The effect of lipopolysaccharides on the aggregation of haematite nanoparticles

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The binding of organic molecules to mineral nanoparticles is the initial stage in the aggregation process that results in soil formation.

Owing to the ubiquitous nature of lipopolysaccharides (LPS) in the cell wall of soil bacteria; its role in bacterial adhesion to mineral surfaces and the abundance of haematite within soil environments, we have used LPS and haematite nanoparticles as a model with which to investigate this system.

We aim to elucidate and quantify the binding of organic material to mineral surfaces by studying the interactions between LPS and the surface of haematite nanoparticles, in order to monitor the initial stages of biomineralisation within soil-bacteria systems.

We have shown that LPS binds to the surface of haematite nanoparticles using batch sorption experiments. The process is homogeneous and favourable at pH 4 and 7 whilst seeming to be impaired at pH 9. This indicates that the binding is strongly influenced by the surface charge of haematite. The binding of calcium to the Lipid A region of LPS causes complexation and collapse of the polymer chain. This results in increased availability of the O-antigen for binding to haematite, as evident from IR and XPS.

By utilising microscopies such as STEM/HAADF and HR-TEM, we have shown that LPS binds to haematite nanoparticles and this process is affected by the presence of other ions. The aggregation process is dominated by kinetics and favoured by charge interactions, as indicated by previous results.

These results provide insight into how molecules of bacterial origin control the subsequent aggregation of mineral particles to form larger aggregates.