# Distribution and degradation of CdSe/ZnS Quantum Dots transported in aged soil systems

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Soil is expected to act as a sink for the accumulation of engineered nanomateirals (ENMs) upon release in the ecosystem, but knowledge about their behaviour and fate is still largely unknown. In this context, recent studies stressed the need for experimental strategies employing aged/altered nanoparticle (NPs) in order to better represent the real conditions at which they will be present in the environmental. In this work we focused on the transport and transformation of organic coated CdSe/ZnS Quantum Dots NPs after 15 d ageing in soil column systems at environmentally relevant conditions. Several experiments were performed employing different mineral surfaces (quartz sand or ferryhidrite) and pore water composition (e.g. $Ca^{2+}$, organic matter).

In general, no QDs were recovered in the column leachates even after the elution of 20 pore volumes, i.e. total deposition of the original NPs occurred onto the porous media. Interestingly, batch experiments carried out at the same experimental conditions (e.g. ageing time, NPs concentration) displayed a lower QDs deposition, suggesting an enhanced NPs alteration/weathering in the column compared to the more static batch systems. Sections of the soil columns were obtained to investigate deposited QDs with the aid of ICP-MS, fluorescence emission, XAS and microscopy (SEM-EDX) techniques. The results highlighted a generally low mobility of both NPs and associated metals, which were accumulated (>65%) immediately at the beginning of the columns with decreasing concentrations detected along the soil profiles. Decreased transport in presence of iron minerals was associated to non-favourable deposition conditions whereas enhanced mobility/dispersion in presence of fulvic acids suggests the formation of a novel organic matter-coating onto the NPs surface. Eventually, loss of QDs fluorescence emission (>75%) at all the conditions tested indicated disruption of the pristine QDs core-shell structures, which was further confirmed by measurement of free Cd and Se in the column leachates and by identification of metals hotspots of accumulation onto the sand surface.