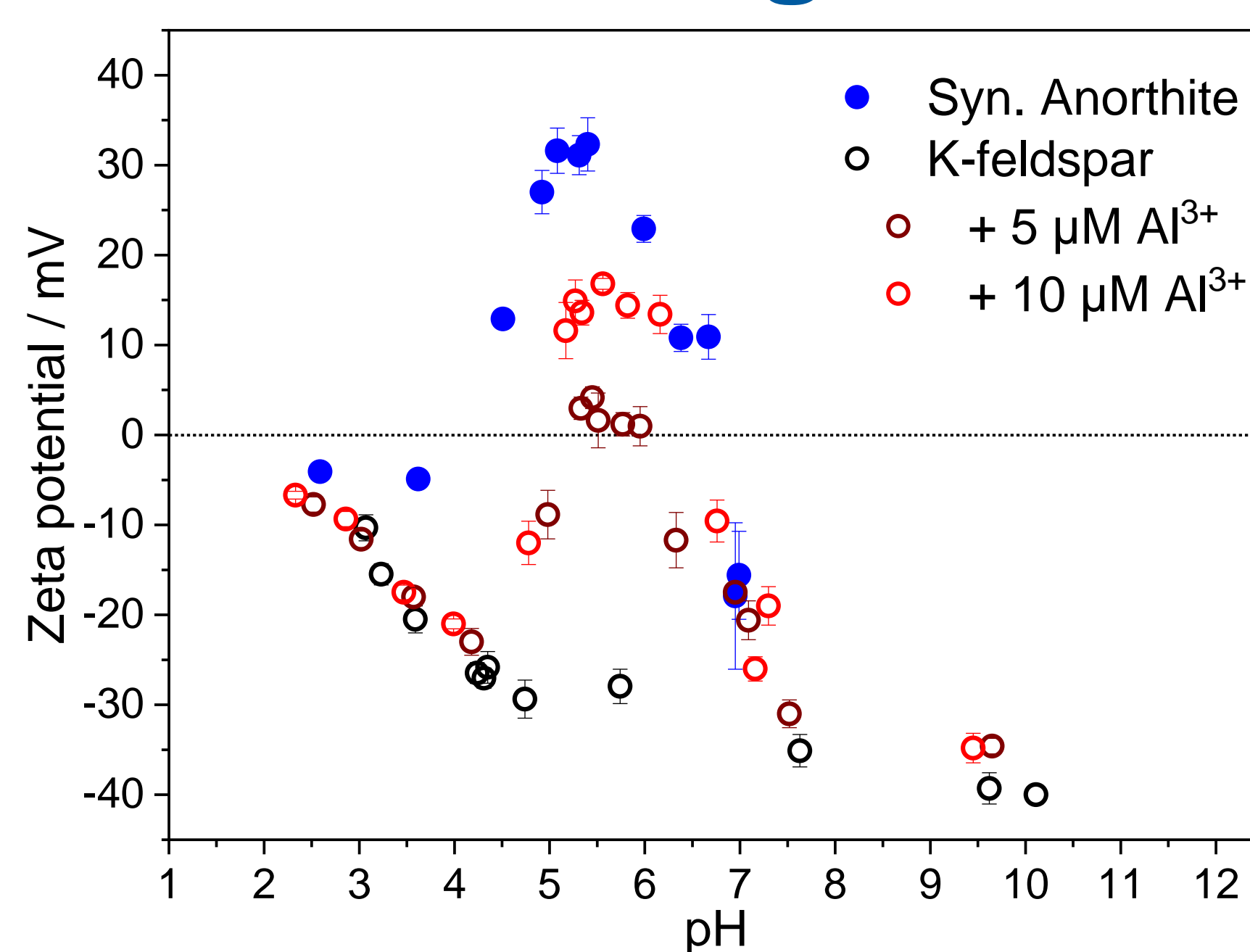


Figure 3. Zeta potential of 0.2 g/L feldspars with and without different amounts of Al³⁺.

Impact of Al on sorption of M(III) on minerals?

