Influence of Column Pre-leaching on Nanoparticle Sorption
G. SINGH, W.F. SPENCER, David E. CROWLEY and Sam R. ALVEY, USDA-ARS and Univ. California, Riverside.

Pre-leaching of packed soil columns, with one or more pore volumes of 0.01M Ca(NO₃)₂ solution, to attain steady-state flow conditions altered some soil properties particularly the dissolved organic matter (DOM) content. Batch equilibrium sorption experiments using nanoparticle and a sandy loam soil washed 1, 2, 3, 4, and 5 times with 0.01M Ca(NO₃)₂ (1:1.5) demonstrated that adsorption of nanoparticle increased significantly with number of washings. Injecting the nanoparticle pulses at different stages of column leaching indicated significant influence of pre-leachings on breakthrough-curves (BTCs). Leachate and washed soils were analyzed for various cations, DOM and microbial activity and supported these results. Incubation of the leached column for 10 days at room temperature resulted in sharp BTCs mainly because the column reached equilibrium and the released DOM helped in eluting the pesticide faster.

Gulab SINGH, (909) 787-4388

Remediation of Strongly Acidic Soils by Using Lime Stabilized Sewage Sludge. J.J. SLOAN* and N.T. BASTA, Oklahoma State Univ.

New federal regulations that allow application of sewage sludge to acid soil make lime stabilized sewage sludge (LSSS) an attractive alternate liming material. The objectives of this study were (1) to eliminate Al and Mn toxicity by LSSS and (2) to determine the effect of direct application of LSSS to acid soils on dissipation and speciation of heavy metals. Three strongly acidic soils (pH = 5) were incubated with LSSS for 6 months. Rates were selected to attain target soil pH levels of 5.5, 6.5, 7.5. For comparison, soils were amended with AgI:AgNO₃ (AgI), Ni:Viro soil (NV), and sewage sludge without lime stabilization (SS). Chemical characterization of soil (fresh, Al, metal speciation) and soil solution (pH, Al, Fe, Mn, and heavy metals) was performed at 1, 30, 90, and 180 days of incubation. In general, increases in soil solution pH and Fe and Mn reduction in solution Al were AgI > LSSS > NV > SS. All treatments, except SS, dramatically reduced exchangeable Al. Heavy metal concentrations in soil solution decreased with application rate of LSSS and NV but dissolved amounts increased for SS.

J.J. Sloan, (405) 744-6414


Soil sorption isotherms for nonionic organic compounds with polar functional groups are often nonlinear. By treating Freundlich nonlinear sorption of five substituted phenylurea herbicides as a phase partition between solution and humic polymer, Freundlich partition coefficients and exponents are clearly interpreted in terms of fundamental thermodynamic principles of the sorbate-sorbent system. Studies of isotherm temperature dependence show variable but negative sorbed phase partial molal enthalpies, demonstrating the presence of specific interactions within the humic phase. Implications for a variety of anomalous sorption behavior including isotherm nonsingularity, nonlinearity, and desorption kinetics are discussed.

F.C. Spurlock, (916) 752-7317


The sorption/desorption kinetics of pentachlorophenol (PCP) on HDTMA modified montmorillonite were investigated using a continuous stir flow reactor. Pentachlorophenol is a hydrophobic ionic有机 compound (HOIC) with a pKa of ~4.7; thus it can exist as both a molecule and/or anion in the environment. We have determined that both the associated and dissociated form soluble AI that elicits HDTMA adsorption. However, the sorption characteristics of the two species are different. The sorption rate for both species was investigated. For these studies, 100% CEC exchanged HDTMA montmorillonite was used as the sorbent, the PCP solution concentration ranged from 20 to 100 μmol kg⁻¹, the pH ranged from 4.0 to 8.0 and the background ionic strength ranged from 1 to 100 mmol kg⁻¹ NaCl. Preliminary results indicate that sorption of the phenolate anion is faster than the PCP molecule. This study investigates the sorption/desorption kinetics of HOICs, and will provide basic information regarding their fate in the environment.

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Insights into the Physical-Chemical Properties of Phyllolastics as Revealed by Oxidation and Reduction of Structural Fe. J.W. STUCKI*, Univ. of Illinois

Empirical correlations between oxidation-reduction processes and mineral properties have been known for decades. Various aspects of these relationships have been quantified, including effects of Fe(II) content on swelling, cation exchange capacity and fixation, specific surface area, c-axis spacing, viscosity, hydraulic conductivity, gel microstructure, and the interaction of Fe ions in adjacent crystallographic sites. Recent work has focused on the reduction reaction mechanism and on surface interactions with various chemical species. Results from these studies indicate that the underlying mechanism governing the effect of structural Fe(II) on the physical-chemical properties of the clay may include changes in electron density of the clay layer and in the polarizability of surface oxygen ions. The surface forces affected by structural Fe(II) are of sufficient magnitude to overcome considerable resistance, indicating that Fe reduction may be a rather aggressive process for invoking changes in mineral properties and behavior.

