Analysis of Natural and Engineered Nanoparticles: A Way Forward

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The last decade has seen a tremendous increase in research efforts to develop and apply sophisticated analytical techniques with the aim of investigating the environmental behavior of engineered nanoparticles (ENPs). Many of these studies were triggered by both the possible applications of these new materials, as well as the implications of these novel products as potentially hazardous particulate pollutants. Recent advances in ENP analysis are now creating new emerging opportunities to elucidate and understand the role and functions of natural colloids (NCs, 1-1000 nm in diameter) and natural nanoparticles (NNPs, 1-100 nm in diameter) in environmental processes from pollutant transport to influences on climate change: their formation, transformation and transport at scales previously inaccessible. NCs and NNPs, are ubiquitous and represent a major fraction of the most important reactive surface area on the planet. They are important nutrients (e.g. iron bearing colloids exported from the continent to the oceans with impact on climate change), scavengers (e.g. arsenic binding in mine effluents), and transport vectors of pollutants (radionuclides, trace metals and organic pollutants). Although the new methods are still in their infancy (particularly single particle inductively coupled plasma-time-of-flightmass spectrometry (spICP-TOFMS)), and have only recently been applied for the first time ever on natural samples they provide groundbreaking capacity to unravel processes with relevance to the planet.

One of the major limitations to overcome in the last decade has been the lack of sensitive analytical techniques and instrumentation capable of detecting and characterizing these materials in complex natural matrices at sufficiently low detection levels (ng L-1). To overcome this limitation, recent progress has been made utilizing ICP-TOFMS in single particle mode, which permits the analysis of nearly the whole elemental spectrum (7-250 a.m.u.). SpICP-TOFMS has the potential to deliver the required detection limits and the particle-specific element/isotopic spectra required to analyze NPs and their trace element associations on a single particle level. Recent studies have demonstrated the capability of using this technique for differentiating engineered and naturally occurring nanoparticles by examining elemental ratios specific to these particle populations.

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