- Unusual increase of zeta potential for pH 4 – 7
- Probably caused by sorption of Ca²⁺ and Al³⁺ and/or precipitation of Al phase

Batch Sorption and Surface Structure

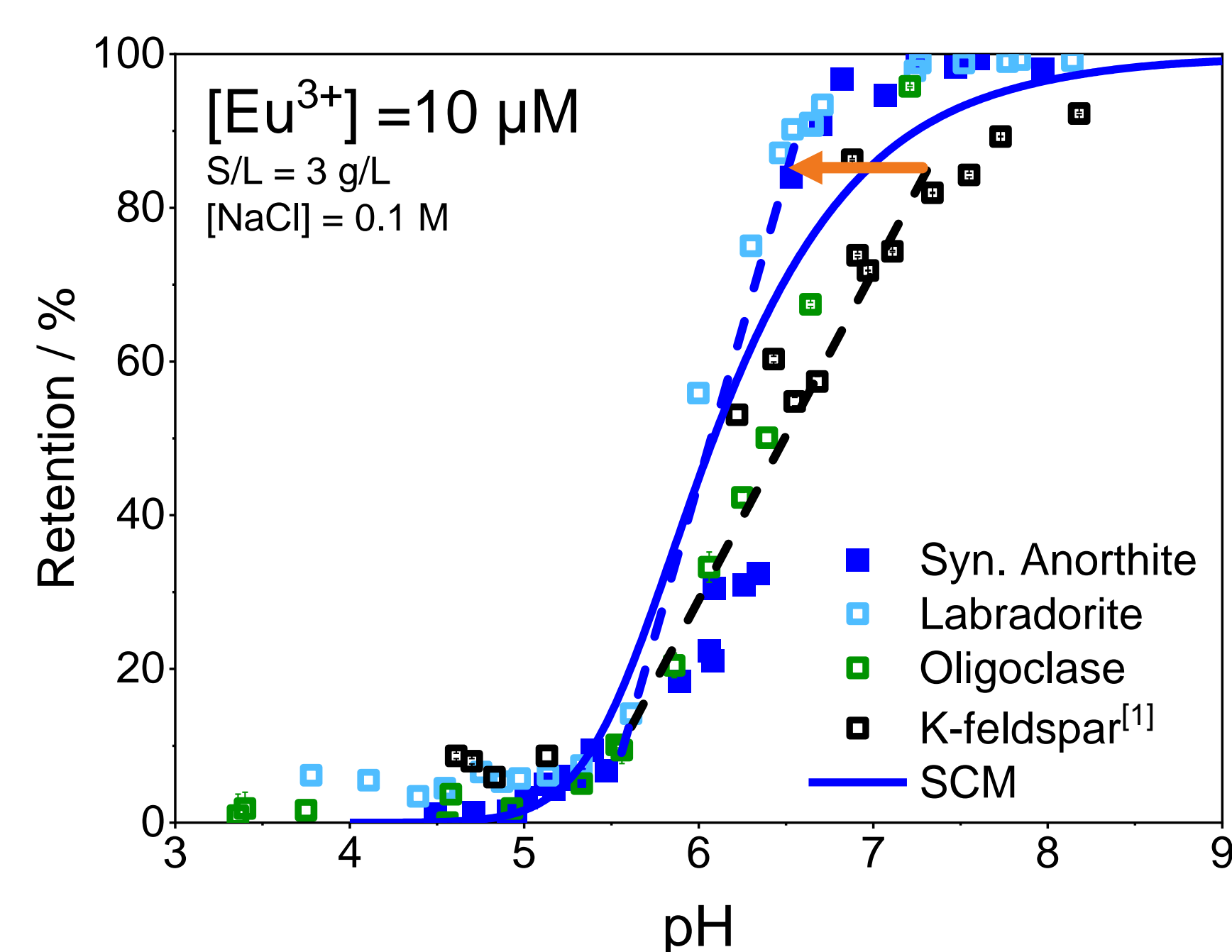


Figure 4. Sorption edge of Eu³⁺ as analogue for M³⁺ on different plagioclases.

