Colloids in Soil Science

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Three questions are in the centre of our presentation: (1) why are colloids important for soil science, (2) what is the special of colloids in soils (3) what are recent research questions and challenges.

In general, there are mainly two properties, which motivate research on soil colloids: the huge surface and reactivity of colloids and their small size. The majority of the soil surface is linked to colloid-sized particles. Thus, reactions between soil solution and the solid phase are often dominated by colloids, which thereby control the mobility of plant nutrients and pollutants in soils. The large specific surface of soil colloids is linked to their small particle size. Due to their small size dispersed colloids can be transported through the soil pores. Thus, some part of the soils’ solid phase is potentially mobile and may transport adsorbed solutes through soils. Controls and relevance of colloid-facilitated transport is a matter of recent studies and will be discussed by Totsche (this session).

Huge surface and diminutive particle size motivate colloid research in general and are not soil-science specific. Soil properties and the properties of soil colloids are the one which make soil colloid science special: soil colloids show a stupendous diversity and their effective surface and particle size show a large temporal and spatial heterogeneity. These properties challenge soil scientists and complicate the analyses of soil colloids. As there are not two colloids in soils which equal, a classification of colloids is needed to characterise soil colloids and classifying colloid properties have to be defined. Things get even more diverse and difficult if we consider the effective properties of colloids. The effective size and surface of soil colloids is much more dynamic than their particle size. Effective properties are affected by aggregation/dispersion reactions, which change over time depending e.g. on the chemical composition of the soil solution.

New methods for the analysis of colloid aggregation are presented by Gleber (this session). While different methods are available for the analysis of the effective size of colloids/aggregates, the effective surface of aggregated colloids is hard to define and among the open research questions. Recently the research on soil colloids has gained new relevance with the increasing use of synthetic nanoparticles, which are reaching soils and other ecosystem components. The combination of nanoparticle and soil colloid research offers synergistic chances for science: Synthetic nanoparticles may be used as models for soil colloids and may help to understand basic processes, on the other hand existing knowledge on the fate of colloids in soils will help to assess the risk of synthetic nanoparticles in soils but also to systematically explore nano-specific processes and potential environmental threats. Beside from the application and development of advanced methods for the analysis of soil colloids, the persistent challenge for soil scientists is to link basic knowledge on soil colloids with effects observed on the scale of pedons and landscapes. Possibilities and problems of such links are discussed.