Low-level arsenic contamination of groundwater with biomarker monitoring in Union County, NC

R.B. MEROLA AND A. VENGOSH*

Earth and Ocean Sciences, Duke University, Durham, NC 27705 (*correspondence: vengosh@duke.edu)

Approximately 43 million people in the US consume drinking water from private wells that are exempted from the Safe Drinking Water Act and thus are unregulated. In several aquifer systems throughout the US, the levels of naturally occurring arsenic exceed the EPA-Maximum Contaminant Level (MCL), which poses health risks for homeowners that consume water directly from their own private wells. As concentrations in drinking water over 100 μg/L are known to cause visible health effects, whereas in lower concentrations the effects are more insidious because of the long latency period between exposure and disease occurrence. This makes correlation between low levels of As exposure to actual disease effects difficult.

This study is focused on two objectives: (1) investigate the occurrence of As in groundwater fracture aquifers of the Carolina Belt, North Carolina; and (2) use As in human nails as a biomarker of exposure. The data show that the distribution of As in the Carolina Belt groundwater is directly associated with the aquifer lithology, as higher concentrations are found in meta-volcanic rocks. Chemical data of seventy private wells show large variations in As concentrations, up to 130 μg/L. In about 20% of the wells, As occurs as As $^{(III)}$ species, while As $^{(V)}$ is the predominate species in the others. In order to evaluate the potential exposure to low levels of As we measured As in human nails as a biomarker of exposure. Data from sixty well water-nail pairs reveals a statistically significant correlation, with males and children being most sensitive to As accumulation in the nail. This suggests that this method can be used in assessing the effect of low-level exposure on human populations prior to disease occurrence.

The size related toxicity of cerium oxide nanoparticles

R.C. MERRIFIELD*, P. COLE AND J.R. LEAD

GEES, The University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK (r.c.merrifield@bham.ac.uk)

Nano-enabled products are being produced more oftern and appearing in the environment, but these products pose poorly characterised risks to ecosystems. Nanoparticles can be made from an enormous variety of materials and there are many unresolved issues concerning their biological effects. Cerium oxide nanoparticles (NPs) have been shown to increase the efficiency of diesel engines, therefore these particles could quite easily enter the environment via the air and subsequently deposit on surface waters.

Here we report an investigation of ceria NP effects on freshwater algae. Both in house synthesised PVP-stabilised cerium oxide nanoparticles of sizes 5, 7, 10, and 35nm and commercially available NPs were used and fully characterised. Exposure was performed on an environmentally relevant aquatic freashwater algae species *Pseudokirchneriella subcapitata* Using standard OECD procedures

By means of a multi-method characterisation protocol, we show that commercially available powders have a large size distribution when dispersed in algae media and have a range in size from a few to several hundred nanometers and a tedndency to aggregate. Our synthesised cerium oxide nanoparticles of sizes 5, 7, 10, and 35nm exhibit very narrow size distributions and are highly stable, even at high ionic strnegths. The fresh water algae (Pseudokirchneriella subcapitata) demonstrated consistent size-dependent mass based EC_{50} values, with most toxicity exhibited at small sizes. Atomic force microscopy (AFM) imaging suggests that NP exposure to the commercial ceria result sin agglomeration and coating of the algal surface but with little effect on growth. Exposure to the smaller, more monodisperse and stables NPs showed significant morphological changes (Figure 1). Mechanisms of toxicity are currently being elucidated by unbiased molecular (omic) methods.

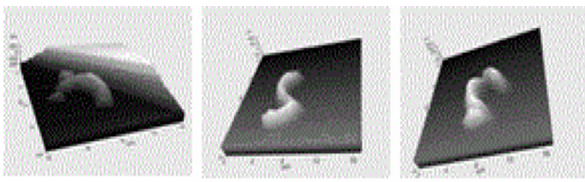

Figure 1: Tapping mode AFM images of algae cell (left) and algae exposed to 5nm ceria nanoparticles (center and right)