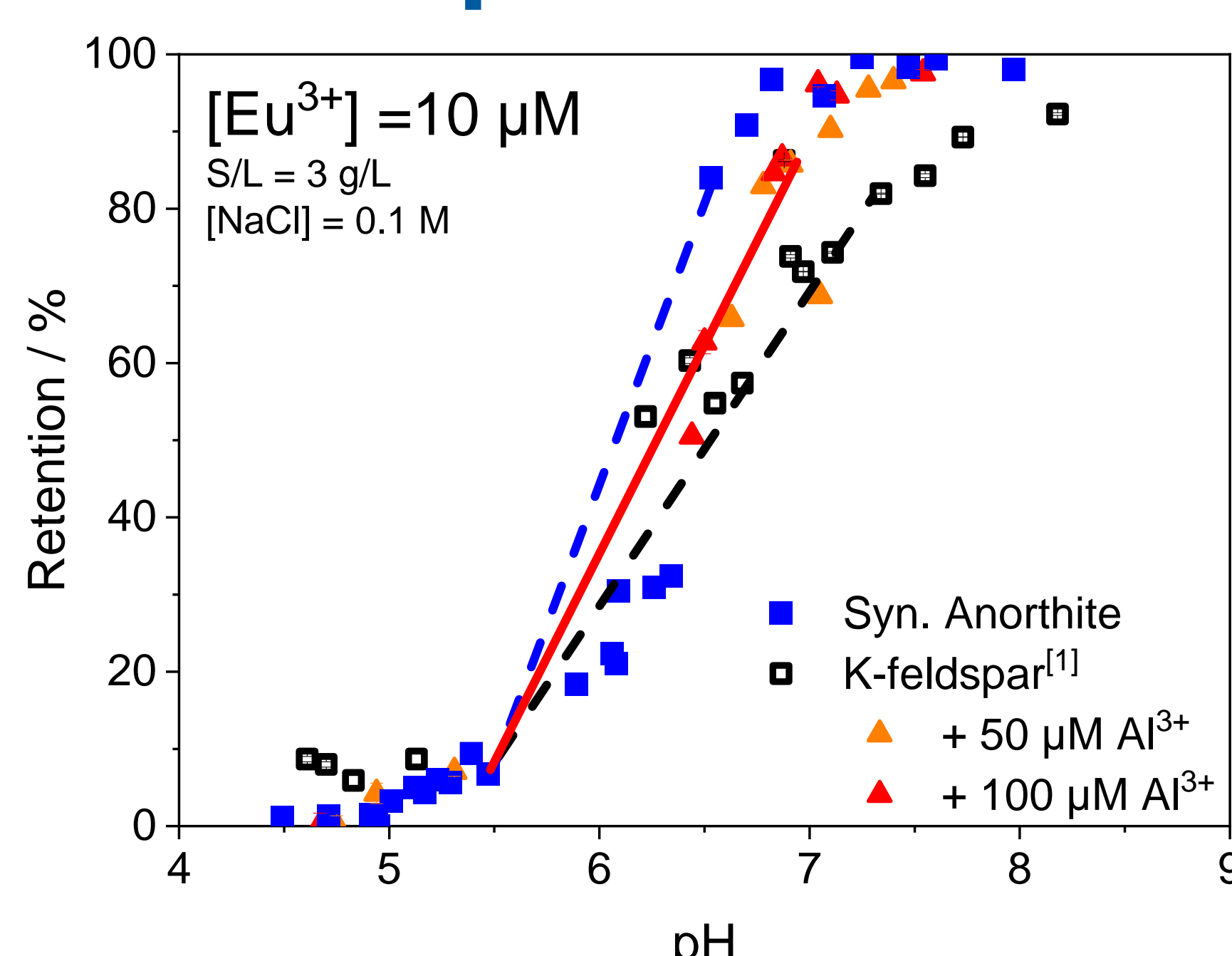


Figure 5. Sorption edge of Eu³⁺ for K-feldspar with different amounts of added Al³⁺.

