



# Effects of inorganic and organic anions on the stability of illite and quartz soil colloids in Na-, Ca- and mixed Na–Ca systems

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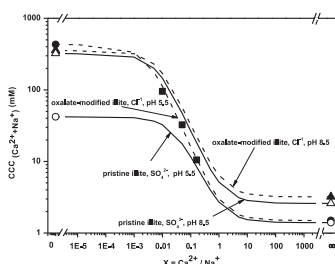
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## HIGHLIGHTS

- ▶ CCC of  $\text{Ca}^{2+}$  and  $\text{Na}^+$  for illite and quartz WDC with different anions.
- ▶ CCC of low soluble  $\text{Ca}^{2+}$ -oxalate tested with oxalate-modified illite in  $\text{CaCl}_2$ .
- ▶ Coagulating  $\text{Ca}^{2+}$  dominates the colloidal dispersion effect of oxalate compared to  $\text{Na}^+$ .
- ▶ Attraction energy between mineral colloids at CCC is scaled.
- ▶ CCC in pure Na- and Ca-systems can be used to predict CCC in mixed systems.

## GRAPHICAL ABSTRACT

Increase of colloidal illite stability ( $\text{CCC}_{\text{Na+Ca}}$ ) in suspension at different molar ratios of calcium to sodium, X, after oxalate modification in the presence of chloride anion compared to pristine illite in the presence of sulfate anion.



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## ABSTRACT

The colloidal behavior of soil mineral colloids (quartz and illite) in Na, Ca and mixed Na–Ca systems was systematically investigated. The critical coagulation concentrations (CCCs) were determined for  $\text{Na}^+$  and  $\text{Ca}^{2+}$  solutions containing anions of a different nature ( $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$  and ubiquitous soil organic anions formate and oxalate) at pH 5.5 and pH 8.5. Higher CCC values in the presence of  $\text{Na}^+$  at pH 8.5 were related to a lower screening effect of monovalent cations and the ionization properties of the soil mineral colloids. Attraction energy between colloids was experimentally scaled at CCC from zeta potential and aggregation kinetics measurements. In the Na-system, a higher stability for colloidal illite and quartz particles suspensions in the presence of oxalate anions confirmed surface complexation at an acidic pH. In the Ca-system, slight CCC variations in illite suspensions in the presence of  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ , formate and oxalate supported attractive ion–ion correlation forces between equally highly charged clay mineral colloids. It was shown that the CCCs of mixed Na–Ca systems close to soil chemical conditions can be calculated using the CCCs for colloidal illite and quartz particles in pure Na and Ca systems at pH 5.5 and pH 8.5. Sensitive dispersion effects due to adsorbed oxalate can be analyzed as a function of the molar ratios of calcium to sodium in solution.

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## 1. Introduction

Water dispersible colloids (WDCs) are soil particles  $<2\ \mu\text{m}$  from soil clay fractions that can be easily dispersed in contact of soil water. They mainly include aluminosilicate and metal oxide particles which can be released from soil aggregate structures and contribute to soil erosion. They have large surface area and exhibit low gravitational velocities which facilitate the sorption and transport of organic matter and pollutants including oxyanions,

Abbreviations: WDC, water dispersible colloids; NOM, natural organic matter; LMW, low molecular weight; SAR, sodium adsorption ratio; PCS, photon correlation spectroscopy.

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