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The influence of environmental complexity on nanoparticle behavior, bioavailability, and toxicity

As our understanding of laboratory toxicity associated with nanoparticles improves, there is a need to push more towards environmentally relevant exposure conditions. Environmental complexity has a profound influence on nanoparticle stability and behavior, and ultimately environmental fate, transport, and transformations. It is now critical to begin to piece together the importance of environmental complexity, including salinity, organic matter, pH, UV, biological interactions, and many others, on nanoparticle transformations, and how those changes subsequently alter bioavailability, biodistribution, and ultimately toxicity. Elucidating the mechanisms that control nanoparticle uptake and biodistribution will dramatically improve the accuracy of environmental risk analyses.

We have conducted experiments that build from controlled single-species laboratory studies to microcosm experiments and even long-term mesocosm experiments. This approach of incrementally increasing complexity allows hypotheses developed in laboratory studies to be tested under environmentally relevant conditions. Additionally, unexpected responses in mesocosm experiments have been examined through a strategy of gradually reducing environmental complexity to test specific hypotheses. Our results suggest that this bi-directional approach provides an accelerated feedback loop, and an appropriate balance between mechanistic understanding and environmental relevance.