J.W. Stucki, (217) 333-9636

Coordination of Boron Adsorbed on Mineral Surfaces as Revealed by FTIR Spectroscopy. Chunming Su* and D.L. Suarez, USDA-ARS, U.S. Salinity Laboratory, Riverside, CA.

Boron adsorption was studied on amorphous Al and Fe hydroxides, allophane and kaolinite as a function of pH in 0.1 M NaCl. Electrophoresis was used to identify surface complex formation. The presence of 250 mg L⁻¹ B lowered the point of zero charge in all the minerals, indicating specific adsorption of B. Fourier transform infrared spectroscopy was utilized to investigate the coordination of adsorbed B species on the mineral surfaces in aqueous mineral pastes. Both trinodal (peaks near 1420 and 1290 cm⁻¹) and tetrahedral B signals (peaks near 1060, 1000 and 920 cm⁻¹) were observed on the difference spectrum for Al hydroxide at pH 6.5, but only tetrahedral B signals (peaks near 1000 and 920 cm⁻¹) were observed at pH 9.8. For Fe hydroxide at pH 7.2 and 10.1, peaks observed indicated trinodal B, whereas stronger tetrahedral B peaks were obtained in allophane. The presence of trinodal B on kaolinite was suppressed at pH 7.0. The results provide spectroscopic evidence that both H₂BO₃ and B(OH)₃ are adsorbed via a ligand exchange mechanism.

Chunming Su (909) 166-4876

Predicting Ca-Mg Exchange Selectivity of Smectite Soils. D.L. SUAREZ* and J.D. Wood, USDA-ARS, U.S. Salinity Laboratory, Riverside, CA.

Despite extensive characterization of Ca-Mg exchange selectivity in reference clays, determination of Ca-Mg selectivity of an individual soil requires measurement on the actual soil. Determinations in calcareous soils have been further confounded by failure to account for calcite dissolution during the extraction step of the exchange procedure. We determined the Ca-Mg selectivity of smectite soil clays using 50 mM mixtures of CaCl₂ and MgCl₂ adjusted to pH = 7 and extracted with NH₄NO₃. Las Flores soil clay exhibited nonlinear Vanselow selectivity coefficients (K⁺) increasing from 2.0 to greater than 4.0 with increasing exchangeable Mg. After correction for calcite dissolution, K⁺ values were relatively constant around 2.9. Selectivity values for smectite soils show greater Ca preference than Wyoming montmorillonite even after correction for organic matter (or removal of organic matter in pretreatment) and correction for calcite dissolution.

D.L. Suarez, (909) 369-4816
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Chemical characterization of soil (exch. Al, metal speciation) and soil solution (pH, Al, Fe, Mn, and heavy metals) was performed at 1, 30, 90, and 180 days of incubation. In general, increases in soil solution pH and Fe, Mn concentration in solution were significant for soils amended with LSSS. Al treatments, except SS, dramatically reduced exchangeable Al. Heavy metal concentrations in soil solution decreased with application rate of LSSS and NV but dissolved amounts increased for SS.

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Sorption Kinetics of Pentachlorophenol on Hexadecyltrimethylammonium clay. M.G. STAPLETON* and D.L. SPARKS, University of Wyoming.

The sorption/desorption kinetics of pentachlorophenol (PCP) on HDTMA modified montmorillonite were investigated using a continuous stir flow reactor. Pentachlorophenol is a hydrophobic ionic compound (HOC) with a pKa of ≈ 4.7; thus it can exist as both a molecule and/or anion in the environment. We have determined that both the associated and dissociated forms of PCP sorb to montmorillonite. However, the sorption characteristics of the two species are different. The sorption rate for both species was investigated. For these studies, 100% CEC exchanged HDTMA montmorillonite was used as the sorbent, the PCP solution concentration ranged from 20 to 100 μmol kg⁻¹; the pH ranged from 4.0 to 8.0 and the background ionic strength ranged from 1 to 100 mmol kg⁻¹ NaCl. Preliminary results indicate that sorption of the phenolate anion is faster than the PCP molecule. This study investigates the sorption/desorption kinetics of HOCs and will provide basic information regarding their fate in the environment.

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Chunming Su (909) 160-4876

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