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Zeta potential and point of zero charge of clay fraction as affected by vinasse and phosphorus*

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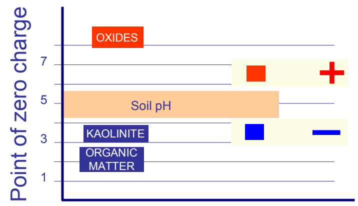
* Part of the doctorate thesis of the first author

INTRODUCTION

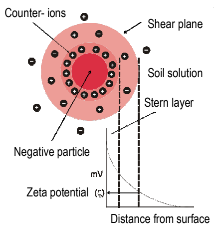
Soil charge - importance

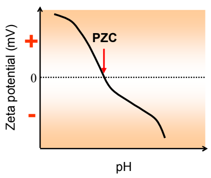
- ✓ Soil dispersion and flocculation (Sumner, 1992; Chorom & Rengasamy, 1995)
- ✓ Cation and anion exchange (Gilman, 1985)
- ✓ Pesticides and heavy metals sorption (Clausen et al., 2001; Appel & Ma, 2002)

Tropical soils – variable charge (pH dependent)



Zeta potential (ζ)





- Zeta potential: the electrical potential developed at the solid-liquid interface (Tan, 1993)

- Point of zero charge (PZC): pH at which the surface charge is electrically neutral, for example, zeta potential = 0 (Tan, 1993)

Brazil

- ➢ Ethanol production: 27 billion liters;
- ➢ Vinasse: the main byproduct of ethanol and brandy production. It is produced in large amounts - about 13 liters per liter of ethanol or brandy;
- ➢ Vinasse: 354 billion liters in 2009;
- ➢ Disposal in soils as liquid fertilizer is an alternative use for this product, mainly as a source of K. This practice avoids dupping vinasse into the water courses and lakes, which was common in the past (Günkel et al., 2007);

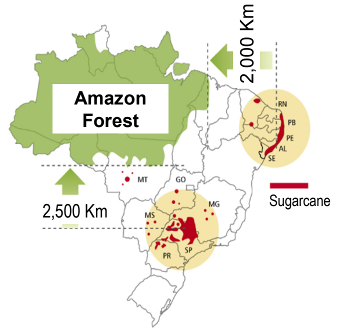


Figure 1. Distribution of sugarcane crops in Brazil. Extracted and adapted from www.unica.com.br

OBJECTIVES

The objective of this work was to evaluate the effect of vinasse, P sorption and the interaction vinasse-phosphorus on zeta potential and point of zero charge (PZC) of clay-fraction samples from two soils with different iron and aluminum contents (Red Latosol and Gleysol).

MATERIAL AND METHODS

- Clay fraction of Dystroferric Red Latosol (LVdf) and Gleysol (referenced as gibbsite)

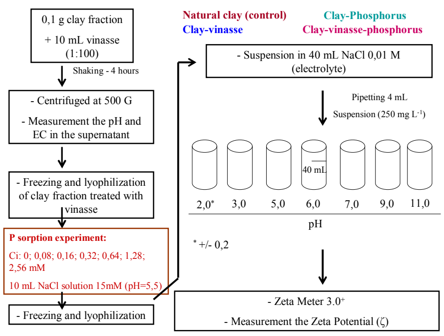
	SiO_2 [1/]	Al_2O_3 [1/]	Fe_2O_3 [1/]	Ki	Kr	TOC
	---------------------------g kg^{-1}	---------------------------				-g kg^{-1}-
LVdf	284	256	177	1,88	1,31	6,0
Gibbsite	86	489	9,1	0,30	0,30	1,5

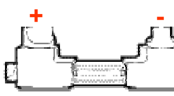
[1/] After acid sulfuric digestion (Embrapa, 1997); Ki: molecular ratio (SiO_2/Al_2O_3); Kr: molecular ratio ($SiO_2/Al_2O_3 + Fe_2O_3$); TOC: total organic carbon.

- Vinasse from sugarcane spirit production

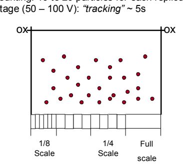
pH	CE	I	OC	P	K	Ca	Mg	S	Na	Cu	Mn	Zn	Fe
			------------------g L^{-1}					------------------	---------------mg L^{-1}				------------
3,5	7,5	0,1	9,6	0,0	2,1	0,2	0,2	0,0	0,7	7,4	1,5	0,0	18,3

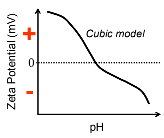
EC: electrical conductivity (dS m^{-1}); I: ionic strength (mol L^{-1}); I = CE.0,0127; OC: organic carbon.





• Counting: 10 to 20 particles for each replicate
Voltage (50 – 100 V): *"tracking"* ~ 5s





RESULTS

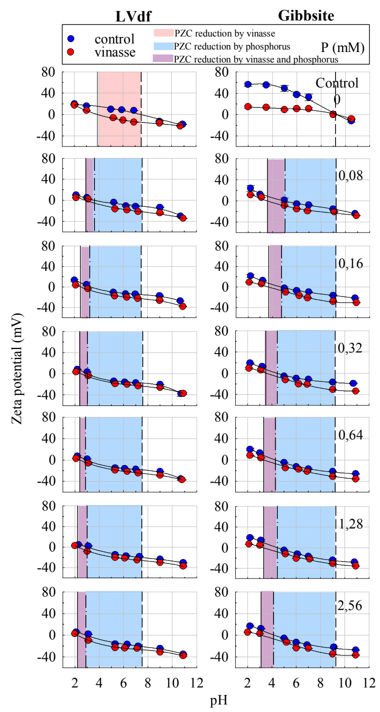


Figure 2. Zeta potential and point of zero charge (PZC) of Dystroferric Red Latosol and Gleysol (gibbsite) as affected by vinasse and phosphorus sorption. Erros bars indicate the standard deviation (n=3)

CONCLUSIONS

✓ The vinasse influenced the zeta potential of clay fraction of both soils. In the Red Latosol, the PZC was reduced from 7.5 to 5.0, and the particles became more negatively charged. For gibbsite, the PZC was not changed, but the positive charges were significantly reduced. The P sorption increased negative charges to the soil particles and reduced the PZC. These effects were more pronounced when the clay fraction was previously treated with vinasse.

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