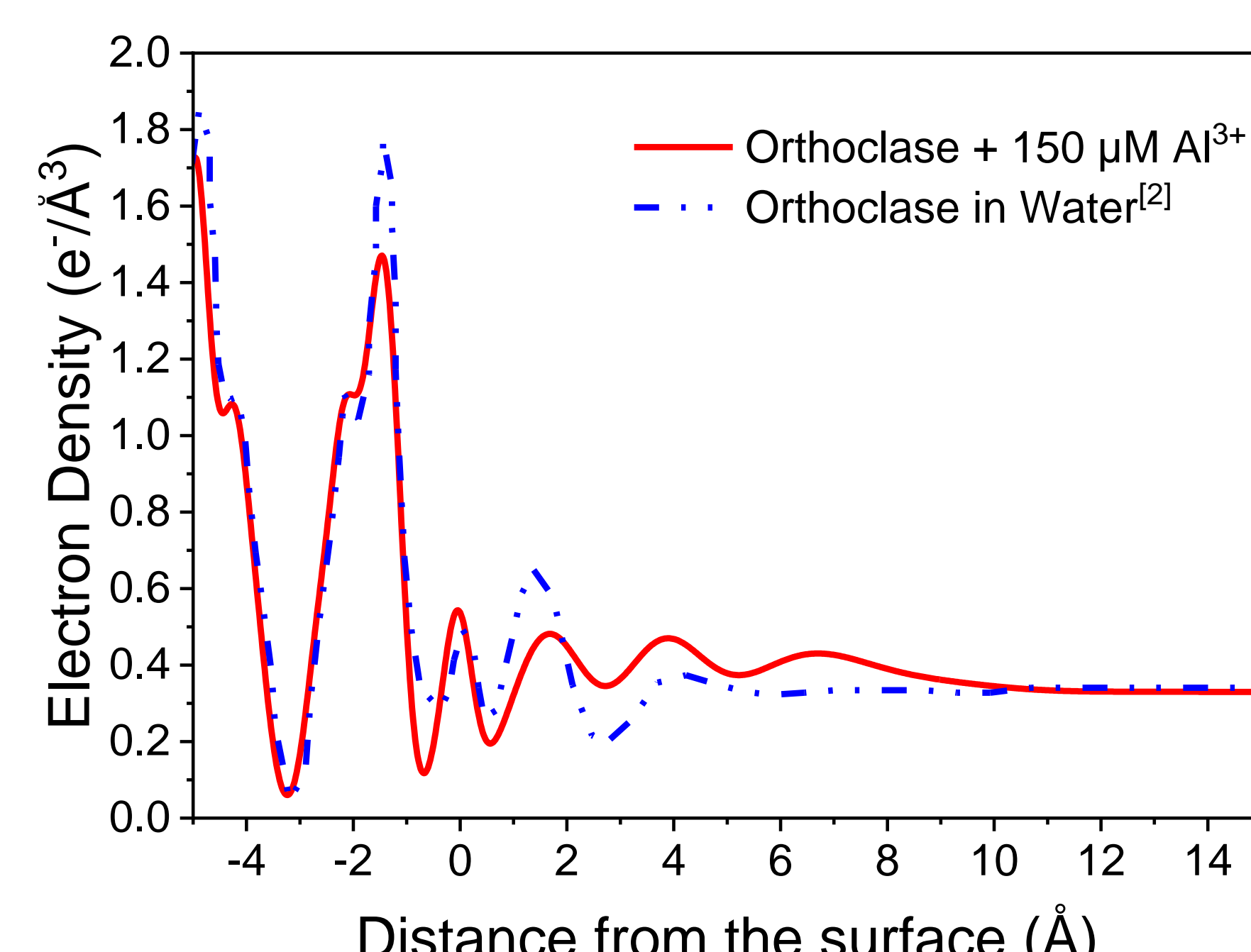


Figure 6. X-ray reflectivity of orthoclase with added Al³⁺.

- Ca-feldspars have slightly higher retention potential towards M(III) compared to K-feldspars

- Suggestion: Al-phase forms on surface

- SXD measurements show Al³⁺ alters interfacial structure
- No evidence for “crystalline” surface precipitate

Conclusion

- Zeta potential increases with increasing amount of Ca²⁺ in the crystal lattice
- Effect can be traced back to dissolved Al³⁺ → SXD reveal interaction of Al³⁺ on surface
- Strong sorption uptake of trivalent f-elements for pH > 6

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[1] Neumann et al. *J. Colloid Interface Sci.*, **2021**, 591, 490–499.

[2] Stumpf et al. *Radiochim. Acta*, **2006**, 94, 243–248.

[3] Lessing et al. *Natural and synthetic plagioclases: Surface charge characterization and sorption of trivalent lanthanides (Eu) and actinides (Am, Cm)*, in preparation.

[4] Fenter et al. *Geochim. Cosmochim. Acta*, **2003**, 67, 4267–4275.