

Redox conditions and mobility of selenium in the presence of sulfur species

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Selenium is an important nutrient for crop growth. At elevated concentrations (>10 µg/L) selenium oxyanions become toxic. Both sulfur and selenium are used in fertilizer and it has been observed that if these applied to soils together, then the selenium bio-availability and solubility can decrease. The interaction between selenium oxyanion and sulfur species is therefore also relevant for selenium mobility in the environment. We investigated the effects of sulfur and sulfate on selenate and selenite bio-reduction by consortia of sulfur reducing bacteria under anaerobic conditions in batch experiments. Our results show that selenium bio-reduction to elemental selenium in the presence of sulfur species is accelerated as well as the formation of the more stable thermodynamic hexagonal phase, that is less soluble and thus less bioavailable. With sulfur or sulfate present, selenite reacted with bio-generated sulfide to form a solid selenium sulfide. The sulfur in SeS₂ can be reduced again to sulfide leaving behind black hexagonal Se. Furthermore, the SeS₂ also can spontaneously separate into hexagonal Se and S. Without sulfur species, an amorphous phase is more dominant and the rounded particles form larger Se crystals slowly by an aggregated growth mechanism only under favorable (pH~7.5) conditions at ambient temperature and pressure. Assuming soil mineralogy does not interfere with this interaction, the different crystallization pathways may explain the observed decreased selenium bio-availability for crops when sulfur is applied simultaneously.