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Mineral-organische Wechselwirkungen: Bildung, Eigenschaften und Auswirkungen auf Stoffkreisläufe

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Titel
Structures and properties of bioorgano-clays

Abstract
Interactions between microbial matter and clays are a common interfacial phenomenon in soil and sediment environments. However, fundamental mechanisms governing the formation and interactions of clay minerals with microbial-derived organic substances are still poorly understood. Therefore, our central aim was to study the formation of bioorgano-clay composites and their specific material properties and compare these properties with those of well-studied organo-clays.
Pure organic cations (e.g., alkylammonium homologues) and complex microbial biomass (e.g., fungal biomass from Aphanocladium sp.) were used to prepare organo- and bioorgano-clays by varying the amount of clay (montmorillonite) and organic materials used. Interaction mechanisms between organic materials and clay and the resulting structure and physicochemical properties were explored by multiple experimental methods (e.g. IR spectroscopy, contact angle, zeta potential, X-ray photoelectron spectroscopy, transmission electron microscopy) in a combination with molecular modelling to determine the structure, composition, and properties of the prepared bioorgano-clays.
Depending on origin, type, and size of the organic material and the clay, two basic types of bioorgano-clays were found: (i) bioorgano-clays having their clay particles coated by bioorganic matter with only limited or no penetration into interlayer galleries and (ii) bioorgano-clays having bioorganic matter distributed in the interlayer galleries and/or on the external surfaces of clay particles. Both types show heterogeneous arrangements of the amended organic matter inducing differences in shape and size of organo-clay particles. Consequently, changes in pore volumes, stability, and elemental interface properties can be verified. Compared to organo-clays, bioorgano-clays provided e.g. a higher adsorption capacity for uranyl, suggesting that modification of clays by rather unspecific microbial compounds significantly enhanced the number of exchange sites. Bioorganic-clays, although being less specific in nature, might therefore be applied more broadly in situations where a high sorption capacity, e.g., for contaminants, is required.