

Petrogenesis and Solidification History of late Pan-African Dykes Assemblage, north Eastern Desert, Egypt

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Abstract

Geologic and geochemical data of intraplate late Pan-African (4937Ma) dykes assemblage in the northern Eastern Desert of Egypt are presented. The dyke swarms consist of a bimodal mafic-felsic suite of transitional alkaline to subalkaline chemistry and exhibit a broad compositional range. Geochemical studies show that they can be subdivided into three distinct chemical groups with two distinct compositional gaps and correlate fairly well with other occurrences of late Pan-African dykes in Egypt. This bimodal suite bears a genetic relation to corresponding rock types in the study area.

These dykes occur predominantly in NE and NNW directions and less frequently in NW and due N orientations; parallel to the major fracture pattern and lineament trends. Despite of the small geographic area and limited time interval in which the dykes were intruded, their complex geochemistry requires multiple sources together with varying amounts of open system fractionation assimilation. It is believed that the crystallization of the studied dykes follow the one-step emplacement either in open or closed system under both brittle and ductile crustal conditions. The time (ts) required to solidify these types of dykes is generally longer in the acidic than the basic varieties.

Metal Sorption and Aggregation in Kaolinite-Fulvic Acid Dispersions

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Adsorbed natural organic matter (NOM) plays an important role in the colloidal stability and mobility of mineral particles in aquatic environments. The effects of adsorbed NOM on colloid aggregation kinetics of clay and oxide particles have been well documented. However, few studies have quantified the effects of strongly adsorbing metal cations, such as Cu(II) and Pb(II), on the surface charge and aggregation kinetics of mineral colloids in the presence of adsorbed NOM. Therefore, we studied the sorption of Cu and Pb in kaolinite-fulvic acid suspensions and the resulting effects on aggregation kinetics of the kaolinite particles.

Sorption of Cu and Pb to pure kaolinite (KGa-2, Clay Minerals Society), fulvic acid (isolated from a surface soil), and kaolinite-fulvic acid (5 g/L kaolinite, 30 mg/L fulvic acid, 0.01 M NaNO₃, pH 4, 6, and 8) suspensions was investigated using a potentiometric titration system with ion-selective electrodes for Cu²⁺, Pb²⁺, and H⁺, respectively (Christl and Kretzschmar, 2001). Particle aggregation kinetics was followed by dynamic laser light scattering (DLS). Kaolinite-fulvic acid suspensions (0.01 M NaNO₃, pH 4 and 6) were spiked with Cu(NO₃)₂, Pb(NO₃)₂ or Ca(NO₃)₂ solutions to give total divalent metal cation concentrations between 10⁻⁵ and 5×10⁻³ M. The average hydrodynamic radius during Brownian aggregation was measured every 15 s and relative aggregation rates were estimated from the initial slope of the radius increase with time (Kretzschmar et al., 1998).

Results of sorption experiments showed that Cu and Pb sorption to kaolinite is enhanced in the presence of fulvic acid. Adsorbed metal cation concentrations in ternary systems exceeded the predicted amounts based on a simple linear additivity model. Analysis of the fulvic acid remaining in solution revealed that the higher molecular weight fraction was preferentially adsorbed to the kaolinite. However, this fractionation could not explain the observed non-additive effects in metal sorption, since the lower molecular weight fraction remaining in solution exhibited similar metal binding affinity as the total fulvic acid. At pH 4, Cu and Pb additions resulted in slightly higher aggregation rates when compared to Ca. However, at pH 6 the aggregation rates were drastically increased in the presence of 10⁻⁴ M Cu or Pb, but not Ca. The aggregating effect of Pb was consistently stronger than that of Cu. Possible implications for colloid-facilitated transport of Cu and Pb will be discussed.

References

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