MINICURSO INTERNACIONAL

MINERAL-ORGANIC INTERACTIONS IN SOILS

PPG Solos e Nutrição de Plantas ESALQ-USP

Dias 5 e 6 de junho de 2017

Duração: 14h

Local: Departamento de Ciência do Solo ESALQ/USP, Anfiteatro de Agricultura e Solos.

Ministrante: Professor Markus Kleber (Crop and Soil Science Department, Oregon State University)

http://cropandsoil.oregonstate.edu/content/markus-kleber

Inscrições: enviar **até 31 de maio de 2017** e-mail com informações pessoais, profissionais e e-mail para o Coordenador do Minicurso, Pedro Martinez: rodrigup@oregonstate.edu

Público: estudantes de pós-graduação, professores, pesquisadores com interesse no estudo da matéria orgânica do solo.

Obs: Não há taxa de inscrição.

Summary:

Treats soil as the interface between organic and mineral components. Introduces molecular scale properties of major system components (mineral types and forms of soil organic matter). Shows how interactions between minerals and organics determine the special nature of the soil "bioreactor". Course is focused on biogeochemical processes that determine soil organic matter turnover.

Suggested pre-requisites: Courses in soil chemistry, mineralogy and organic matter

Syllabus:

	Topic	Objectives	References
June 5st			
8:00 to 9:30	**Water, hydration, hydrolysis, hydrogen bonding, water cage, entropy**	Explain why water (the polar solvent "H_2O") is a critical component of the soil system. Show how it both participates in and determines the outcome of chemical and physical reactions within the system.	**Essington ME (2003)** Soil and water chemistry, pp 183-198. CRC Press, Boca Raton.

9:30 to 10:30	**Energy and Redox**	Show that energy moves from one molecule/ element to another through the corresponding transfer of electrons, show implications for both mineral and organic system compounds	**Schlesinger WH (1997)** Redox potential: the basics. In "Biogeochemistry - an Analysis of Global Change , pp. 226-242, Academic Press, Amsterdam.
10:30 to 10:50	**Morning break**		
10:50 to 12:00	**Humus, humification, humic substances, Molecularly Uncharacterized Compounds (MUC)**	Establish the context for this widely used terminology. Provide definitions and show conflicts between contemporary understanding and traditional use of terms.	**Waksman SA (1936)** Nature and Characteristics of Humus. In "Humus Origin, Chemical Composition, and Importance in Nature", pp. 3-9, Williams and Wilkins, Baltimore, MD. **Burdon, J., 2001**. Are the traditional concepts of the structures of humic
12:00 to 13:00	**Lunch**		
13:00 to 14:00	**Adsorption/ Desorption**	Show how the attachment of a dissolved substance to a mineral surface is handled. Explain sorption isotherms, hystereses, background electrolyte	**Essington, M. E**. (1994). "Adsorption of Aniline and Toluidines on Montmorillonite." Soil Science 158: 181-188.
14:00 to 15:00	**Chemical reactivity of organic functional groups**	Establish understanding of the reactions to be expected between organic molecules among each other and with mineral surfaces by showing what gives them the ability to interact.	**Essington ME (2003)** Soil and water chemistry, pp 133-140. CRC Press, Boca Raton.
15:00 to 15:20	**Afternoon break**		
15:20 to 17:00	**The energetics of decomposition**	Understand the energetic drivers behind decomposition. Distinguish between the concepts of "free energy change" and "activation energy". Understand why the latter depends on temperature, while the former does not.	**LaRowe, D. E.; Van Cappellen, P.,** Degradation of natural organic matter: A thermodynamic analysis. Geochimica et Cosmochimica Acta 2011, 75, (8), 2030-2042. **Davidson, E. A.; Janssens, I. A.,** Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. Nature 2006, 440, (7081), 165-173.
June 6th			
8:00 to 9:20	**The chemistry of organic inputs to soil organic matter**	Give overview of the "parent materials" for soil organic matter formation	**Kogel-Knabner I (2002)** The macromolecular organic composition of plant and microbial residues as inputs to soil organic matter. Soil Biology and Biochemistry, 34, 139-162.

9:20 to 10:30	**SOM stabilization**	Use three milestone papers to show how the understanding of mineral influence on soil carbon paper has evolved over the last 20 years. Introduce the concepts of recalcitrance, accessibility and interactions.	**Oades JM (1988)** The retention of organic matter in soils. Biogeochemistry. 5, 35-70. **Sollins P, Homann P, and Caldwell BA (1996)** Stabilization and destabilization of soil organic matter: Mechanisms and controls. Geoderma, 74, 65-105. **Lutzow Mv, et al. (2006)** Stabilization of organic matter in temperate soils: mechanisms and their relevance under different soil conditions – a review. European Journal of Soil Science, 57, 426-445.
10:30 to 10:50	**Morning break**		
10:50 to 12:00	**Methods of organic matter analysis**	Show, how upon suspension / dissolution of organics in a polar solvent (water), the physical properties of organic moieties can lead to predictable arrangements. Introduce basic thermodynamic principles (2nd law)	**Swift R (1999)** Macromoleclar properties of soil humic substances: fact, fiction and opinion. Soil Science, 164, 790-802. **Sutton R, and Sposito G (2005)** Molecular structure in soil humic substances: The new view. Environ. Sci.Technol., 39, 9009-9015.
12:00 to 13:00	**Lunch**		
13:00 to 14:00	**Minerals as electron donors and electron acceptors**	Show that minerals are more than passive adsorbents: they can replace food and air	**Brock** Biology of Microorganisms
14:00 to 15:00	**Archetypes of mineral surfaces, solid solution interface**	Show that mineral surfaces in the "clay"-fraction can be grouped into three major categories and how these categories relate to chemical and physical reactivity. Explain the particularities of mineral surfaces. Introduce Double Layer Concept, surface acidity, points of zero charge	**Sposito G et al. (1999)** Surface geochemistry of the clay minerals. Proceedings of the National Academy of Sciences USA, 96, 3358-3364.
15:00 to 15:20	**Afternoon break**		
15:20 to 17:00	**Ion exchange (organic and inorganic, cation and anion)**	Explain that ion exchange is an adsorption process that is distinguished from other adsorption processes in that it involves only ions held by weak electrostatic interactions. Show that all aqueous species, inorganic and organic, that exist as cations/anions in soil solutions may participate in ion exchange reactions.	**Hiemstra, T., and W.H. VanRiemsdijk. 1996.** A surface structural approach to ion adsorption: The charge distribution (CD) model. Journal of Colloid and Interface Science 179:488-508.